



SYLLABUS

FOR

4 YEAR B.TECH (MARINE ENGINEERING)

INDIAN MARITIME UNIVERSITY

(A Central University, Govt. of India)

2024

(With effect from Academic Year 2024-25 onwards)

The Curriculum for the Four Year “B.Tech (Marine Engineering)” includes the requirements of STCW Convention, as amended, of IMO Model Course 7.02 & 7.04 and that of the Directorate General of Shipping, Government of India for competencies required for “Officer Incharge of an Engineering watch”.

Syllabus Revision Committee 2024

B. Tech (Marine Engineering) Syllabus R-2024 has been revised in June 2024. In this regard, a Syllabus Revision Committee was constituted with following members:

1. Dr.K. Sivasami, HoD, School of Marine Engineering and Technology – Chairman
2. Prof. Sumitra Neogi, Professor of Practice (SMET), IMU Kolkata Campus – Member
3. Shri. David Blaise D’Sylva, DGM (Trg), Fleet Management Training Institute – Member from School Board
4. Dr. K. Thiyagarajah, Former Faculty NIT Surathkal – Member (External expert from Academic)
5. Shri Md. Shaji, HoD (I/c) & Associate Professor, IMU Mumbai Port Campus – Member
6. Dr. Deepak Mishra, Assistant Professor, IMU Kolkata Campus – Member
7. Dr. S. Kanungo, Principal, Tolani Maritime Institute – Member (Expert from Affiliated Institutes)
8. Capt. Saurabh Varshney, Principal, International Maritime Institute, Greater Noida – Member (Expert from Affiliated Institutes)
9. Shri. Abhishek Kumar, Technical Manager, Synergy Maritime, Chennai – Member from Industry
10. Shri. Shailendra Kumar, Vice Principal (Marine Engineering), TMI – Special Invitee
11. Shri. Uday Bhandoola, Marine Faculty, IMI – Special Invitee
12. Dr.Y.V.V.S. N Murthy, Associate Professor (SMET), IMU Chennai Campus – Convenor

Acknowledgement

The Syllabus Revision Committee whole heartedly thanking

The Honorable Vice-Chancellor of IMU

Pro Vice-Chancellor of IMU

Controller of Examinations of IMU

School Board Members of SMET

Industry Experts-FML, Synergy, IMEI

Faculty of IMU Campuses (Chennai, Kolkata & Mumbai Port)

TMI, IMI, HIMT & Other Affiliated Colleges

The Committee wishes to acknowledge the inputs from various stakeholders and all others who had been supportive for these efforts.

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MMU

Mapping of Programme Education Outcomes [PEO] to Programme Learning Outcomes [PLO]

Programme Learning Outcomes [PLO]		Achievement of PEO		
		Three to five years after graduation, the graduate would be:		
At the end of the programme, graduates should be able to:		A Maritime professional who partakes and leads teams in problem solving tasks through analytical thinking and effective communication	A Maritime professional who continues to advance the knowledge and competencies to explore future developments in the maritime and related industries	A Maritime professional who practices ethical and professional values in providing services to the recipients and providers of the maritime industry and society at large
		PEO 1	PEO 2	PEO 3
PLO 1	[APPLY ENGINEERING KNOWLEDGE] Apply knowledge of mathematics, science, engineering fundamentals and engineering specialisation principles to defined and applied engineering procedures, processes, systems or methodologies [C, P]	H		
PLO 2	[BE COMPETENT] Understand and solve marine engineering problems systematically to reach substantiated results, using tools and techniques in a competent manner [C, P]	H		
PLO 3	[DESIGN SOLUTIONS] Design solutions for broadly-Defined engineering technology problems, and to design systems, components or processes to meet specified needs with appropriate consideration for public health and safety, as well as cultural, societal, environmental and sustainability concerns [C]	M		
PLO 4	[DO BASIC RESEARCH] Plan and conduct experimental investigations of broadly-defined problems, using data from relevant sources [C, P]		L	
PLO 5	[USE MODERN TOOLS] Select and apply appropriate techniques, resources and modern engineering tools for problem solving with an understanding of their limitations [C, P]		M	
PLO 6	[LEAD] Function effectively as individuals, and as members or leaders in diverse technical teams [P, A]		M	
PLO 7	[COMMUNICATE] Communicate effectively with the engineering community and society at large [P]	M		
PLO 8	[CARE FOR HEALTH, SAFETY, SOCIETY] Demonstrate an awareness of and consideration for societal, health, safety, legal and cultural issues and their consequent responsibilities [A, P]			H
PLO 9	[BE ETHICAL] Demonstrate an understanding of professional ethics, responsibilities and norms of engineering technology practices [A]	H		
PLO 10	[BE AN ENTREPRENEUR] Demonstrate an awareness of management, business practices and entrepreneurship [C, P]			M
PLO 11	[UNDERSATND SUSTAINABILITY] Demonstrate an understanding of the impact of engineering practices, taking into account the need for sustainable development [C, P]		M	
PLO 12	[PURSUE LIFELONG LEARNING] Recognise the need for professional development and to engage in independent and lifelong learning [C]			H

Domains: [C] Cognitive; [P] Psychomotor; [A] Affective **Impact:** H High; M Medium; L Low

INDIAN MARITIME UNIVERSITY

COURSE CURRICULUM FOR 4 YEAR BACHELOR OF TECHNOLOGY (MARINE ENGINEERING)

SEMESTER – I

S.No.	Course Title	Code	Course Code	Lecture	Tutorial	Practical	Total Hours	Credits
	Theory							
1	English and Communication	101	UG11T5101	45			45	3
2	Engineering Mathematics I	102	UG11T5102	45	15		60	4
3	Engineering Chemistry	103	UG11T5103	45			45	3
4	Workshop Technology	104	UG11T5104	45			45	3
5	Basic Electrical Technology	105	UG11T5105	45	15		60	4
6	Basic Electronics	106	UG11T5106	45			45	3
7	Induction Programme	107		15			15	0
	Practical Laboratories/Workshops							
1	Geometrical Drawing Skills	108	UG11P5101			45	45	1.5
2	Engineering Workshop Training	109	UG11P5102			45	45	1.5
3	Basic Electrical Technology Lab	110	UG11P5103			45	45	1.5
4	Basic Electronics Lab	111	UG11P5104			45	45	1.5
				285	30	180	495	26

SEMESTER – II

S.No.	Course Title	Code	Course Code	Lecture	Tutorial	Practical	Total Hours	Credits
	Theory							
1	Engineering Mathematics II	201	UG11T5201	45	15		60	4
2	Introduction to Computers & Python Programming	202	UG11T5202	45	15		60	4
3	Thermodynamics	203	UG11T5203	45	15		60	4
4	Engineering Mechanics	204	UG11T5204	45	15		60	4
5	Maritime Awareness	205	UG11T5205	45			45	3
6	Indian Tradition Knowledge and its Maritime Linkage	206	UG11T5206	15			15	0
7	Constitution of India and Merchant Shipping Act	207	UG11T5207	15			15	0
	Practical Laboratories/Workshops							
1	Engineering Machine Shop Practice	208	UG11P5201			45	45	1.5
2	English Communication Lab	209	UG11P5202			45	45	1.5
3	Marine Drawing Skills	210	UG11P5203			45	45	1.5
4	Mechanics & Thermal Engineering Lab	211	UG11P5204			45	45	1.5
				255	60	180	495	25

SEMESTER – III

S.No.	Course Title	Code	Course Code	Lecture	Tutorial	Practical	Total Hours	Credits
	Theory							
1	Fluid Mechanics and Hydraulic Machinery	301	UG11T5301	45	15		60	4
2	Solid Mechanics	302	UG11T5302	45	15		60	4
3	Electrical Machines	303	UG11T5303	45	15		60	4
4	Engineering Materials	304	UG11T5304	45			45	3
5	Marine Boilers	305	UG11T5305	45	15		60	4
6	Marine Environment Pollution and Protection	306	UG11T5306	45			45	3
	Practical Laboratories/Workshops							
1	Computer and Python Lab	307	UG11P5301			45	45	1.5
2	Fluid Mechanics and Hydraulics Lab	308	UG11P5302			45	45	1.5
3	Material Testing and Applied Mechanics Lab	309	UG11P5303			45	45	1.5
4	Electrical Machines Lab	310	UG11P5304			45	45	1.5
				270	60	180	510	28

SEMESTER – IV

S.No.	Course Title	Code	Course Code	Lecture	Tutorial	Practical	Total Hours	Credits
	Theory							
1	Marine Diesel Engine Components and Functions	401	UG11T5401	45	15		60	4
2	Marine Auxiliary Systems	402	UG11T5402	45	15		60	4
3	Shipboard Power Generation and Distribution	403	UG11T5403	45	15		60	4
4	Ship Structure and Construction	404	UG11T5404	45	15		60	4
5	Control Engineering and Marine Automation	405	UG11T5405	45	15		60	4
6	Mechanics of Machines	406	UG11T5406	45	15		60	4
7	Marine Refrigeration and Air Conditioning	407	UG11T5407	45	15		60	4
	Practical Laboratories/Workshops							
1	Marine Diesel Engines Lab	408	UG11P5401			45	45	1.5
2	Control Engineering and Automation Lab	409	UG11P5402			45	45	1.5
				315	105	90	510	31

SEMESTER – V

S.No.	Course Title	Code	Course Code	Lecture	Tutorial	Practical	Total Hours	Credits
	Theory							
1	Marine Diesel Engines Operation & Manoeuvring	501	UG11T5501	45	15		60	4
2	Marine Turbo Machinery	502	UG11T5502	45	15		60	4
3	Marine Steam Engineering	503	UG11T5503	45	15		60	4
4	Naval Architecture - Hydrostatics and Ship Stability	504	UG11T5504	45	15		60	4
5	Fuels and Lubricants	505	UG11T5505	45	15		60	4
6	Digital Electronics and PLC	506	UG11T5506	45	15		60	4
	Practical Laboratories/Workshops							
1	Marine Auxiliary Machinery Lab	507	UG11P5501			45	45	1.5
2	Marine Steam Engineering Lab	508	UG11P5502			45	45	1.5
3	Digital Electronics and PLC Lab	509	UG11P5503			45	45	1.5
4	Seamanship and Safe Work Practices	510	UG11P5504			45	45	1.5
				270	90	180	540	30

SEMESTER – VI

S.No.	Course Title	Code	Course Code	Lecture	Tutorial	Practical	Total Hours	Credits
	Theory							
1	Marine Information Technology	601	UG11T5601	45			45	3
2	Shipboard Safety Practices	602	UG11T5602	45	15		60	4
3	Naval Architecture - Ship Resistance and Propeller	603	UG11T5603	45	15		60	4
4	Marine Auxiliary and Deck Machinery	604	UG11T5604	45	15		60	4
5	Marine Components and Systems Design	605	UG11T5605	45	15		60	4
6	Marine Instrumentation Engineering	606	UG11T5606	45	15		60	4
7	Shipboard Electrical Equipment and Protection Devices	607	UG11T5607	45	15		60	4
	Practical Laboratories/Workshops							
1	Marine Engine Simulator	608	UG11P5601			45	45	1.5
2	Marine Electro Technology Lab	609	UG11P5602			45	45	1.5
				315	90	90	495	30

SEMESTER – VII

S.No.	Course Title	Code	Course Code	Lecture	Tutorial	Practical	Total Hours	Credits
	Theory							
1	Marine Diesel Engines – Modern Trends and Maintenance	701	UG11T5701	45	15		60	4
2	Ship Operations and Management	702	UG11T5702	45	15		60	4
3	Marine Conventions and Maritime Law	703	UG11T5703	45	15		60	4
4	Sustainable Development Goals	704	UG11T5704	45			45	3
5	Elective – 1	705	UG11E5701-7	45			45	3
6	Elective – 2	705	UG11E5708-14	45			45	3
	Practical Laboratories/Workshops							
1	Technical Paper Writing and Engineering Models	706	UG11P5701			45	45	1.0
2	Hydraulics and Pneumatics Lab	707	UG11P5702			45	45	1.5
3	Shipboard Safety and Appliances Lab	708	UG11P5703			45	45	1.5
				270	45	135	450	25

SEMESTER – VIII

S.No.	Course Title	Code	Course Code	Lecture	Tutorial	Practical	Total Hours	Credits
	Eighth Semester							
1	Practical Training With Assignments (With TAR Book *)	801	UG11P5801			990	990	12
2	Project Work	802	UG11P5802					3
						990	990	15
	Totals			1980	480	2025	4485	210
	Total L+T (Hours)			2460				
	Total L+T+P (Hours)						4485	

*TAR Book: The Training and Assessment Record (TAR) Book refers to the MTI's Practical Training (e.g., Ship-in-Campus; Afloat; Approved Marine Workshops etc.)

SEMESTER 1

Subject Name/Code: English and Communication/UG11T5101

Instructional hours:

Lecture	: 45 hours
Total contact hours	: 45 hours
Credits	: 3

Teaching Methods

The course shall be conducted in a combination of classroom lectures, case study analysis, writing assignments and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments)	: 30%
Final Exam	: 70%

Text book:

1. M Ashraf Rizvi. Effective Technical Communication. 2nded.McGrawHill.
2. Sanjay Kumar and Pushp Lata. English for Effective Communication. Oxford University Press.

Reference:

1. English and Human Factors (IMU/BNA-017). Chennai: Indian Maritime University.
2. Furber, Holdenetal. Maritime India. Oxford University Press.
3. M. Swan, Practical English usage, 4th ed. NewYork: Oxford University Press.
4. Raman, Meenakshi, and Sangeeta Sharma. Fundamentals of Technical Communication. Oxford University Press.

Table of Topics

Unit	Topic	Hour (L)
I	Fundamentals of Communication Subtopics: Communication: Concept, Process, Levels, Flow, Styles, Verbal and Non-verbal Communication, General and Technical Communication, Effective Communication, and Barriers to Communication	9
II	Grammar and its usage on board Subtopics: Types of sentences, Conditionals, Modal verbs, Prepositions, Subject-verb agreement, Tense, Voice, Articles, Determiners, Imperatives, Common errors in English	8
III	Listening skills: Subtopics: Listening: Concept, Process and types of listening Listening vs Hearing, Barriers to effective listening	4
IV	Reading Skills Subtopics: Reading Process, reading different kinds of text, (User's Manual, Manufacturer's Manual, Engineering Publication's) Reading Speed, Reading types	6
V	Writing Skills Subtopics: Writing Process, Letter/ Email Writing, Resume Writing, Report Writing, Meeting related communication, Paragraph or Essay Writing on maritime related topics, Job Requirements, Functions and Responsibilities onboard	18
	Total	45

Learning Objectives		L
I - Fundamentals of Communication		
General Learning Objective: Understand various aspects of communication process Subtopics & SLOs: 1.1 Communication: Concept, Process, Levels, Flow, and Styles 1.2 Verbal and Non-verbal Communication 1.3 Technical Communication, Effective Communication, and Barriers to communication		
Specific Learning Objectives: 1. 1 Communication: Concept, Process, Levels, Flow, and Styles 1.1.1 Define the concept of communication 1.1.2 Explain the process of communication with a diagram 1.1.3 Draw a diagram of the communication process 1.1.4 Explain the levels of communication-i.e., Extra-personal, Intrapersonal, Interpersonal, and Organizational communication 1.1.5 Describe and compare different communication styles, i.e., Passive, Aggressive, Passive-aggressive, and Assertive 1.1.6 Draw the diagrams of the flow of Communication-Downward, Upward, Horizontal, and Diagonal Communication 1.1.7 Outline the main features of different flows of communication		3

<p>Specific Learning Objectives: 1.2 Verbal and Non-verbal Communication 1.2.1 Describe and Compare Verbal and Non-verbal Communication 1.2.2 Explain the following terms: Para linguistics, Proxemics and Chronemics 1.2.3 List the features of non-verbal communication</p>	3
<p>Specific Learning Objectives: 1.3 Technical Communication, Effective Communication and Barriers to communication 1.3.1 Compare General and Technical Communication 1.3.2 Outline the main features of technical communication 1.3.3 Explain the importance of visual aids in technical communication 1.3.4 List the factors that would help you decide whether communication has succeeded or failed 1.3.5 Classify and explain communication barriers under the following categories: Linguistic, Psychological, Cultural, Physical, and Organizational Barriers 1.3.6 Match the situations with the categories of communication barriers 1.3.7 Describe the ways to overcome communication barriers</p>	3
II - Grammar and its usage onboard	
<p>General Learning Objective: Use the English Language effectively in spoken and written forms</p> <p>Sub topics & SLOs: 2.1 Types of sentences, Conditionals, Modal verbs, Prepositions, Subject Verb Agreement, Active/Passive voice, Determiners, Imperatives, Common errors in English</p>	
<p>Specific Learning Objectives: 2.2 Types of sentences, Conditionals, Modal verbs, Prepositions, Subject verb agreement, Tense, Voice, Articles, Common errors in English 2.2.1 Ask for and give personal data using correct sentence structures 2.2.2 Find the error(s) in the sentence/paragraph 2.2.3 Underline the error(s) in the sentence/paragraph and rewrite 2.2.4 Transform the sentence (tense, voice, Subject verb-agreement)</p>	8
III - Listening Skills	
<p>General Learning Objective: Understand listening skills, comprehend a verbal message and respond appropriately</p> <p>Subtopics & SLOs: 3.1 Listening: Concept, Process, importance, and types 3.2 Listening vs Hearing, Barriers to effective listening</p>	
<p>Specific Learning Objectives: 3.1 Listening: Concept, Process, importance, and types 3.1.1 Define and explain the concept and process of listening 3.1.2 Discuss the importance of listening 3.1.3 Match the types of listening with given situations 3.1.4 Name and explain types of listening- Empathetic, Appreciative, Evaluative, Comprehensive/attentive listening</p>	2
<p>Specific Learning Objectives: 3.2 Listening vs Hearing, Barriers to effective listening 3.2.1 Compare listening and hearing 3.2.2 List the factors that would help you decide whether listening has succeeded or failed 3.2.3 Explain barriers to effective listening 3.2.4 Describe the ways to overcome listening barriers</p>	2

IV - Reading Skills		
<p>General Learning Objective: Comprehend a written document and respond appropriately</p> <p>Subtopics & SLOs: 4.1 Reading: Process, reading different kinds of texts (User Manuals, Manufacturer's Manuals, Engineering Publications), Reading speed 4.2 Reading types (clarify with activities): Prediction, Scanning, Skimming, and Intensive Reading</p>		
<p>Specific Learning Objectives: 4.1 Reading: Process, reading different kinds of texts, Reading speed 4.1.1 Define the concept of reading 4.1.2 Explain the process of reading 4.1.3 Describe different kinds of texts. (User Manuals, Manufacturer's Manuals, Engineering Publications) 4.1.4 Explain the importance of reading speed</p>		2
<p>Specific Learning Objectives: 4.2 Reading types (clarify with activities): Prediction, Scanning, Skimming, and Intensive reading 4.2.1 Describe different types of reading 4.2.2 Match the types of reading with the situations 4.2.3 Read the passages and answer the questions- for example – related to dealing with emergency situations on board by receiving or sending commands, processing cargo, safety, and passenger information 4.2.4 Reading different kinds of texts (User Manuals, Manufacturer's Manuals, Engineering Publications)</p>		4
V - Writing Skills		
<p>General Learning Objective: Understand various components of business writing skills</p> <p>Subtopics & SLOs: 5.1 Writing Process 5.2 Letter/Email Writing 5.3 Résumé writing 5.4 Report Writing (Factual Report, Routine Report), Meeting related communication 5.5 Paragraph/Essay writing 5.6 Job Requirements, Functions and responsibilities on board</p>		
<p>Specific Learning Objectives: 5.1 Writing Process 5.1.1 Describe ABC (Accuracy, Brevity and Clarity) of writing skills. 5.1.2 Identify, organize and list the points/ideas related to a given topic in a logical Sequence</p>		2
<p>Specific Learning Objectives: 5.2 Letter/Email Writing 5.2.1 Explain the 7 C's of letter writing 5.2.2 Describe different parts of a formal letter/email 5.2.3 List the steps to write a letter 5.2.4 Compare letter writing layouts/styles- Full Block, Modified Block, and Semi Block 5.2.5 Write a letter/email – asking for information, giving information, making arrangements, giving recommendations, etc.</p>		3
<p>Specific Learning Objectives: 5.3 Résumé writing</p>		

<p>5.3.1 Outline the objectives of writing a cover letter</p> <p>5.3.2 Explain the structure (various parts) of a résumé</p> <p>5.3.3 Prepare a cover letter and a résumé</p>	2
<p>Specific Learning Objectives:</p> <p>5.4 Report Writing (Factual Report, Routine Report), Meeting related communication</p> <p>5.4.1 Discuss the structure of a report. (Factual Report / Routine Report)</p> <p>5.4.2 Prepare a factual/routine report on the given topic/situation</p> <p>5.4.3 Write a report (Incident Report, Accident Report, and Visit Report) on the given incident</p> <p>5.4.4 Prepare notice, agenda and minutes of a meeting</p>	3
<p>Specific Learning Objectives:</p> <p>5.5 Paragraph/ Essay Writing:</p> <p>5.5.1 Explain how to draft a paragraph?</p> <p>5.5.2 Write a paragraph/an essay related to the following topics for example –</p> <p>a) Indian Maritime History: Pre-independence and post-independence</p> <p>b) Significance of National Maritime Day of India</p> <p>c) The Sagarmala Project</p> <p>d) Ports of India</p> <p>e) Role of shipping on national economic development</p> <p>f) Maritime Training in India</p>	2
<p>Specific Learning Objectives:</p> <p>5.6 Job Requirements, Functions and responsibilities on board</p> <p>5.6.1 Describe the nature of the job at sea</p> <p>5.6.2 Explain demands of the career – technical, practical, physical, emotional and psychological</p> <p>5.6.3 List Personal traits that will assist in effective functioning on board</p> <p>5.6.4 Why it is important to maintain personal hygiene</p> <p>5.6.5 Explain the importance of Physical fitness, health and personal hygiene on board</p> <p>5.6.6 Write a note on the travel arrangements for joining a ship</p> <p>5.6.7 Sketch shipboard organizational chart</p>	6

Subject Name/Code: Engineering Mathematics I/UG11T5102

Instructional hours:

Lecture	: 45 hours
Tutorial	: 15 hours
Total contact hours	: 60 hours
Credits	: 4

Teaching Methods

The course shall be conducted in a combination of classroom lectures, case study analysis, writing assignments and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments)	: 30%
Final Exam	: 70%

Text book:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers.
2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, Latest edition.

Reference:

1. Ordinary and Partial Differential Equations by Dr M.D. Raisinghania
2. Dennis G. Zill and Warren S. Wright, Advanced Engineering Mathematics, Fourth Edition, Jones & Bartlett.
3. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint.
4. Veerarajan T., Engineering Mathematics for first year, Tata McGraw Hill, New Delhi.
5. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi.
6. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint.

Table of Topics

Unit	Topic	Hour (L)
I	Matrices Types of Matrices: Symmetric, Skew-symmetric and Orthogonal Matrices; Complex Matrices, Inverse and Rank of matrix using elementary transformations, Rank-Nullity theorem; System of linear equations, Characteristic equation, Cayley-Hamilton Theorem and its application, Eigen values and eigenvectors; Diagonalization of a Matrix	14
II	Differential Calculus Introduction to limits, continuity and differentiability, Rolle's Theorem, Lagrange's Mean value theorem and Cauchy mean value theorem, Successive Differentiation (nth order derivatives), Curve tracing: Cartesian and Polar co-ordinates, Define differential equation, formation of differential equation, linear differential equation (LDE), solution of differential equation using variable separable method, integration factor, exact differential equation, Leibnitz linear equation, Partial derivatives, Total derivative	14
III	Differential Calculus Euler's Theorem for homogeneous functions, operator D, auxiliary equation (AE), complementary function, particular integral (PI), rules of finding the complementary function (CF) of the given LDE based on the nature of roots of AE, explain rules for finding PI of LDE, Taylor and Maclaurin's theorems for a function of one and two variables, Maxima and Minima of functions of several variables, Lagrange Method of Multipliers, Jacobians, Approximation of errors	14
IV	Multivariable Calculus Double and triple integrals, change of order of integration, Change of variables, Application of integration to lengths, Volumes and Surface areas – Cartesian and Polar coordinates, Dirichlet's integral and applications.	9
V	Vector Calculus Point function, Gradient, Divergence and Curl and their physical interpretations, Vector identities, Directional derivatives. Line, Surface and Volume integrals, Applications of Green's, Stoke's and Gauss divergence theorems (without proofs)	9
Total		60

Learning Objectives		L
General Learning Objective: To develop a comprehensive understanding of different types of matrices, their properties, and applications in solving systems of linear equations, as well as mastering key matrix theorems and concepts such as eigenvalues, eigenvectors, and diagonalization.		
I. Matrices		14
Specific Learning Objectives: 1.1 Types of Matrices: 1.1.1 Symmetric and Skew-symmetric Matrices: 1.1.2 Identify and define symmetric and skew-symmetric matrices. 1.1.3 Prove properties of symmetric and skew-symmetric matrices. 1.1.4 Apply properties to solve problems involving these types of matrices. 1.1.5 Orthogonal Matrices: 1.1.6 Define orthogonal matrices. 1.1.7 Demonstrate understanding by verifying orthogonality of given matrices. 1.1.8 Apply orthogonal matrices to solve related problems. 1.1.9 Complex Matrices: 1.1.10 Define and explain complex matrices. 1.1.11 Perform basic operations involving complex matrices. 1.1.12 Analyze and solve problems involving complex matrices.		3

<p>1.2 Matrix Operations:</p> <p>1.2.1 Inverse and Rank of a Matrix using Elementary Transformations:</p> <p>1.1.2 Calculate the inverse of a matrix using elementary row and column transformations.</p> <p>1.2.3 Determine the rank of a matrix using elementary transformations.</p> <p>1.2.4 Solve problems that require finding the inverse or rank of matrices.</p> <p>1.2.5 Rank-Nullity Theorem:</p> <p>1.2.6 State and explain the rank-nullity theorem.</p> <p>1.2.7 Apply the rank-nullity theorem to solve problems and proofs.</p>	3
<p>1.3 Systems of Linear Equations:</p> <p>1.3.1 Formulate systems of linear equations in matrix form.</p> <p>1.3.2 Solve systems of linear equations using various matrix methods (e.g., Gaussian elimination, matrix inversion).</p>	2
<p>1.4. Characteristic Equation and Cayley-Hamilton Theorem:</p> <p>1.4.1 Define the characteristic equation of a matrix.</p> <p>1.4.2 Use the characteristic equation to find eigenvalues and eigenvectors.</p> <p>1.4.3 State and prove the Cayley-Hamilton theorem.</p> <p>1.4.4 Apply the Cayley-Hamilton theorem to find powers of matrices and solve related problems.</p>	2
<p>1.5 Eigenvalues and Eigenvectors:</p> <p>1.5.1 Define eigenvalues and eigenvectors.</p> <p>1.5.2 Calculate eigenvalues and eigenvectors for given matrices.</p> <p>1.5.3 Apply properties of eigenvalues and eigenvectors to solve practical problems.</p>	2
<p>1.6 Diagonalization of a Matrix:</p> <p>1.6.1 Define and explain the process of diagonalization.</p> <p>1.6.2 Determine if a matrix is diagonalizable.</p> <p>1.6.3 Perform diagonalization of a matrix and solve related problems.</p> <p>1.6.4 Apply diagonalization to simplify matrix computations and solve related practical problems.</p>	2
<p>II. Differential Calculus</p>	14
<p>General Learning Objective:</p> <p>To develop a foundational understanding of differential calculus, focusing on limits, continuity, differentiability, and the application of key theorems. This module also introduces the basics of differential equations, their formation, and methods of solution, along with an introduction to partial and total derivatives.</p>	
<p>Specific Learning Objectives:</p> <p>2.1 Limits, Continuity, and Differentiability:</p> <p>2.1.1 Define and explain the concepts of limits and continuity.</p> <p>2.1.2 Determine the limits of functions at given points.</p> <p>2.1.3 Evaluate the continuity of functions at given points and over intervals.</p> <p>2.1.4 Understand and explain differentiability and its relationship with continuity.</p> <p>2.1.5 Determine the differentiability of functions and compute derivatives.</p>	2
<p>2.2 Key Theorems in Differential Calculus:</p> <p>2.2.1 Rolle's Theorem:</p> <p>2.2.2 State and prove Rolle's Theorem.</p> <p>2.2.3 Apply Rolle's Theorem to find points where the derivative of a function is zero.</p> <p>2.2.4 Lagrange's Mean Value Theorem (LMVT):</p> <p>2.2.5 State and prove Lagrange's Mean Value Theorem.</p> <p>2.2.6 Apply LMVT to find points where the derivative equals the average rate of change over an interval.</p> <p>2.2.7 Cauchy's Mean Value Theorem (CMVT):</p> <p>2.2.8 State and prove Cauchy's Mean Value Theorem.</p> <p>2.2.9 Apply CMVT to solve problems involving two functions and their derivatives.</p>	2

<p>2.3 Successive Differentiation (nth Order Derivatives):</p> <p>2.3.1 Define and compute higher-order derivatives of functions.</p> <p>2.3.2 Apply nth order derivatives to solve problems in calculus.</p> <p>2.3.3 Use higher-order derivatives in applications such as Taylor series expansion.</p>	2
<p>2.4 Curve Tracing:</p> <p>2.4.1 Cartesian Coordinates:</p> <p>2.4.2 Analyze and sketch curves defined by equations in Cartesian coordinates.</p> <p>2.4.3 Polar Coordinates:</p> <p>2.4.4 Analyze and sketch curves defined by equations in polar coordinates.</p> <p>2.4.5 Convert between Cartesian and polar coordinates for curve tracing.</p>	2
<p>2.5 Differential Equations:</p> <p>2.5.1 Define and explain what constitutes a differential equation.</p> <p>2.5.2 Formation of Differential Equations:</p> <p>2.5.3 Formulate differential equations from given functions or physical situations.</p> <p>2.5.4 Linear Differential Equations (LDE):</p> <p>2.5.5 Define linear differential equations and provide examples.</p> <p>2.5.6 Solve linear differential equations using various methods.</p> <p>2.5.7 Methods of Solution:</p> <p>2.5.8 Variable Separable Method:</p> <p>2.5.9 Solve differential equations by separating variables and integrating.</p> <p>2.5.10 Integration Factor:</p> <p>2.5.11 Understand and apply the integration factor method to solve linear differential equations.</p> <p>2.5.12 Exact Differential Equations:</p> <p>2.5.13 Define and solve exact differential equations.</p> <p>2.5.14 Apply techniques to determine if a differential equation is exact and find solutions accordingly.</p> <p>2.5.15 Leibnitz Linear Equation:</p> <p>2.5.16 State and solve Leibnitz linear differential equations.</p>	4
<p>2.6 Partial Derivatives and Total Derivative:</p> <p>2.6.1 Define and compute partial derivatives of multivariable functions.</p> <p>2.6.2 Understand and calculate total derivatives.</p> <p>2.6.3 Apply partial and total derivatives in solving problems involving functions of multiple variables.</p>	2
<p>III. Differential Calculus</p>	14
<p>General Learning Objective:</p> <p>To deepen the understanding of advanced topics in differential calculus, including Euler's theorem, linear differential equations, and the application of Taylor and Maclaurin series. This module also covers techniques for finding extrema of multivariable functions, Jacobians, and error approximation.</p>	
<p>Specific Learning Objectives:</p> <p>3.1 Euler's Theorem for Homogeneous Functions:</p> <p>3.1.1 Define homogeneous functions and identify their degree.</p> <p>3.1.2 State and prove Euler's Theorem for homogeneous functions.</p> <p>3.1.3 Apply Euler's Theorem to solve problems involving homogeneous functions.</p>	2
<p>3.2 Linear Differential Equations (LDE) with Operator D:</p> <p>3.2.1 Understand the operator D and its role in solving differential equations.</p> <p>3.2.2 Auxiliary Equation (AE):</p> <p>3.2.3 Formulate the auxiliary equation from a given linear differential equation.</p> <p>3.2.4 Solve the auxiliary equation to find roots.</p> <p>3.2.5 Complementary Function (CF):</p> <p>3.2.6 Define the complementary function.</p> <p>3.2.7 Determine the CF based on the nature of the roots of the AE (real and distinct, real and repeated, complex).</p> <p>3.2.8 Particular Integral (PI):</p>	4

<p>3.2.9 Define the particular integral.</p> <p>3.2.10 Apply rules for finding the PI of linear differential equations with different types of right-hand sides (polynomials, exponentials, trigonometric functions).</p> <p>3.2.11 Combine CF and PI to find the general solution of LDE.</p>	
<p>3.3 Taylor and Maclaurin Series:</p> <p>3.3.1 Taylor Series:</p> <p>3.3.2 State and prove Taylor's theorem for functions of one and two variables.</p> <p>3.3.3 Derive the Taylor series expansion of a function around a given point.</p> <p>3.3.4 Maclaurin Series:</p> <p>3.3.5 State and prove Maclaurin's theorem as a special case of Taylor's theorem.</p> <p>3.3.6 Derive the Maclaurin series expansion of a function around zero.</p> <p>3.3.7 Use Taylor and Maclaurin series to approximate functions and solve problems.</p>	2
<p>3.4 Maxima and Minima of Functions of Several Variables:</p> <p>3.4.1 Define critical points of multivariable functions.</p> <p>3.4.2 Use the second derivative test to classify critical points as maxima, minima, or saddle points.</p> <p>3.4.3 Solve optimization problems involving functions of several variables.</p>	2
<p>3.5 Lagrange Method of Multipliers:</p> <p>3.5.1 Explain the method of Lagrange multipliers for constrained optimization.</p> <p>3.5.2 Apply the method to find extrema of functions subject to constraints.</p> <p>3.5.3 Solve practical problems using Lagrange multipliers.</p>	2
<p>3.6 Jacobians:</p> <p>3.6.1 Define the Jacobian matrix and determinant for functions of several variables.</p> <p>3.6.2 Use Jacobians to change variables in multiple integrals.</p> <p>3.6.3 Apply Jacobians in solving problems involving transformations and coordinate changes.</p>	1
<p>3.7 Approximation of Errors:</p> <p>3.7.1 Understand the concept of error approximation in numerical calculations.</p> <p>3.7.2 Use Taylor series to approximate errors in function values.</p> <p>3.7.3 Apply error approximation techniques to practical problems.</p>	1
<p>IV. Multivariable Calculus</p>	9
<p>General Learning Objective:</p> <p>To develop proficiency in evaluating and applying double and triple integrals, including changing the order of integration and variables. The module also focuses on using integration techniques to solve problems related to lengths, volumes, and surface areas in both Cartesian and polar coordinates, along with understanding Dirichlet's integral and its applications.</p>	
<p>Specific Learning Objectives:</p> <p>4.1 Double and Triple Integrals:</p> <p>4.1.1 Define and set up double integrals over rectangular and general regions.</p> <p>4.1.2 Define and set up triple integrals over rectangular and general regions.</p> <p>4.1.3 Evaluate double and triple integrals in Cartesian coordinates.</p> <p>4.1.4 Apply double and triple integrals to compute volumes, surface areas, and other quantities.</p>	1
<p>4.2 Change of Order of Integration:</p> <p>4.2.1 Understand the concept of changing the order of integration in double integrals.</p> <p>4.2.2 Reorganize the limits of integration to change the order of integration.</p> <p>4.2.3 Solve double integrals by changing the order of integration to simplify computation.</p>	2
<p>4.3 Change of Variables:</p> <p>4.3.1 Understand the method of changing variables in double and triple integrals.</p>	2

<p>4.3.2 Use the Jacobian determinant to change variables in integrals.</p> <p>4.3.3 Solve integrals using polar, cylindrical, and spherical coordinates by changing variables.</p>	
<p>4.4 Applications of Integration:</p> <p>4.4.1 Lengths:</p> <p>4.4.2 Apply integration techniques to find the arc length of curves in Cartesian and polar coordinates.</p> <p>4.4.3 Volumes:</p> <p>4.4.4 Use double and triple integrals to compute volumes of solids in both Cartesian and polar coordinates.</p> <p>4.4.5 and polar coordinates.</p> <p>4.4.6 Surface Areas:</p> <p>4.4.7 Apply double integrals to find the surface area of surfaces in three-dimensional space.</p> <p>4.4.8 Solve problems involving the surface area of solids of revolution.</p>	2
<p>4.5 Dirichlet's Integral and Applications:</p> <p>4.5.1 Define Dirichlet's integral and understand its significance.</p> <p>4.5.2 Evaluate Dirichlet's integral in various contexts.</p> <p>4.5.3 Apply Dirichlet's integral to solve problems in mathematical physics and engineering.</p>	2
<p>V. Vector Calculus</p>	9
<p>General Learning Objective: To develop an understanding of vector calculus concepts, including gradient, divergence, curl, and their applications. This module also focuses on computing line, surface, and volume integrals, and applying fundamental theorems of vector calculus such as Green's, Stokes', and Gauss' divergence theorems.</p>	
<p>Specific Learning Objectives:</p> <p>5.1 Point Function and Vector Fields:</p> <p>5.1.1 Define and explain point functions and vector fields.</p> <p>5.1.2 Understand scalar and vector fields and their representations.</p>	1
<p>5.2 Gradient, Divergence, and Curl:</p> <p>5.2.1 Gradient:</p> <p>5.2.2 Define the gradient of a scalar function.</p> <p>5.2.3 Compute the gradient and understand its physical interpretation as the rate of change in space.</p> <p>5.2.4 Divergence:</p> <p>5.2.5 Define the divergence of a vector field.</p> <p>5.2.6 Compute the divergence and understand its physical interpretation related to sources and sinks.</p> <p>5.2.7 Curl:</p> <p>5.2.8 Define the curl of a vector field.</p> <p>5.2.9 Compute the curl and understand its physical interpretation related to rotation and circulation.</p>	2
<p>5.3. Vector Identities and Directional Derivatives:</p> <p>5.3.1 Prove and use vector identities involving gradient, divergence, and curl.</p> <p>5.3.2 Define and compute directional derivatives.</p> <p>5.3.3 Understand the physical interpretation of directional derivatives as the rate of change of a function in a specific direction.</p>	2
<p>5.4. Line, Surface, and Volume Integrals:</p> <p>5.4.1 Line Integrals:</p> <p>5.4.2 Define line integrals for scalar and vector fields.</p> <p>5.4.3 Compute line integrals over various paths.</p> <p>5.4.4 Apply line integrals to problems in physics and engineering, such as work done by a force field.</p>	2

<p>5.4.5 Surface Integrals: 5.4.6 Define surface integrals for scalar and vector fields. 5.4.7 Compute surface integrals over various surfaces. 5.4.8 Apply surface integrals to compute flux across surfaces. 5.4.9 Volume Integrals: 5.4.10 Define volume integrals. 5.4.11 Compute volume integrals for scalar fields. 5.4.12 Apply volume integrals to problems involving the integration of functions over three-dimensional regions.</p>	
<p>5.5. Applications of Fundamental Theorems: 5.5.1 Green's Theorem: 5.5.2 State Green's Theorem and understand its application to converting line integrals to double integrals. 5.5.3 Apply Green's Theorem to solve problems involving circulation and flux in the plane. 5.5.4 Stokes' Theorem: 5.5.5 State Stokes' Theorem and understand its application to converting surface integrals to line integrals. 5.5.6 Apply Stokes' Theorem to problems involving the circulation of vector fields. Gauss' Divergence Theorem: 5.5.6 State Gauss' Divergence Theorem and understand its application to converting volume integrals to surface integrals. 5.5.7 Apply Gauss' Divergence Theorem to problems involving flux through closed surfaces.</p>	2

Subject Name/Code: Engineering Chemistry/UG11T5103

Instructional hours:

Lecture : 45 hours

Total contact hours : 45 hours

Credits : 3

Teaching Methods

The course shall be conducted in a combination of classroom lectures, case study analysis, writing assignments and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments) : 30%

Final Exam : 70%

Text book:

1. N. Krishnamurthy, P. Vallinayagam, D. Madhan Engineering Chemistry, 3rd edition, PHI Publications, Delhi, 2014

Reference:

1. D.A. Skoog, D.M. West and F.J. Holler, Analytical Chemistry an Introduction, Saunders College Publishing, Philadelphia. Latest Edition.

2. Introduction to Surfactant Chemistry, Tharwat F Tadros, Degruyter publications.

Table of Topics

Unit	Topic	Hour (L)
I	Polymers and their Applications	09
II	Water Testing and Treatment	14
III	Corrosion	12
IV	Surfactants and Dispersants	10
	Total	45

Learning Objectives	L
<p>General Learning Objectives: To expose the students about the manufacturing techniques of various materials, their properties, uses</p> <p>I. Polymers and their applications& Miscellaneous Materials (IMO /7.04 / 2014 / 1.3) 1.1 Introduction – Classification of Polymers – Types of Polymerizations – Preparation 1.2 Properties and uses of some important polymers 1.3 Preparation, properties and uses of some important polymers – Nylon, Nylon 6, epoxy resins, Phenol formaldehyde resins & Melamine formaldehyde resins etc., 1.4 Rubber – Synthetic rubbers –Composites, Difference between thermoplastics and thermosetting plastics 1.5 Rubber: Types, Properties, and on-board applications. 1.6 Fabrication of plastics 1.7 Glass and carbon fibers, FRP, GRP materials 1.8 Refractory materials: Types, Properties, and on-board applications</p>	9
<p>II. Acidity & Alkalinity (Water Testing and Treatment) (IMO /7.04 / 2014 / 1.2& 1.4) 2.1 Sources of water, Types of water 2.2 Potable water – Treatment Process for removal of impurities, 2.3 Definition – Hydrogen ion, Hydroxyl ion, p H, Litmus test, etc., 2.4 Softening water Ion exchange process 2.5 Break point chlorination 2.6 Desalination& Electro dialysis, 2.7 Reverse Osmosis, and its applications 2.8 Various water testing such as Chloride & alkalinity 2.9 Hardness &hydrazine, 2.10 Arsenic, and Fluoride 2.11 Phosphate, DO, p H etc.,</p>	14
<p>III. Corrosion (IMO / 7.04 / 2014 / 1.3) pg.256 -257 3.1 Corrosion definitions, Principle, factors influencing corrosion 3.2 Mechanism of Corrosion – Dry Corrosion and their types 3.3 Mechanism of Corrosion – Wet or Electrochemical Corrosion 3.4 Various types of Corrosion – Pitting, Crevice, Pipeline, 3.5 Fretting, fatigue, erosion, stress corrosion, 3.6 Microbiological, Inter granular corrosion 3.7 Selective Leaching – Dezincification, Decarburization, Dealuminification 3.8 Material selection, alternative environment 3.9 Cathodic Protection, sacrificial anode method 3.10 Protective coating, Metallic coatings –Organic and Inorganic coatings protection by Paints 3.11 Corrosion Inhibitors, corrosion rate expression and rate measurements 3.12 Biofouling control, antifouling coatings etc.,</p>	12

IV. Surfactants and Dispersants

- 4.1 Introduction to surfactants
- 4.2 General classification of surfactants
- 4.3 Types of Anionic surfactants
- 4.4 Types Nonionic surfactants
- 4.5 Mechanism of emulsification
- 4.6 Role of surfactants in emulsion formation
- 4.7 The Hydrophilic-Lipophile Balance (HLB) concept;
- 4.8 Role of surfactants in preparation of solid/liquid dispersions (suspensions)
- 4.9 Basic concept of Surfactant micellization
- 4.10 Physicochemical properties of surfactants and polymers containing oxyethylene groups
- 4.11 Introduction of Microemulsions
- 4.12 Role of Microemulsions for oil removal

10



Subject Name/Code: Workshop Technology/UG11T5104

Instructional hours

Lecture : 45 hours

Total contact hours : 45 hours

Credits : 3

Teaching Methods

The course shall be conducted in a combination of classroom lectures, case study analysis, writing assignments and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments) : 30%

Final Exam : 70%

Text book:

1. Workshop Technology I & II, Hazra Choudhury, Latest edition

Reference:

1. Workshop Technology Vol I & II, W. A. J. Chapman 2021.
2. Production Technology HMT - Tata McGraw Hill.
3. Unitor Welding Hand Book, 2023.

Table of Topics

Unit	Topic	Hour (L)
I	Safety Measures	
	Sub-Topics: Safe working practices, Safety, while working on Rotating Machinery, Personal protective equipment and Fire and Electrical safety. Types of Guards and Safety Devices.	3
	Common Workshop Tools	
	Sub-Topics: Bench Fitting Tools, Carpentry and Pattern Makers Tools, Smithy and Molding Tools, Jigs & Fixtures	4
II	Theory of Metal Cutting	
	Sub-Topics: Principle of machining processes. Tool geometry, Tool signature, Orthogonal and Oblique cutting, Types of chips, cutting fluid and machinability.	4
	Lathe Machine and Operations	
	Sub-Topics: Introduction, function and specifications of lathe machine, Classification of lathe machine, Main parts and accessories, General operations, Operating conditions.	5
III	Drilling and Allied Operations	
	Sub-Topics: Specifications, classifications of Drilling machine, General constructions, Main parts, accessories and work holding devices and General operations.	4
	Shaping, Planning Machine & Operations	
	Sub-Topics: Specification, classification of Shaping and Planning machine, General constructions and mechanism, Main parts and Holding devices and General operations.	5
IV	Milling machine and Operations	
	Sub-Topics: Classifications, Specifications of Milling Machine, General construction (Main parts, accessories & holding devices), General operations and Milling processes.	4
	Joining Processes	
	Sub-Topics: Classification of joining process, Pre welding requirements, types of welding joints, welding techniques. Arc welding, Gas welding & cutting, Resistance welding, TIG, MIG, Submerged, welding defects, Brazing and Soldering Welding process, Safety requirements during welding.	6
V	Finishing Processes	
	Sub-Topics: Introduction of abrasive & abrasive machining processes, grinding machine construction and classifications, Grinding wheel, construction. Process of making grinding wheel, characteristics and selection, Different types of Abrasives used in grinding, Fine finishing operations like lapping, honing, polishing and buffing.	5
	Measurement and Quality in Manufacturing	
	Sub-Topics: Introduction of Metrology- Limits, fits and tolerance, Measuring and Inspection Instruments, Optical methods of measurement, Introduction to Quality Management and Reliability.	5
Total		45

Specific Learning Objective	L
I. Safety Measures	
<p>General Learning Objective:</p> <p>To ensure that students understand and can apply safe working practices in engineering environments, particularly when working with rotating machinery, personal protective equipment (PPE), and fire and electrical safety. This module also covers the types and functions of guards and safety devices used in these settings.</p>	
<p>1.1 Safe Working Practices:</p> <p>1.1.1 Understand the importance of adhering to safe working practices in engineering environments.</p> <p>1.1.2 Identify general safety procedures and protocols that should be followed in a workshop or lab setting.</p> <p>1.1.3 Recognize the potential hazards in engineering environments and how to mitigate them.</p>	1
<p>1.2 Safety While Working on Rotating Machinery:</p> <p>1.2.1 Understand the specific risks associated with working on rotating machinery.</p> <p>1.2.2 Identify safe practices for operating and maintaining rotating machinery.</p> <p>1.2.3 Learn the correct procedures for starting, stopping, and troubleshooting rotating machinery to prevent accidents.</p>	2
<p>1.3 Personal Protective Equipment (PPE):</p> <p>1.3.1 Identify different types of personal protective equipment and their specific uses.</p> <p>1.3.2 Understand the proper use, maintenance, and limitations of PPE.</p> <p>1.3.3 Recognize the importance of PPE in preventing injuries and illnesses in the workplace.</p>	
<p>1.4 Fire Safety:</p> <p>1.4.1 Understand the causes and prevention of fires in engineering environments.</p> <p>1.4.2 Identify different types of fire extinguishers and their appropriate uses.</p> <p>1.4.3 Learn emergency procedures for responding to fires, including evacuation plans and the use of fire-fighting equipment.</p>	
<p>1.5 Electrical Safety:</p> <p>1.5.1 Understand the dangers of working with electrical systems and equipment.</p> <p>1.5.2 Identify safe practices for working with electrical equipment, including lockout/tagout procedures.</p> <p>1.5.3 Recognize the importance of proper grounding, insulation, and circuit protection to prevent electrical accidents.</p>	
<p>1.6 Types of Guards and Safety Devices:</p> <p>1.6.1 Identify the different types of guards used in machinery, such as fixed, adjustable, and self-adjusting guards.</p> <p>1.6.2 Understand the function and importance of safety devices such as emergency stop buttons, interlocks, and presence-sensing devices.</p> <p>1.6.3 Learn how to properly use and maintain guards and safety devices to ensure they provide effective protection.</p>	
II. Common Workshop Tools	
<p>General Learning Objective:</p> <p>To gain comprehensive knowledge of common workshop tools used in various trades such as bench fitting, carpentry, pattern making, smithy, molding, and the use of jigs and fixtures. Students will learn about the types, uses, and maintenance of these tools to perform tasks efficiently and safely.</p>	

<p>2.1 Bench Fitting Tools:</p> <p>2.1.1 Identify and understand the use of common bench fitting tools.</p> <p>2.1.2 Demonstrate the proper techniques for using bench fitting tools.</p> <p>2.1.3 Maintain and care for bench fitting tools to ensure longevity and precision.</p>	
<p>2.2 Carpentry and Pattern Makers Tools:</p> <p>2.2.1 Recognize and describe the functions of common carpentry and pattern-making tools.</p> <p>2.2.2 Demonstrate the correct use of carpentry tools for various woodworking tasks.</p> <p>2.2.3 Understand the principles of pattern making and the tools required for creating accurate patterns.</p>	2
<p>2.3 Smithy and Molding Tools:</p> <p>2.3.1 Identify and understand the use of common smithy tools for metalworking.</p> <p>2.3.2 Demonstrate the correct techniques for using smithy tools in forging and shaping metal.</p> <p>2.3.3 Recognize and describe the functions of molding tools used in casting processes.</p>	1
<p>2.4 Jigs & Fixtures:</p> <p>2.4.1 Define jigs and fixtures and explain their importance in manufacturing processes.</p> <p>2.4.2 Design and use basic jigs and fixtures to improve efficiency and accuracy in production.</p> <p>2.4.3 Understand the principles of jigs and fixtures and how they contribute to quality control.</p>	1
III. Theory of Metal Cutting	
<p>General Learning Objective:</p> <p>To understand the fundamental principles of metal cutting, including the geometry of cutting tools, cutting mechanics, chip formation, and factors affecting machinability. This module also covers the use of cutting fluids and their role in machining processes.</p>	
<p>3.1 Principle of Machining Processes:</p> <p>3.1.1 Understand the basic principles of metal cutting and machining processes.</p> <p>3.1.2 Identify and explain the different types of machining processes, such as turning, milling, drilling, and grinding.</p> <p>3.1.3 Analyze the mechanics of material removal in machining processes.</p>	0.5
<p>3.2 Tool Geometry and Tool Signature:</p> <p>3.2.1 Define and explain the various elements of cutting tool geometry.</p> <p>3.2.2 Understand the significance of tool angles and their impact on the cutting process.</p> <p>3.2.3 Interpret tool signature and its components (rake angle, clearance angle, cutting edge angle, etc.).</p> <p>3.2.4 Recognize different types of cutting tools and their applications.</p>	1
<p>3.3 Orthogonal and Oblique Cutting:</p> <p>3.3.1 Differentiate between orthogonal and oblique cutting.</p> <p>3.3.2 Explain the mechanics and characteristics of orthogonal cutting, including chip formation and force analysis.</p> <p>3.3.3 Describe oblique cutting and how it differs from orthogonal cutting in terms of tool geometry and cutting mechanics.</p>	1
<p>3.4 Types of Chips:</p> <p>3.4.1 Identify and describe the different types of chips produced in metal cutting (continuous, discontinuous, and built-up edge chips).</p> <p>3.4.2 Understand the conditions under which each type of chip is formed.</p> <p>3.4.3 Analyze the impact of chip type on surface finish and tool wear.</p>	0.5
<p>3.5 Cutting Fluid:</p> <p>3.6.1 Define the purpose and types of cutting fluids used in machining processes.</p> <p>3.6.2 Explain the functions of cutting fluids, including cooling, lubrication, and chip removal.</p>	0.5

3.6.3 Evaluate the selection criteria for cutting fluids based on the material being machined and the cutting process.	
3.4 Machinability: 3.6.1 Define machinability and the factors that influence it. 3.6.2 Understand how material properties, tool geometry, cutting conditions, and cutting fluids affect machinability. 3.6.3 Evaluate methods for improving machinability, including tool material selection, cutting parameters optimization, and the use of appropriate cutting fluids.	0.5
IV. Lathe machine and operations	
General Learning Objective: To understand the fundamental principles, functions, and operations of lathe machines. This module covers the classification, main parts, accessories, and general operations of lathe machines, along with the operating conditions necessary for optimal performance.	
4.1 Introduction, Function, and Specifications of Lathe Machine: 4.1.1 Define what a lathe machine is and its primary function in machining. 4.1.2 Understand the basic working principle of a lathe machine. 4.1.3 Identify and interpret the specifications of a lathe machine, such as swing, distance between centers, spindle speed, and feed rates.	1
4.2 Classification of Lathe Machines: 4.2.1 Differentiate between various types of lathe machines based on their design, size, and intended use. 4.2.2 Describe the characteristics and applications of different types of lathes, including engine lathes, bench lathes, tool room lathes, capstan & turret lathes, and CNC lathes.	1
4.3 Main Parts and Accessories: 4.3.1 Identify the main parts of a lathe machine, such as the bed, headstock, tailstock, carriage, and lead screw. 4.3.2 Understand the function of each main part in the operation of a lathe. 4.3.3 Recognize common lathe accessories, including chucks, faceplates, steady rests, and tool posts, and understand their specific uses.	1
4.4 General Operations: 4.4.1 Describe the basic operations that can be performed on a lathe machine, including turning, facing, threading, drilling, boring, knurling, and parting-off. 4.4.2 Demonstrate the proper setup and execution of these operations. 4.4.3 Understand the importance of selecting the appropriate cutting tools and parameters for each operation.	1
4.5 Operating Conditions: 4.5.1 Understand the factors affecting the operating conditions of a lathe machine, such as cutting speed, feed rate, depth of cut, and tool material. 4.5.2 Learn how to adjust operating conditions to optimize performance and tool life. 4.5.3 Recognize the importance of proper machine maintenance and safety practices to ensure safe and efficient operation.	1
V. Drilling and Allied operations	
General Learning Objective: To understand the principles, specifications, classifications, construction, and main parts of drilling machines. This module also covers the accessories and work holding devices used in drilling, as well as the general operations performed with drilling machines.	
5.1 Specifications of Drilling Machine: 5.1.1 Understand and interpret the specifications of drilling machines, such as drilling capacity, spindle speed, feed rate, and power rating. 5.1.2 Identify how these specifications influence the performance and suitability of a drilling machine for various tasks.	0.5

<p>5.2 Classifications of Drilling Machines:</p> <p>5.2.1 Differentiate between various types of drilling machines based on their design and application.</p> <p>5.2.2 Describe the characteristics and uses of different types of drilling machines, including bench drills, pillar drills, radial drills, gang drills, and CNC drilling machines.</p>	1
<p>5.3 General Construction of Drilling Machines:</p> <p>5.3.1 Understand the basic construction and design principles of drilling machines.</p> <p>5.3.2 Identify and describe the structural components that make up a drilling machine, emphasizing their functions and importance.</p>	0.5
<p>5.4 Main Parts, Accessories, and Work Holding Devices:</p> <p>5.4.1 Identify the main parts of a drilling machine, such as the base, column, table, spindle, and drill head.</p> <p>5.4.2 Understand the function of each main part and how they interact to perform drilling operations.</p> <p>5.4.3 Recognize common accessories and work holding devices, such as drill chucks, vices, clamps, and jigs, and understand their specific uses in enhancing drilling operations.</p>	1
<p>5.5 General Operations:</p> <p>5.5.1 Describe the basic operations that can be performed with a drilling machine, including drilling, reaming, boring, countersinking, and tapping.</p> <p>5.5.2 Demonstrate proper setup and execution of these operations.</p> <p>5.5.3 Understand the importance of selecting the appropriate cutting tools and parameters for each operation to ensure precision and efficiency.</p>	1
<p>VI. Shaping, Planning Machine & Operations</p>	
<p>General Learning Objective: To understand the fundamental principles, specifications, classifications, construction, main parts, and mechanisms of shaping and planning machines. This module also covers the holding devices and general operations performed with these machines.</p>	
<p>6.1 Specification of Shaping and Planning Machines:</p> <p>6.1.1 Understand and interpret the specifications of shaping and planning machines, such as stroke length, table size, and power rating.</p> <p>6.1.2 Identify how these specifications influence the performance and suitability of these machines for various tasks.</p>	1
<p>6.2 Classification of Shaping and Planning Machines:</p> <p>6.2.1 Differentiate between various types of shaping and planning machines based on their design and application.</p> <p>6.2.2 Describe the characteristics and uses of different types of shaping and planning machines.</p>	1
<p>6.3 General Construction and Mechanism:</p> <p>6.3.1 Understand the basic construction and design principles of shaping and planning machines.</p> <p>6.3.2 Identify and describe the structural components that make up these machines, emphasizing their functions and importance.</p> <p>6.3.3 Explain the working mechanisms that drive the motion of these machines.</p>	1
<p>6.4 Main Parts and Holding Devices:</p> <p>6.4.1 Identify the main parts of shaping and planning machines, such as the ram, table, clapper box, and tool head.</p> <p>6.4.2 Understand the function of each main part and how they interact to perform machining operations.</p> <p>6.4.3 Recognize common holding devices, such as vices, clamps, and jigs, and understand</p>	2

their specific uses in securing work pieces during machining.	
<p>6.5 General Operations:</p> <p>6.5.1 Describe the basic operations that can be performed with shaping and planing machines, including flat surfaces, angular surfaces, slots, and grooves.</p> <p>6.5.2 Demonstrate proper setup and execution of these operations.</p> <p>6.5.3 Understand the importance of selecting the appropriate cutting tools and parameters for each operation to ensure precision and efficiency.</p>	
VII. Milling Machine and Operations	
<p>General Learning Objective:</p> <p>To understand the fundamental principles, classifications, specifications, construction, main parts, accessories, holding devices, and operations of milling machines. This module also covers various milling processes performed with these machines.</p>	
<p>7.1 Classifications of Milling Machines:</p> <p>7.1.1 Differentiate between various types of milling machines based on their design, configuration, and application.</p> <p>7.1.2 Describe the characteristics and uses of different types of milling machines, such as horizontal milling machines, vertical milling machines, knee-and-column milling machines, bed-type milling machines, and CNC milling machines.</p>	1.5
<p>7.2 General Construction (Main Parts, Accessories, and Holding Devices):</p> <p>7.2.1 Identify and describe the main parts of a milling machine, including the base, column, knee, saddle, table, spindle, and overarm.</p> <p>7.2.2 Understand the function of each main part and how they contribute to the milling process.</p> <p>7.2.3 Recognize common accessories and work holding devices, such as vises, clamps, collets, and rotary tables, and understand their specific uses in enhancing milling operations.</p>	1
<p>7.3 General Operations and Milling Processes:</p> <p>7.3.1 Describe the basic operations that can be performed with a milling machine, including face milling, end milling, slotting, and drilling.</p> <p>7.3.2 Demonstrate proper setup and execution of these operations. Understand the importance of selecting the appropriate cutting tools and parameters for each operation to ensure precision and efficiency.</p> <p>7.3.3 Explore various milling processes, such as plain milling, angular milling, form milling, and gang milling.</p>	1.5
IX. Finishing Processes	
<p>General Learning Objective:</p> <p>To understand the principles and applications of abrasive and abrasive machining processes, including the construction, classification, and use of grinding machines and grinding wheels. This module also covers fine finishing operations such as lapping, honing, polishing, and buffing.</p>	
<p>8.1 Introduction to Abrasive and Abrasive Machining Processes:</p> <p>8.1.1 Define abrasive machining and explain its importance in achieving fine surface finishes and precision.</p> <p>8.1.2 Understand the basic principles of abrasive machining processes and its applications.</p>	1
<p>8.2 Grinding Machine Construction and Classifications:</p> <p>8.2.1 Understand the general construction and working principles of grinding machines.</p> <p>8.2.2 Differentiate between various types of grinding machines based on their design and application, such as surface grinders, cylindrical grinders, and centerless grinders.</p>	1.5
<p>8.3 Grinding Wheel Construction and Process of Making Grinding Wheel:</p> <p>8.3.1 Describe the construction of a grinding wheel, including the abrasive grains, bond, and structure.</p>	

8.3.2 Understand the process of making a grinding wheel, including the selection of abrasive grains, bonding materials, and the manufacturing process.	
8.4 Characteristics and Selection of Grinding Wheels: 8.4.1 Identify the characteristics of grinding wheels, such as grain size, grade, structure, and bond type. 8.4.2 Understand the criteria for selecting appropriate grinding wheels for different materials and applications.	2.5
8.5 Different Types of Abrasives Used in Grinding: 8.5.1 Recognize the various types of abrasives used in grinding, such as aluminum oxide, silicon carbide, cubic boron nitride (CBN), and diamond. 8.5.2 Understand the properties and applications of each type of abrasive.	
8.6 Fine Finishing Operations: 8.6.1 Describe the processes and applications of fine finishing operations such as lapping, honing, polishing, and buffing. 8.6.2 Understand the principles and techniques used in each finishing process to achieve high surface quality and precision.	
X. Measurement and Quality in Manufacturing	
General Learning Objective: To understand the principles of metrology, including limits, fits, and tolerances, as well as the use of measuring and inspection instruments. This module also covers optical methods of measurement and introduces concepts of quality management and reliability in manufacturing.	
9.1 Introduction to Metrology: 9.1.1 Define metrology and explain its importance in manufacturing. 9.1.2 Understand the concepts of limits, fits, and tolerances and their applications in ensuring the interchangeability and functionality of manufactured parts.	1
9.2 Limits, Fits, and Tolerances: 9.2.1 Explain the definitions and differences between limits, fits, and tolerances. 9.2.2 Understand the various types of fits (e.g., clearance, interference, transition) and its applications. 9.2.3 Describe the role of tolerances in manufacturing and how they affect part quality and assembly.	1
9.3 Measuring and Inspection Instruments: 9.3.1 Identify and describe the use of various measuring instruments, such as calipers, micrometers, gauges, and coordinate measuring machines (CMMs). 9.3.2 Understand the principles of operation and the applications of these instruments in inspecting and measuring dimensions and geometric features of manufactured parts.	1
9.4 Optical Methods of Measurement: 9.4.1 Understand the principles and applications of optical methods in measurement. 9.4.2 Describe different optical measurement techniques, such as optical comparators, laser interferometry, and vision systems.	1
9.5 Introduction to Quality Management and Reliability: 9.5.1 Define quality management and its importance in manufacturing. 9.5.2 Understand the basic principles of quality management systems, such as ISO standards. 9.5.3 Explain the concept of reliability and its significance in ensuring product performance and longevity.	1

VIII. Joining Processes		
General Learning Objective: To understand the fundamental principles, classifications, techniques, and safety requirements of various joining processes, including welding, brazing, and soldering. This module also covers welding defects and the specifics of different welding methods.		
10.1 Classification of Joining Processes: 10.1.1 Understand and differentiate between the various types of joining processes used in manufacturing. 10.1.2 Explain the applications and limitations of each joining process.		0.5
10.2 Pre-Welding Requirements: 10.2.1 Identify the necessary preparations and considerations before performing welding operations. 10.2.2 Understand the importance of proper joint design, material selection, and surface preparation.		0.5
10.3 Types of Welding Joints: 10.3.1 Describe the different types of welding joints, such as butt, lap, corner, edge, and T-joints. 10.3.2 Understand the applications and advantages of each type of welding joint.		0.5
10.4 Welding Techniques: 10.4.1 Understand the basic principles and applications of various welding techniques. 10.4.2 Differentiate between manual, semi-automatic, and automatic welding techniques.		0.5
10.5 Arc Welding: 10.5.1 Explain the principles, equipment, and applications of arc welding. 10.5.2 Understand the types of arc welding, such as Shielded Metal Arc Welding (SMAW) and Flux-Cored Arc Welding (FCAW).		0.5
10.6 Gas Welding and Cutting: 10.6.1 Describe the principles and applications of gas welding and cutting. 10.6.2 Understand the equipment, gases used, and safety measures for gas welding and cutting.		0.5
10.7 Resistance Welding: 10.7.1 Explain the principles and types of resistance welding, such as spot welding, seam welding, and projection welding. 10.7.2 Understand the applications and advantages of resistance welding.		0.5
10.8 TIG and MIG Welding: 10.8.1 Describe the principles, equipment, and applications of Tungsten Inert Gas (TIG) and Metal Inert Gas (MIG) welding. 10.8.2 Understand the differences, advantages, and limitations of TIG and MIG welding.		0.5
10.9 Submerged Arc Welding: 10.9.1 Explain the principles, equipment, and applications of submerged arc welding (SAW). 10.9.2 Understand the advantages and limitations of SAW.		0.5
10.10 Welding Defects: 10.10.1 Identify common welding defects such as cracks, porosity, and undercut. 10.10.2 Understand the causes and prevention methods for welding defects.		0.5
10.11 Brazing and Soldering: 10.11.1 Describe the principles, equipment, and applications of brazing and soldering. 10.11.2 Understand the differences between brazing and soldering, and their respective advantages and limitations.		0.5
10.12 Safety Requirements During Welding: 10.12.1 Understand the safety hazards associated with welding and the necessary precautions to prevent accidents. 10.12.2 Describe the safety equipment and procedures required to ensure a safe welding environment.		0.5

Subject Name/Code: Basic Electrical Technology/UG11T5105

Instructional hours:

Lecture	: 45 hours
Tutorial	: 15 hours
Total contact hours	: 60 hours
Credits	: 4

Teaching Methods

The course shall be conducted in a combination of classroom lectures, case study analysis, writing assignments and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments)	: 30%
Final Exam	: 70%

Text book:

1. A Textbook of Electrical Technology - Vol. 1, A. K. Thereja, B.L. Thereja, Latest Edition.
2. Basic Electrical Engineering, D. P. Kothari, I.J. Nagrath, McGraw Hill Higher Education, 2019.

Reference:

1. Electrical and Electronic Technology, E. Hughes, Pearson Education
2. Electrical and Electronic Technology, Hilley John, Brown Keith and Smith Lan M, Pearson Education
3. Electricity one to seven, Harry Mileaf, Latest Edition.

Table of Topics

Unit	Topic	Hour (L)
I	Fundamental Concept Electrical Quantities: Concept of current, voltage, resistance, work, power, energy and the relationship between them. Ohm's Law, KCL, KVL, Voltage and Current Sources, Mesh analysis & Nodal analysis, Basic problems.	12
II	Magnetism and Electromagnetism MMF, flux, flux density, reluctance, permeability, magnetizing force, Ohm's Law of Magnetic circuit, Force on current-carrying conductor lying in the magnetic field, Faraday's law of electromagnetic induction, Eddy current Hysteresis Loop, and Hysteresis Loss and Lenz's Law	12
III	1-phase AC Circuits Generation of AC voltage, Average Value, RMS Values, Form Factor, Peak Factor, Representation of a sinusoidal signal as a rotating phasor Representation of series and parallel RL, RC and RLC circuits, Phasor diagram Impedance, Admittance and resonance in RLC circuit, Basic problems	12
IV	Poly phase AC Circuits 3 Phase AC circuits, the relationship between phase and line voltages and currents for star delta connections, Delta Star and Star Delta Conversion, Measurement of power in 3 phase circuits, Basic problems.	10
V	Electrical Instruments and Measurements Requirements of measuring instrument deflection, control and damping devices. Moving coil and moving iron instruments, Galvanometer. Wattmeter and Energy Meter (single phase), Megger, Multimeter (construction and principle of operation)	14
Total		60

Learning Objectives	L
I. Fundamental Concept	
General Learning Objective: To understand the basic principles and relationships of electrical quantities, including current, voltage, resistance, work, power, and energy. This module covers Ohm's Law, Kirchhoff's Current Law (KCL), Kirchhoff's Voltage Law (KVL), voltage and current sources, as well as mesh and nodal analysis with practical problem-solving applications.	
1.1 Electrical Quantities: 1.1.1 Define and understand the concepts of current, voltage, resistance, work, power, and energy. 1.1.2 Describe the relationships between these electrical quantities.	2
1.2 Ohm's Law: 1.2.1 State Ohm's Law and explain its significance in electrical circuits. 1.2.2 Apply Ohm's Law to solve basic circuit problems involving resistors.	2

1.3 Kirchhoff's Laws: 1.3.1 Understand Kirchhoff's Current Law (KCL) and Kirchhoff's Voltage Law (KVL). 1.3.2 Apply KCL and KVL to analyze electrical circuits.	2
1.4 Voltage and Current Sources: 1.4.1 Differentiate between independent and dependent voltage and current sources. 1.4.2 Understand the characteristics and applications of these sources in circuits.	2
1.5 Mesh Analysis: 1.5.1 Explain the concept and steps of mesh analysis for solving circuit problems. 1.5.2 Apply mesh analysis to determine currents in various loops of a circuit.	2
1.6 Nodal Analysis: 1.6.1 Describe the concept and steps of nodal analysis for solving circuit problems. 1.6.2 Apply nodal analysis to determine voltages at different nodes of a circuit.	2
1.7 Basic Problem-Solving: 1.7.1 Solve basic electrical circuit problems using Ohm's Law, KCL, KVL, mesh analysis, and nodal analysis. 1.7.2 Develop proficiency in analyzing simple resistive circuits.	2
III. 1-phase AC Circuits	
General Learning Objective: To understand the principles of single-phase AC circuits, including the generation of AC voltage, calculation of average and RMS values, and representation of sinusoidal signals. This module covers the analysis of series and parallel RL, RC, and RLC circuits, including phasor diagrams, impedance, admittance, and resonance, with practical problem-solving applications.	
2.1 Generation of AC Voltage: 2.1.1 Understand the principles behind the generation of alternating current (AC) voltage. 2.1.2 Explain the basic concepts of electromagnetic induction as it applies to AC voltage generation.	2
2.2 Average Value, RMS Value, Form Factor, and Peak Factor: 2.2.1 Define and calculate the average value of an AC signal. 2.2.2 Define and calculate the root mean square (RMS) value of an AC signal. 2.2.3 Understand and calculate the form factor and peak factor of an AC signal.	3
2.3 Representation of a Sinusoidal Signal as a Rotating Phasor: 2.3.1 Represent a sinusoidal signal using phasors. 2.3.2 Understand the concept of phasor diagrams and their use in AC circuit analysis.	2
2.4 Representation of Series and Parallel RL, RC, and RLC Circuits: 2.4.1 Analyze series and parallel RL, RC, and RLC circuits. 2.4.2 Draw and interpret phasor diagrams for these circuits. 2.4.3 Calculate impedance and admittance in these circuits.	3
2.5 Impedance, Admittance, and Resonance in RLC Circuits: 2.5.1 Define and calculate impedance and admittance for RLC circuits. 2.5.2 Explain the concept of resonance in RLC circuits and its effects. 2.5.3 Solve basic problems involving impedance, admittance, and resonance in RLC circuits.	2
IV. Poly phase AC Circuits	
General Learning Objective: To understand the principles and analysis of three-phase AC circuits, including the relationships between phase and line voltages and currents in star (Y) and delta (Δ) connections. This module	

covers star-delta and delta-star conversions, measurement of power in three-phase circuits, and solving basic problems related to these concepts.	
3.1 Three-Phase AC Circuits: 3.1.1 Understand the basic principles and advantages of three-phase AC circuits over single-phase AC circuits. 3.1.2 Explain the generation and characteristics of three-phase AC power.	2
3.2 Relationship Between Phase and Line Voltages and Currents: 3.2.1 Understand the relationships between phase and line voltages and currents in star (Y) connections. 3.2.2 Understand the relationships between phase and line voltages and currents in delta (Δ) connections.	2
3.3 Star-Delta and Delta-Star Conversion: 3.3.1 Explain the process of converting a star (Y) connection to a delta (Δ) connection and vice versa. 3.3.2 Understand the mathematical relationships and formulas involved in these conversions.	2
3.4 Measurement of Power in Three-Phase Circuits: 3.4.1 Explain the methods of measuring power in three-phase circuits, including the two-wattmeter and three-wattmeter methods. 3.4.2 Understand the calculation of active, reactive, and apparent power in three-phase circuits.	2
3.5 Basic Problem-Solving: 3.5.1 Solve basic problems involving three-phase circuits, star-delta and delta-star conversions, and power measurement in three-phase systems.	2
II. Magnetism and Electromagnetism	
General Learning Objective: To understand the fundamental principles of magnetism and electromagnetism, including magnetic circuits, magnetic field interactions with current-carrying conductors, and electromagnetic induction. This module covers magnetic quantities, Ohm's Law for magnetic circuits, Faraday's Law, eddy currents, hysteresis loop and loss, and Lenz's Law, with practical problem-solving applications.	
4.1 Magnetic Quantities and Their Relationships: 4.1.1 Understand and define magnetic quantities such as magneto motive force (MMF), magnetic flux, flux density, reluctance, permeability, and magnetizing force.	2
4.2 Ohm's Law for Magnetic Circuits: 4.2.1 Explain and apply Ohm's Law for magnetic circuits, drawing analogies between electrical and magnetic circuits.	2
4.3 Force on a Current-Carrying Conductor: 4.3.1 Understand the force exerted on a current-carrying conductor placed in a magnetic field and apply the relevant formulas to calculate this force.	2
4.4 Faraday's Law of Electromagnetic Induction: 4.4.1 Explain Faraday's Law of electromagnetic induction and its significance in generating induced EMF.	2
4.5 Eddy Currents and Hysteresis: 4.5.1 Understand the concepts of eddy currents and hysteresis, including their causes and effects in magnetic materials. 4.5.2 Describe and analyze the hysteresis loop and calculate hysteresis loss.	2

4.6 Lenz's Law: 4.6.1 Explain Lenz's Law and its role in electromagnetic induction.	2
4.7 Basic Problem-Solving: 4.7.1 Solve basic problems involving magnetic circuits, forces on conductors, and electromagnetic induction.	2
V. Electrical Instruments and Measurements	
General Learning Objective: To understand the principles, construction, and operation of various electrical measuring instruments. This module covers the requirements of measuring instruments, deflection, control and damping devices, and the operation of specific instruments such as moving coil and moving iron instruments, galvanometers, wattmeter's, energy meters, megger, and multimeters.	
5.1 Requirements of Measuring Instruments: 5.1.1 Understand the key requirements for measuring instruments, including accuracy, precision, sensitivity, and resolution. 5.1.2 Explain the importance of deflection, control, and damping mechanisms in measuring instruments.	2
5.2 Deflection, Control, and Damping Devices: 5.2.1 Understand the role of deflection systems in measuring instruments. 5.2.2 Explain the mechanisms for controlling the movement of the measuring needle. 5.2.3 Understand damping methods used to stabilize the pointer movement and ensure accurate readings.	2
5.3 Moving Coil and Moving Iron Instruments: 5.3.1 Explain the construction, principle of operation, and applications of moving coil instruments. 5.3.2 Explain the construction, principle of operation, and applications of moving iron instruments.	1
5.4 Galvanometer: 5.4.1 Understand the construction and working principle of a galvanometer. 5.4.2 Explain its use in detecting and measuring small electric currents.	1
5.5 Wattmeter and Energy Meter (Single Phase): 5.5.1 Explain the construction, working principle, and applications of a single-phase wattmeter. 5.5.2 Understand the construction, working principle, and applications of a single-phase energy meter.	2
5.6 Megger: 5.6.1 Describe the construction and working principle of a megger. 5.6.2 Explain its use in measuring insulation resistance.	2
5.7 Multimeter: 5.7.1 Understand the construction and working principle of a multimeter. 5.7.2 Explain its use in measuring voltage, current, and resistance.	2
5.8 Basic Problem-Solving: 5.8.1 Solve basic problems involving the interpretation of measurements taken using these instruments. 5.8.2 Understand calibration and error correction in measuring instruments.	2

Subject Name/Code: Basic Electronics/UG11T5106

Instructional hours

Lecture	: 45 hours
Total contact hours	: 45 hours
Credits	: 3

Teaching Methods

The course shall be conducted in a combination of classroom lectures, case study analysis, writing assignments and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments)	: 30%
Final Exam	: 70%

Text book:

1. Electrical and Electronic Technology; Hilley John, Brown Keith and Smith Lan Mckenzie; Pearson Education.
2. Electronic Devices and Circuit Theory; Boylestad and Nashelsky; Pearson Education.

Reference:

1. Digital Electronics: Principles and Application; Roger L Tokheim; McGraw Hill; ISBN: 978-0078309823.
2. Basic Electronics (Solid State), B.L. Theraja, S Chand Publishing.

Table of Topics

Unit	Topic	Hour (L)
I	Fundamental Concept Semiconductors: germanium, silicon-properties, intrinsic and extrinsic p-n junction diode, Characteristics and Parameters, Diode approximations, Half-wave rectifier, Two-diode Full-wave rectifier, Bridge rectifier, Zener diode: characteristics, voltage regulators	12
II	Bipolar Junction Transistors: BJT operation and characteristics, BJT amplification, Common Base, Common Emitter, DC Load line and Bias Point, Base Bias, Voltage divider Bias Metal oxide Field Effect Transistors and Uni- Junction Transistor: Construction, operation and characteristics	12
III	Introduction to Operational Amplifiers: Ideal OPAMP, Inverting and Non-Inverting OPAMP circuits, OPAMP applications: voltage follower, addition, subtraction, integration, differentiation- Basic Problems.	6
IV	Digital Electronics: Number systems, binary codes, binary arithmetic, Boolean algebra, laws & theorems, simplification of Boolean expressions Logic Gates: AND, OR, NOR, NOT, XOR, XNOR and their Truth Tables, universal gates.	6
V	Communication Systems Block diagram of a basic communication system, frequency spectrum, need for modulation, methods of modulation, principles of AM, FM, transmitters & receivers (block diagram description only), pulse analog and pulse digital modulation Satellite Communication, Radar systems, data transmission and MODEM	9
Total		45

Learning Objectives	L
<p>I. Fundamental Concept</p>	
<p>General Learning Objective: To understand the properties of semiconductor materials, the operation of p-n junction diodes, and their applications in rectification and voltage regulation. This module covers the characteristics of intrinsic and extrinsic semiconductors, p-n junction diodes, rectifier circuits, and Zener diodes.</p>	
<p>1.1 Semiconductor Materials:</p> <ul style="list-style-type: none"> 1.1.1 Understand the properties of semiconductor materials such as germanium and silicon. 1.1.2 Differentiate between intrinsic and extrinsic semiconductors. 1.1.3 Properties of Germanium and Silicon: 1.1.4 Describe the basic properties of germanium and silicon as semiconductor materials. 1.1.5 Explain the band structure and energy gap of these materials. 1.1.6 Intrinsic Semiconductors: 1.1.7 Define intrinsic semiconductors and explain their behavior in terms of electron-hole pairs. 1.1.8 Extrinsic Semiconductors: 1.1.9 Differentiate between n-type and p-type extrinsic semiconductors. 1.1.10 Explain the doping process and its impact on the electrical properties of semiconductors. 	2
<p>1.2 P-N Junction Diode:</p> <ul style="list-style-type: none"> 1.2.1 Explain the formation and operation of a p-n junction diode. 1.2.2 Understand the characteristics and parameters of p-n junction diodes. 1.2.3 Formation and Operation: 1.2.4 Describe the formation of a p-n junction and the concept of depletion region. 1.2.5 Explain the forward and reverse biasing of a p-n junction diode. 1.2.6 Characteristics and Parameters: 1.2.7 Plot and interpret the I-V characteristics of a p-n junction diode. 1.2.8 Understand key parameters such as forward voltage drop, reverse saturation current, and breakdown voltage. 	2
<p>1.3 Diode Approximations:</p> <ul style="list-style-type: none"> 1.3.1 Understand and apply different diode approximations for circuit analysis. 1.3.2 Ideal Diode Approximation: 1.3.3 Apply the ideal diode approximation in circuit analysis, assuming zero forward voltage drop and infinite reverse resistance. 1.3.4 Practical Diode Approximation: 1.3.5 Apply the practical diode approximation, considering a small forward voltage drop (e.g., 0.7V for silicon diodes) and high but finite reverse resistance. 1.3.6 Piecewise-Linear Approximation: 1.3.7 Use the piecewise-linear approximation for more accurate circuit analysis, incorporating the forward voltage drop and the dynamic resistance in the forward-biased region. 	2

<p>1.4 Rectifier Circuits:</p> <p>1.4.1 Explain the operation of half-wave, two-diode full-wave, and bridge rectifiers.</p> <p>1.4.2 Analyze the performance of these rectifier circuits.</p> <p>1.4.3 Half-Wave Rectifier:</p> <p>1.4.4 Explain the operation of a half-wave rectifier and analyze its output waveform, average value, and efficiency.</p> <p>1.4.5 Two-Diode Full-Wave Rectifier:</p> <p>1.4.6 Describe the operation of a two-diode full-wave rectifier using a center-tapped transformer.</p> <p>1.4.7 Analyze the output waveform, average value, and efficiency of the full-wave rectifier.</p> <p>1.4.8 Bridge Rectifier:</p> <p>1.4.9 Explain the operation of a bridge rectifier and analyze its output waveform, average value, and efficiency.</p> <p>1.4.10 Compare the performance of half-wave, two-diode full-wave, and bridge rectifiers.</p> <p>1.4.11 Zener Diode:</p> <p>1.4.12 Understand the characteristics and operation of Zener diodes.</p> <p>1.4.13 Explain the application of Zener diodes in voltage regulation.</p> <p>1.4.14 Characteristics and Operation:</p> <p>1.4.15 Describe the I-V characteristics of a Zener diode and explain its breakdown mechanism.</p> <p>1.4.16 Understand the Zener voltage and its temperature dependence.</p> <p>1.4.17 Voltage Regulation:</p> <p>1.4.18 Explain the use of Zener diodes in voltage regulation circuits.</p> <p>1.4.19 Analyze simple Zener diode voltage regulator circuits and calculate the output voltage and load regulation.</p>	6
<p>1.5 Basic Problem-Solving:</p> <p>1.5.1 Semiconductor Properties:</p> <p>1.5.2 Solve problems involving the calculation of carrier concentration, conductivity, and mobility in intrinsic and extrinsic semiconductors.</p> <p>1.5.3 Diode Characteristics:</p> <p>1.5.4 Analyze and interpret the I-V characteristics of p-n junction and Zener diodes.</p> <p>1.5.5 Rectifier Circuits:</p> <p>1.5.6 Solve problems involving the analysis of half-wave, full-wave, and bridge rectifier circuits.</p> <p>1.5.7 Voltage Regulation:</p> <p>1.5.8 Solve problems involving Zener diode voltage regulator circuits, including calculations of output voltage, load regulation, and power dissipation.</p>	
<p>II. Bipolar Junction Transistors: Metal-Oxide Semiconductor Field-Effect Transistors (MOSFETs) and Uni-Junction Transistors (UJT)</p>	
<p>General Learning Objective: To understand the operation, characteristics, and applications of Bipolar Junction Transistors (BJTs) and Metal Oxide Field Effect Transistors (MOSFETs), including their use in amplification and biasing techniques. Uni Junction Transistor (UJT)</p>	
<p>2.1 BJT Operation and Characteristics:</p> <p>2.1.1 Understand the basic structure and operation of BJTs.</p> <p>2.1.2 Explain the characteristics and behavior of BJTs in different regions of operation.</p> <p>2.1.3 Structure and Operation:</p> <p>2.1.4 Describe the structure of NPN and PNP BJTs.</p> <p>2.1.5 Explain the operation of BJTs in active, cutoff, and saturation regions.</p> <p>2.1.6 I-V Characteristics:</p> <p>2.1.7 Plot and interpret the I-V characteristics of BJTs.</p> <p>2.1.8 Understand the significance of different regions (active, saturation, and cutoff) in the output characteristics.</p>	2

<p>2.2 BJT Amplification:</p> <p>2.2.1 Understand the principles of BJT amplification.</p> <p>2.2.2 Explain the operation of BJTs in common base (CB) and common emitter (CE) configurations.</p> <p>2.2.3 Amplification Principles:</p> <p>2.2.4 Explain how BJTs amplify signals.</p> <p>2.2.5 Define and calculate current gain (β) and voltage gain.</p> <p>2.2.6 Describe the common emitter configuration and its input/output characteristics.</p> <p>2.2.7 Explain why the common emitter configuration is widely used in amplification.</p> <p>2.2.8 Common Base (CB) Configuration:</p> <p>2.2.9 Describe the common base configuration and its input/output characteristics.</p> <p>2.2.10 Explain the typical applications of the common base configuration.</p>	2
<p>2.3 DC Load Line and Bias Point:</p> <p>2.3.1 Understand the concept of the DC load line and its significance in BJT circuits.</p> <p>2.3.2 Determine the operating or bias point (Q-point) of a BJT.</p> <p>2.3.3 DC Load Line:</p> <p>2.3.4 Explain the concept of the DC load line in BJT circuits.</p> <p>2.3.5 Draw the DC load line on the output characteristics of a BJT.</p> <p>2.3.6 Bias Point (Q-point):</p> <p>2.3.7 Determine the bias point (Q-point) from the intersection of the load line and the characteristic curves.</p> <p>2.3.8 Explain the importance of selecting a proper Q-point for linear amplification.</p>	2
<p>2.4 BJT Biasing Techniques:</p> <p>2.4.1 Understand and apply different biasing techniques for BJTs, including base bias and voltage divider bias.</p> <p>2.4.2 Base Bias:</p> <p>2.4.3 Explain the base biasing method and its limitations.</p> <p>2.4.4 Calculate the base resistor value for desired operating point.</p> <p>2.4.5 Voltage Divider Bias:</p> <p>2.4.6 Describe the voltage divider biasing technique.</p> <p>2.4.7 Calculate the resistor values for setting the desired Q-point in a voltage divider bias network.</p>	2
<p>2.5 MOSFETs:</p> <p>2.5.1 Construction and Operation:</p> <p>2.5.2 Describe the basic construction of MOSFETs (enhancement and depletion types).</p> <p>2.5.3 Explain the operation of MOSFETs in different regions (cutoff, triode, and saturation).</p> <p>2.5.4 Characteristics:</p> <p>2.5.5 Plot and interpret the I-V characteristics of MOSFETs.</p> <p>2.5.6 Explain the transfer characteristics (I_D vs V_{GS}) of MOSFETs.</p> <p>2.5.7 Applications:</p> <p>2.5.8 Discuss common applications of MOSFETs in switching and amplification.</p>	2
<p>2.6 Uni-Junction Transistors (UJT):</p> <p>2.6.1 Construction and Operation:</p> <p>2.6.2 Describe the basic construction of UJTs.</p> <p>2.6.3 Explain the operation of UJTs and their unique characteristics.</p> <p>2.6.4 Characteristics:</p> <p>2.6.5 Plot and interpret the I-V characteristics of UJTs.</p> <p>2.6.6 Applications:</p> <p>2.6.7 Discuss typical applications of UJTs in triggering and timing circuits.</p>	2
III. Introduction to Operational Amplifiers:	
<p>General Learning Objective:</p> <p>To understand the principles, configurations, and applications of operational amplifiers (Op-Amps), including their ideal characteristics, inverting and non-inverting circuits, and common applications such as voltage followers, adders, subtractors, integrators, and differentiators.</p>	

<p>3.1 Ideal Operational Amplifier (Op-Amp):</p> <p>3.1.1 Understand the characteristics and assumptions of an ideal Op-Amp.</p> <p>3.1.2 Explain the concept of infinite open-loop gain, infinite input impedance, zero output impedance, and infinite bandwidth in ideal Op-Amps.</p> <p>3.1.3 Characteristics of an Ideal Op-Amp:</p> <p>3.1.4 Describe the characteristics of an ideal Op-Amp: infinite open-loop gain, infinite input impedance, zero output impedance, and infinite bandwidth.</p> <p>3.1.5 Assumptions for Ideal Op-Amp Analysis:</p> <p>3.1.6 Explain the key assumptions used in ideal Op-Amp analysis (e.g., virtual short concept and zero offset voltage).</p>	1
<p>3.2 Inverting and Non-Inverting Op-Amp Circuits:</p> <p>3.2.1 Understand the configuration and operation of inverting Op-Amp circuits.</p> <p>3.2.2 Understand the configuration and operation of non-inverting Op-Amp circuits.</p> <p>3.2.3 Analyze the voltage gain of inverting and non-inverting Op-Amp circuits.</p> <p>3.2.4 Inverting Op-Amp Circuit:</p> <p>3.2.5 Explain the configuration and operation of an inverting Op-Amp circuit.</p> <p>3.2.6 Derive and analyze the voltage gain formula for an inverting Op-Amp circuit</p> <p>3.2.7 Non-Inverting Op-Amp Circuit:</p> <p>3.2.8 Explain the configuration and operation of a non-inverting Op-Amp circuit.</p> <p>3.2.9 Derive and analyze the voltage gain formula for a non-inverting Op-Amp circuit</p>	1
<p>3.3 Op-Amp Applications:</p> <p>3.3.1 Understand and analyze the operation of a voltage follower (buffer).</p> <p>3.3.2 Understand and analyze the operation of Op-Amp circuits for addition and subtraction.</p> <p>3.3.3 Understand and analyze the operation of Op-Amp circuits for integration and differentiation.</p> <p>3.3.4 Voltage Follower (Buffer):</p> <p>3.3.5 Explain the configuration and operation of a voltage follower.</p> <p>3.3.6 Discuss the advantages of using a voltage follower (e.g., impedance matching, buffering).</p> <p>3.3.7 Adder (Summing Amplifier):</p> <p>3.3.8 Explain the configuration and operation of an Op-Amp adder circuit.</p> <p>3.3.9 Derive and analyze the output voltage formula for an adder circuit</p> <p>3.3.10 Subtractor (Difference Amplifier):</p> <p>3.3.11 Explain the configuration and operation of an Op-Amp Subtractor circuit.</p> <p>3.3.12 Derive and analyze the output voltage formula for a Subtractor circuit</p> <p>3.3.13 Integrator:</p> <p>3.3.14 Explain the configuration and operation of an Op-Amp integrator circuit.</p> <p>3.3.15 Derive and analyze the output voltage formula for an integrator</p> <p>3.3.16 Differentiator:</p> <p>3.3.17 Explain the configuration and operation of an Op-Amp differentiator circuit.</p> <p>3.3.18 Derive and analyze the output voltage formula for a differentiator</p>	2
<p>3.4 Basic Problem-Solving:</p> <p>3.4.1 Solve basic problems involving the design and analysis of inverting and non-inverting Op-Amp circuits.</p> <p>3.4.2 Solve problems involving the application circuits of Op-Amps such as voltage followers, adders, subtractors, integrators, and differentiators.</p> <p>3.4.3 Inverting and Non-Inverting Circuits:</p> <p>3.4.4 Solve problems involving the design and analysis of inverting and non-inverting Op-Amp circuits, including calculating the gain</p> <p>3.4.5 Application Circuits:</p> <p>3.4.6 Solve problems involving analysis of Op-Amp application circuits such as voltage followers, adders, subtractors, integrators, and differentiators.</p> <p>3.4.7 Calculate the output voltages for given input conditions in these application circuits.</p>	2

IV. Digital Electronics:	
General Learning Objective: To understand the fundamental concepts of digital electronics, including number systems, binary codes, binary arithmetic, Boolean algebra, logic gates, and their applications. This module covers the simplification of Boolean expressions and the operation of basic and universal logic gates.	
4.1 Number Systems and Binary Codes: 4.1.1 Understand different number systems and their conversions. 4.1.2 Explain binary codes and their applications. 4.1.3 Decimal, Binary, Octal, and Hexadecimal Systems: 4.1.4 Explain the decimal, binary, octal, and hexadecimal number systems. 4.1.5 Perform conversions between these number systems. 4.1.6 Binary Codes: 4.1.7 Describe different types of binary codes such as Binary Coded Decimal (BCD), Gray code 4.1.8 Explain the applications and significance of each binary code.	1
4.2 Binary Arithmetic: 4.2.1 Perform basic arithmetic operations using binary numbers. 4.2.2 Addition, Subtraction, Multiplication, and Division: 4.2.3 Perform binary addition, including handling of overflow. 4.2.4 Perform binary subtraction using the 2's complement method. 4.2.5 Perform binary multiplication and division.	1
4.3 Boolean Algebra: 4.3.1 Understand the fundamental laws and theorems of Boolean algebra. 4.3.2 Simplify Boolean expressions using these laws and theorems. 4.3.3 Fundamental Laws and Theorems: 4.3.4 Explain the fundamental laws of Boolean algebra (e.g., commutative, associative, distributive). 4.3.5 Understand De Morgan's theorems and their application in simplifying Boolean expressions. 4.3.6 Simplification of Boolean Expressions: 4.3.7 Simplify Boolean expressions using algebraic methods and Karnaugh maps (K-maps).	1
4.4 Logic Gates: 4.4.1 Understand the operation and truth tables of basic logic gates: AND, OR, NOT, NAND, NOR, XOR, XNOR. 4.4.2 Explain the concept of universal gates and their applications. 4.4.3 AND, OR, NOT, NAND, NOR, XOR, XNOR Gates: 4.4.4 Explain the operation of each logic gate and their truth tables. 4.4.5 Draw the circuit symbols for each gate. 4.4.6 Truth Tables: 4.4.7 Construct and analyze truth tables for given logic gate circuits. 4.4.8 Universal Gates: 4.4.9 Explain the concept of universal gates (NAND and NOR). 4.4.10 Demonstrate how universal gates can be used to implement any Boolean function.	1
4.5 Basic Problem-Solving: 4.5.1 Solve problems related to number system conversions, binary arithmetic, Boolean algebra, and logic gates. 4.5.2 Number System Conversions: 4.5.3 Solve problems involving conversions between decimal, binary, octal, and hexadecimal number systems. 4.5.4 Binary Arithmetic: 4.5.5 Solve problems involving binary addition, subtraction, multiplication, and division. 4.5.6 Boolean Algebra: 4.5.7 Simplify complex Boolean expressions using Boolean algebra laws and K-maps. 4.5.8 Logic Gate Circuits: 4.5.9 Analyze and design basic logic gate circuits. 4.5.10 Implement Boolean expressions using basic and universal logic gates.	2

V. Communication Systems	
<p>General Learning Objective: To understand the fundamentals of communication systems, including frequency spectrum, modulation techniques, and applications such as satellite communication, radar systems, data transmission, and MODEMs.</p>	
<p>5.1 Basic Communication System:</p> <p>5.1.1 Understand the block diagram of a basic communication system.</p> <p>5.1.2 Explain the significance of the frequency spectrum in communication systems.</p> <p>5.1.3 Block Diagram of a Basic Communication System:</p> <p>5.1.4 Identify and describe the transmitter, transmission medium, receiver, and noise.</p> <p>5.1.5 Frequency Spectrum:</p> <p>5.1.6 Explain the importance of the frequency spectrum and its allocation for various communication services.</p> <p>5.1.7 Understand the concept of bandwidth and its role in communication systems.</p>	1
<p>5.2 Modulation Techniques:</p> <p>5.2.1 Understand the need for modulation in communication systems.</p> <p>5.2.2 Explain different methods of modulation, including amplitude modulation (AM), frequency modulation (FM), pulse analog, and pulse digital modulation.</p> <p>5.2.3 Need for Modulation:</p> <p>5.2.4 Reasons for Modulation:</p> <p>5.2.5 Explain why modulation is necessary in communication systems (e.g., to transmit signals over long distances, to allow multiple signals to share the same channel).</p> <p>5.2.6 Methods of Modulation:</p> <p>5.2.7 Amplitude Modulation (AM):</p> <p>5.2.8 Describe the principles of amplitude modulation and its applications.</p> <p>5.2.9 Frequency Modulation (FM):</p> <p>5.2.10 Explain the principles of frequency modulation and its advantages over AM.</p> <p>5.2.11 Pulse Analog Modulation:</p> <p>5.2.12 Understand the concepts of pulse amplitude modulation (PAM), pulse width modulation (PWM), and pulse position modulation (PPM).</p> <p>5.2.13 Pulse Digital Modulation:</p> <p>5.2.14 Explain pulse code modulation (PCM) and delta modulation (DM)</p>	2
<p>5.3 AM and FM Transmitters and Receivers:</p> <p>5.3.1 Understand the block diagrams of AM and FM transmitters and receivers.</p> <p>5.3.2 Explain the basic principles of operation for AM and FM transmitters and receivers.</p> <p>5.3.3 Block Diagram Descriptions:</p> <p>5.3.4 AM Transmitters:</p> <p>5.3.5 Describe the block diagram of an AM transmitter and explain the function of each block.</p> <p>5.3.6 FM Transmitters:</p> <p>5.3.7 Describe the block diagram of an FM transmitter and explain the function of each block.</p> <p>5.3.8 AM Receivers:</p> <p>5.3.9 Describe the block diagram of an AM receiver and explain the function of each block.</p> <p>FM Receivers:</p> <p>5.3.10 Describe the block diagram of an FM receiver and explain the function of each block.</p>	2
<p>5.4 Satellite Communication:</p> <p>5.4.1 Understand the principles and components of satellite communication systems.</p> <p>5.4.2 Principles and Components:</p> <p>5.4.3 Satellite Communication Systems:</p> <p>5.4.4 Explain the basic principles of satellite communication, including geostationary and low Earth orbit satellites.</p> <p>5.4.5 Describe the main components of a satellite communication system: transponder, uplink, and downlink.</p> <p>5.4.6 Discuss the applications of satellite communication (e.g., GPS, internet access).</p>	1

<p>5.5 Radar Systems:</p> <p>5.5.1 Explain the basic principles and applications of radar systems.</p> <p>5.5.2 Radar Systems:</p> <p>5.5.3 Explain the basic operating principle of radar systems (e.g., transmission and reception of radio waves).</p> <p>5.5.4 Describe different types of radar systems and their applications</p>	
<p>5.6 Data Transmission and MODEMS:</p> <p>5.6.1 Understand the principles of data transmission and the role of MODEMS in communication systems.</p> <p>5.6.2 Principles of Data Transmission:</p> <p>5.6.3 Data Transmission:</p> <p>5.6.4 Explain the basic principles of data transmission, including analog and digital transmission.</p> <p>5.6.5 Discuss the role of encoding and decoding in data transmission.</p> <p>MODEMS:</p> <p>5.6.6 Describe the function of a MODEM (modulator-demodulator) in converting digital data to analog signals and vice versa.</p> <p>5.6.7 Explain the different types of MODEMS and their applications in communication systems.</p>	
<p>5.7 Problem-Solving:</p> <p>5.7.1 Communication Systems:</p> <p>5.7.2 Analyze block diagrams of communication systems and identify the function of each component.</p> <p>5.7.3 Modulation Techniques:</p> <p>5.7.4 Solve problems involving the calculation of modulation indices and bandwidth requirements for AM and FM signals.</p> <p>5.7.5 Transmitters and Receivers:</p> <p>5.7.6 Interpret and analyze block diagrams of AM and FM transmitters and receivers.</p>	

Subject Name/Code: Induction Programme / 107

Instructional hours:

Lecture : 15 hours

Total contact hours : 15 hours

Credits : Nil

Table of Topics

Unit	Topic	Hour (L)
I	Gender Sensitisation Training (DGS Order)	12
II	Anti- Ragging Guidelines (UGC Act)	03
	Total	15

Subject Name/Code: Geometrical Drawing Skills/UG11P5101

Instructional hours:

Practical	: 45 hours
Total contact hours	: 45 hours
Credits	: 1.5

Teaching Methods

The practical training will be hands-on with focus on safety and skills.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments)	: 50%
Final Exam	: 50%

Text Book:

1. N.D. Bhatt, Engineering Drawing, Charotar Publishing House.

Reference:

1. Simmonds, C.H. and Maguire D.E. Progressive Engineering Drawing for T.E.C students, London, Hodder and Stoughton Ltd.
2. M. B. Shah and B.C. Rana, Engineering Drawing, Pearson Education.

Table of Topics

Unit	Topic	Hour (P)
I	Dimensioning	4
II	Types of drawings	2
III	Line work	2
IV	Pictorial Projection	6
V	Development	6
VI	Engineering drawing practice	25
	Total	45

Learning Objectives		P
<p>I. Dimensioning General Learning Objective Demonstrate insertion of various dimensions following conventional methods Sub-topics & SLOs 1.1 Draughtsman ship 1.2 Lettering, dimensioning 1.3 Types of lines and correct use of drawing instruments 1.4 Construction of geometrical figures specially showing joining of straight lines and Curves, dimensions a simple component, applying all correct standards 1.5 Explain the advantage of datum dimensioning</p>	4	
<p>II. Types of drawings General Learning Objective Understand about good draftsman-ship curves used in the engineering practice and projection of solids Sub-topics & SLOs 2.1 Explain the purpose of the general arrangement 2.2 Explain the purpose of the assembly drawings 2.3 Explain the purpose of component drawings 2.4 Explain the use of collective single-part drawings 2.5 Explain the use of pictorial drawings 2.6 List the standard/ routine information and references commonly given on drawings</p>		2
<p>III. Line work General Learning Objective Draw and illustrate various projections of engineering drawings Sub-topics & SLOs 3.1 Relate examples of lines to applications and vice-versa 3.2 Draw tangents as required in practice 3.3 Demonstrate what is meant by: first-angle projection third-angle projection and sketch the correct symbol for both cases using given examples 3.4 Complete first and third-angle projections with missing lines missing views simple plotted curves 3.5 Prepare a sketch given simple components and provides sufficient dimensions for their Manufacture</p>		2

<p>IV. Pictorial Projection General Learning Objective Draw and illustrate various isometric views of few basic engineering components</p> <p>Sub-topics & SLOs</p> <ol style="list-style-type: none"> 4.1 Draw isometric projections of simple solids 4.2 Draw orthographic projections of simple solids 4.3 Axis perpendicular to a plane 4.4 Axis parallel to both planes 4.5 Axis parallel to one plane and inclined to the other 4.6 Axis inclined to both planes 4.7 Generate sectional views in orthographic projection 	6
<p>V. Development General Learning Objective Draw and illustrate various projections of regular geometric shapes</p> <p>Sub-topics & SLOs</p> <ol style="list-style-type: none"> 5.1 Draw the development of a 90° intersection of circular trunking 5.2 Draw the development of a cone 5.3 Draw the development of a square pyramid 5.4 Draw the development of a square-to-round transition piece 5.5 Develop the surface of prisms 5.6 Draw pyramids and cones and the curves of intersection of cylinders to cylinders, cylinders to cones and other solids 	6
<p>VI. Engineering Drawing Practice General Learning Objective Demonstrate by drawings sectional views using 1st angle projection method, an understanding of Engineering drawing</p> <p>Sub-topics & SLOs</p> <ol style="list-style-type: none"> 6.1 Sections in two parallel planes 6.2 Revolved sections 6.3 Removed Sections 6.4 Part sections 6.5 Half sections 6.6 Hidden detail 6.7 Conic sections construction of ellipse, 6.8 Parabola and hyperbola by various methods 6.9 Drawing of spirals 6.10 Involutives 6.11 Cycloids 6.12 Helixes 	25

Subject Name/Code: Engineering Workshop Training/UG11P5102

Instructional hours:

Practical	: 45 hours
Total contact hours	: 45 hours
Credits	: 1.5

Teaching Methods

The practical training will be hands-on with focus on safety and skills.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual locations.

Class Assessments (Written tests/MCQs/Projects/Assignments)	: 50%
Final Exam	: 50%



Table of Topics

Unit	Topic	Hour (P)
I	Safety Measures Sub-Topic: Safe working practices, Introduction to workshop machines and Personal protective equipment and Risk hazards in workshop while performing practical and Identification and checks of safety equipment /guards	2
II	Fitting shop Bench Work & Tools Sub - Topic: Bench Fitting hand and measuring Tools Fasteners, hand and measuring Tools, Job Holding Devices, striking tools, marking tools, Cutting and their application. Drill machine introduction, parts, speed setting and operation. Making of a Fitting task involving application of all above tools and accessories	15
III	Carpentry Shop Sub Topic: Carpentry Hand tools (different types of chisels, hammer, marking tools, planning tools), Job holding devices, Carpenter drilling and boring tools and their correct use while making wood joints Dovetail and Lap Joint.	6
IV	Smithy Shop Sub - topic: Smithy tools and accessories (Furnace, Anvil, Swage Block, flatter, fuller, hot chisel, smithy tong, drift), Use of above tools in smithy operation (Drawing down, Hot bending and up setting, making square head.)	3
V	Power operated hand Tools Sub Topic: Safe handling of Power tools like, Electrical hand grinder, buffing machine, pneumatic chipping hammer, Pneumatic wrench	3
VI	Joining Processes Sub-Topic: Electric Arc Welding, process and techniques, TIG, MIG, and Oxyacetylene Gas Welding/Cutting, Inspection of Arc and Gas welding, Spot Welding, Brazing techniques.	12
VII	Identify parts & mechanisms of lathe Identify parts & mechanisms of lathe understand their application, Different types of Cutting Tools Used in lathe operations.	4
	Total	45

Learning Objectives	P
I. Safety measures	
<p>General Learning Objective (IMO7.04,2014, F3/3.15P135and 7.02D3/3.3P144-146) Increase safety awareness and develop the safety culture in the student while working on the shop floor /equipment</p> <p>Sub-topic: Safety measures Sub-subtopics &SLOs Safe working practices, Introduction to workshop machines and Personal protective Equipment Risk hazards in workshop while performing practical and Identification and checks of safety equipment/guards</p>	
<p>Specific Learning Objectives:</p> <p>1.1 Safe working practice, Introduction to workshop machines and Personal protective equipment.</p> <p>1.1.1 Explain the safe working practices to be followed while working in the workshop area/equipment.</p> <p>1.1.2 Explain the importance of PPE.</p> <p>1.1.3 Explain the various hazards of shop floor/equipment and protection for each.</p> <p>1.1.4 Explain safety instructions and operating instruction for each workplace and equipment.</p>	1
<p>1.2 Risk hazards in the workshop while performing practical and Identification and checks of safety equipment/guards.</p> <p>1.2.1 Explain the importance of safety Guards and Safety Devices provided in each equipment /workplace</p> <p>1.2.2 Demonstrate safe working practices while performing working in the workshop/equipment</p> <p>1.2.3 Describe/ Familiarization of Workshop area / Equipment.</p>	1
II. Fitting shop Bench Work & Tools	
<p>General Learning Objective (IMO7.04,2014, F3/3.16) P136 Bench Fitting hand and measuring Tools Identify and explain uses of various. Fasteners, hand and measuring Tools, Job Holding Devices, striking tools, marking tools, Cutting and their application. Drill machine introduction, parts, speed setting and operation. Making of a Fitting task involving application of all above tools and accessories</p> <p>Sub topic: Common Workshop Tools Sub-subtopics & SLOs</p> <p>2.1 Bench and Fitting Tools 2.2 Carpentry Shop 2.3 Smithy Shop 2.4 Power operated hand Tools</p>	
<p>Specific Learning Objectives:</p> <p>2.1 Bench Fitting hand and measuring Tools</p> <p>2.1.1 Explain and Demonstrate Uses of Common Fasteners, spanners and wrenches</p> <p>2.1.2 Explain and demonstrate application of different work holding devices like Bench vice, Hand vice and v-block with clamp</p> <p>2.1.3 Explain and demonstrate application of different Striking tools (Ball-peen, cross-peen, straight-peen, Double-headed and soft hammer)</p> <p>2.1.4 Explain and Demonstrate Application of Cutting Tools (Chisels, files, scraper and Hacksaw)</p> <p>2.1.5 Explain and demonstrate uses of Measuring Tools i.e. Vernier Caliper, Micrometer, Dial Gauge, Thread Pitch Gauge, Ring Gauge, Plug Gauge Etc.</p> <p>2.1.6 Explain and Demonstrate Different Marking Tools (surface plate, scribe, punches, angle plate, Try-square etc.</p> <p>2.1.7 Demonstrate making of an open fitting task using hacksawing, and filing operation Sketch and describe about Twist drill nomenclature and angle</p> <p>2.1.8 ExplainDrillmachineanditsparts.DemonstrateSpeedsettingofdrillmachine</p>	15

2.1.9 Demonstrate Close fitting task us hacksawing, chain drilling, chipping and filing operation any one task Close/ open fitting	
III. Carpentry Work	
3.1.1 Demonstrate use of Marking and measuring tools (Marking gauge, mortise gauge, fold rule, Try square, MITRE square, pattern Maker scale, caliper and sprit level etc.) 3.1.2 Demonstrate Use of Cutting Tools (Saw, chisel and Gouge tools etc.) 3.1.3 Demonstrate Use of Tools (Jack Plane, smoothing plane etc.) 3.1.4 Demonstrate Use of Job Holding Device and Boring Tools Demonstrate making of Dove Tail Joint, Lap Joint	6
IV. Smith and Foundry work	
4.1.1 Explain and demonstrate use of smithy tools (Anvil, swage block, hammers, tongs, chisel, fullers, flatters, punches drift etc.) 4.1.2 Demonstrate Making of job consisting of drawing down, hot bending and making square head	3
V. Power Operated Hand Tools	
5.1.1 Demonstrate Safe Working Practices while operating Power hand tools 5.1.2 Demonstrate Grinding/buffing operation using hand grinder 5.1.3 Demonstrate Use of Pneumatic Tools	3
VI. Joining Processes	
General Learning Objective (IMO7.04,2014, F3/3.16) P (137-141) Understand the various aspects of permanent material joining processes like welding, soldering, brazing Sub - topic: Joining Processes (Electric Arc Welding- Gas Welding /Cutting-Soldering Brazing) Sub – subtopics & SLOs 6.1 Electric Arc Welding process, techniques and Inspection 6.2 Oxy Acetylene Gas Welding/Cutting and Inspection 6.3 Soldering Brazing	
Specific Learning Objectives: 6.1 Electric Arc Welding process and techniques 6.1.1 Demonstrates a reworking practice while performing welding, Safety instruction Hot work permit and operating instruction of the welding machine 6.1.2 Demonstrate the connection of the welding machine and preparation for welding. Straight Polarity and Reverse Polarity 6.1.3 Demonstrate Arc striking an arc stabilizing 6.1.4 Demonstrate weld acceptable bead making for a satisfactory weld 6.1.5 Demonstrate Lap Joint weld, T Weld and Butt Weld 6.1.6 Demonstrate V Weld 6.1.7 Explain common defecting arc welding and their remedial action 6.1.8 Demonstrate TIG/MIG welding process 6.1.9 Demonstrate Brazing and soldering operation	12
6.2 Oxy Acetylene Gas Welding/Cutting 6.2.1 Demonstrates a reworking practice while performing Oxy acetylene welding/cutting, Safety instruction Hot work permit and operating instruction of the oxy acetylene system 6.2.2 Demonstrate connecting oxy acetylene system and preparing for operation 6.2.3 Identify different components and accessories of oxy acetylene system and explain their applications 6.2.4 Demonstrate different flame setting and explain their uses 6.2.5 Demonstrate Fusion welding without/with filler 6.2.6 Demonstrate gas cutting of a 10mm thick plate straight and circular and Inspection process	

<p>6.3 Brazing 6.3.1 Explain the Process of Brazing</p>	
<p>VII. Identify parts & mechanisms of lathe and understand their application, Different types of Cutting Tools Used in lathe operations General Learning Objective (IMO 7.04,2014/3.1.6(6.3) P-137) Subtopics & SLO Safe working practices while working on lathe machine Subtopics & SLO 7.1 Make a step pulley of given size as per given tolerances (facing, turning, center drilling, drilling, step turning operation) 7.2 Demonstrate safe working practices while using lathe machine 7.3 Carry out facing operation of a given job 7.4 Demonstrate center drilling and subsequent drilling operation 7.5 Demonstrate step turning operation as per given dimension 7.6 Explain Drilling operation on lathe and thread Cutting using tap and dies 7.7 Carry out job setting on lathe machine 7.8 Demonstrate facing and center drilling operation 7.9 Demonstrate turning operation as per given dimension 7.10 Demonstrate tapping and die operation using taps and dies</p>	<p>4</p>

Subject Name/Code: Basic Electrical Technology Lab /UG11P5103

Instructional hours

Practical	: 45 hours
Total contact hours	: 45 hours
Credits	: 1.5

Teaching Methods

The practical training will be hands-on with focus on safety and skills.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments)	: 50%
Final Exam	: 50%

List of Experiments:

1. Familiarization of electrical components
2. Verification of KCL and KVL for DC circuits
3. Measurement of series and parallel combination of resistances
4. Series resonance in RLC based circuit
5. Estimation of phase angle in RL circuit
6. Measurement of current, power and power factor of incandescent lamp, fluorescent lamp, LED lamp and draw the comparison
7. Measurement of resistance and inductance of a choke coil
8. Determination of phase and line quantities in three phase star and delta connected loads
9. Measurement of three phase power using two wattmeter method
10. Measurement of Resistance by Wheatstone bridge
11. Measurement of Insulation Resistance by Megger

Subject Name/Code: Basic Electronics Lab /UG11P5104

Instructional hours:

Practical	: 45 hours
Total contact hours	: 45 hours
Credits	: 1.5

Teaching Methods

The practical training will be hands-on with focus on safety and skills.

Assessment Methods: Refer to IMU Guide lines prior to the start to the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments)	: 50%
Final Exam	: 50%

List of Experiments:

1. Familiarization of Electronic Components
2. I-V characteristics of forward biased P-N Junction Diode.
3. Reverse characteristics of Zener Diode
4. Zener Diode as a voltage regulator.
5. Half-wave rectifier using diode
6. Full wave Bridge rectifier
7. Truth Table verification of Logic Gates.
8. Realization of basic logic gates using NAND & NOR Gates.
9. Input & output characteristics of BJT in CE and CB mode.
10. Voltage follower and summing amplifier using op amp
11. Op-Amp as an Integrator
12. Shipboard based electronic circuit diagram familiarisation and reading (at least two circuits): (from Shipboard Electrical Manual)

SEMESTER – II

Subject Name/Code: Engineering Mathematics-II/UG11T5201

Instructional Hours:

Lecture	: 45 hours
Tutorial	: 15 hours
Total Contact hours	: 60 hours
Credits	: 4

Teaching Methods

The course shall be conducted in a combination of classroom lectures, case study analysis, writing assignments and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/ Assignments)	: 30 %
Final Exam	: 70 %

Text Book:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44th edition, 2010.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, Latest edition.

Reference:

1. Ordinary and Partial Differential Equations by Dr M.D. Raisinghania
2. Dennis G. Zill and Warren S. Wright, Advanced Engineering Mathematics, Fourth Edition, Jones & Bartlett.
3. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson, Reprint.
4. Veerarajan T., Engineering Mathematics for first year, Tata McGraw Hill, New Delhi.
5. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint.
6. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint

Table of Topics

Unit	Topics	Hour (L)
I	Complex Mathematics Function of Complex variable: Analytic function, C-R equations, Harmonic Functions, Cauchy's integral theorem, Cauchy's integral formula, Derivatives of analytic functions, Taylor's and Laurent's series, Singularities, Zeroes and Poles, Residue theorem, Evaluation of real integrals of the type $\int_0^{2\pi} f(\cos \theta, \sin \theta) d\theta$ and $\int_{-\infty}^{+\infty} f(x) dx$.	12
II	Laplace Transform Laplace transform, properties of Laplace Transform, Existence theorem, Laplace transform of derivatives and integrals, Inverse Laplace transform, Unit step function, Dirac-delta function, Laplace transform of periodic functions, Convolution theorem, Applications to solve simple linear and simultaneous differential equations	14
III	Fourier Series Periodic functions: Properties, Even & Odd functions: Properties, Special wave forms: Square wave, Sine wave, Saw tooth wave, Triangular wave. Euler's Formulae for Fourier Series, Fourier Series for functions of period 2π , Dirichlet's conditions, Sum of Fourier series. Examples. Theorem for the convergence of Fourier series (statement only). Fourier series of a function with its periodic extension, Half Range Fourier Series: Construction of Half range Sine Series, Parseval's identity (statement only), Examples.	12
IV	Fourier Transform Fourier Integral Theorem (statement only), Fourier Transform of a function, Fourier Sine and Cosine Integral Theorem (statement only), Fourier Cosine & Sine Transforms. Fourier Cosine & Sine Transforms of elementary functions, Properties of Fourier Transform: Linearity, Shifting, Change of scale, Examples, Convolution Theorem (statement only), Inverse of Fourier Transform, Examples	10
V	Numerical Solution of Algebraic, Transcendental & Ordinary Differential Equations Solution of Algebraic & Transcendental equations: Regula Falsi, Newton-Raphson, Iterative and Secant Method. Solution of simultaneous linear equations: Gauss Elimination, Gauss Jordan, Jacobi and Gauss-Seidel Iterative methods. Solution of Ordinary Differential Equations: Picard's Method, Modified Euler's Method, Runge-Kutta Method.	12
	Total	60

Learning Objectives	L
I. Complex Mathematics	
General Learning Objective: To understand the theory of functions of a complex variable, including analytic functions, harmonic functions, Cauchy-Riemann equations, Cauchy's theorems, series expansions, and the evaluation of real integrals using residue theory.	
1.1 Analytic Functions: 1.1.1 Understand the concept of analytic functions in the context of complex variables. 1.1.2 Apply the Cauchy-Riemann (C-R) equations to determine whether a function is analytic.	1
1.2 Definition and Properties: 1.2.1 Define an analytic (holomorphic) function and understand its properties. 1.2.2 Explain the significance of a function being differentiable in the complex plane.	1
1.3 Harmonic Functions: 1.3.1 Recognize and understand harmonic functions and their properties.	
1.4 Definition and Relationship to Analytic Functions: 1.4.1 Define harmonic functions and understand their relationship to analytic functions. 1.4.2 Prove that the real and imaginary parts of an analytic function are harmonic.	1
1.5 Cauchy's Integral Theorem and Formula: 1.5.1 Understand and apply Cauchy's Integral Theorem. 1.5.2 Understand and apply Cauchy's Integral Formula for the evaluation of integrals.	1
1.6 Statement and Proof: 1.6.1 State and prove Cauchy's Integral Theorem.	1
1.7 Applications: 1.7.1 Apply Cauchy's Integral Theorem to evaluate contour integrals.	1
1.8 Cauchy's Integral Formula: 1.8.1 Statement and Applications: 1.8.2 State Cauchy's Integral Formula 1.8.3 Apply Cauchy's Integral Formula to find values of analytic functions and their derivatives.	1
1.9 Derivatives of Analytic Functions: 1.9.1 Understand the process of finding derivatives of analytic functions.	1
1.10 Higher-Order Derivatives: 1.10.1 Understand and calculate higher-order derivatives of analytic functions using Cauchy's formulas.	1
1.11 Series Expansions: 1.11.1 Understand Taylor's series and Laurent's series expansions for complex functions.	1
Taylor's Series: 1.11.2 Series Expansion: 1.11.3 Derive and apply Taylor's series expansion for functions analytic at a point.	1
Laurent's Series: 1.11.4 Series Expansion: 1.11.5 Derive and apply Laurent's series expansion for functions with singularities. 1.11.6 Understand the difference between Taylor and Laurent series.	1
1.12. Singularities, Zeroes, and Poles: 1.12.1 Classify and analyze singularities, zeroes, and poles of complex functions.	1
Singularities: 1.12.2 Classification: 1.12.3 Classify singularities as removable, poles, or essential.	1

<p>1.12.4 Determine the order of poles and describe the behavior of functions near singularities.</p> <p>Zeroes and Poles:</p> <p>1.12.5 Properties and Calculations:</p> <p>1.12.6 Identify and characterize the zeroes and poles of complex functions.</p> <p>1.12.7 Calculate residues at poles.</p> <p>1.13 Residue Theorem:</p> <p>1.13.1 Understand and apply the Residue Theorem for evaluating complex integrals.</p> <p>1.13.2 Statement and Proof:</p> <p>1.13.3 State and prove the Residue Theorem.</p> <p>1.14 Applications:</p> <p>1.14.1 Apply the Residue Theorem to evaluate complex integrals.</p> <p>1.14.2 Solve problems involving contour integrals using residues.</p> <p>1.15 Evaluation of Real Integrals:</p> <p>1.15.1 Use residue calculus to evaluate real integrals of specific types.</p> <p>1.16 Types and Methods:</p> <p>1.16.1 Use residue calculus to evaluate real integrals of the type</p> <p>1.17 Techniques:</p> <p>1.17.1 Apply techniques involving semicircular contours and the Jordan Lemma.</p> <p>1.17.2 Evaluate integrals of trigonometric functions using contour integration.</p> <p>1.18 Problem-Solving:</p> <p>1.18.1 Analytic Functions:</p> <p>1.18.2 Solve problems to determine whether a function is analytic using the C-R equations.</p> <p>1.19 Harmonic Functions:</p> <p>1.19.1 Identify and solve problems involving harmonic functions.</p> <p>1.20 Cauchy's Theorems and Formula:</p> <p>1.20.1 Apply Cauchy's Integral Theorem and Formula to evaluate contour integrals.</p> <p>1.21 Series Expansions:</p> <p>1.21.1 Derive Taylor and Laurent series for given functions.</p> <p>1.22 Singularities and Residues:</p> <p>1.22.1 Classify singularities and calculate residues for given functions.</p> <p>1.23 Real Integrals:</p> <p>1.23.1 Use the Residue Theorem to evaluate specific types of real integrals.</p>	4
II. Laplace Transform	
<p>General Learning Objective: To understand the theory and applications of the Laplace Transform, including its properties, theorems, and its use in solving differential equations.</p> <p>2.1 Understand the definition and basic concepts of the Laplace Transform.</p> <p>2.2 Compute the Laplace Transform of standard functions.</p> <p>2.3 Properties of Laplace Transform:</p> <p>2.3.1 Understand and apply the properties of the Laplace Transform, including linearity, shifting, and scaling.</p> <p>2.4 Existence Theorem:</p> <p>2.4.1 Understand the conditions under which the Laplace Transform exists.</p> <p>2.5 Laplace Transform of Derivatives and Integrals:</p> <p>2.5.1 Compute the Laplace Transform of derivatives and integrals of functions.</p> <p>2.6 Inverse Laplace Transform:</p> <p>2.6.1 Understand and compute the Inverse Laplace Transform of functions.</p> <p>2.7 Unit Step Function and Dirac-Delta Function:</p> <p>2.7.1 Understand and compute the Laplace Transform of the unit step function and Dirac-delta function.</p> <p>2.8 Laplace Transform of Periodic Functions:</p> <p>2.8.1 Compute the Laplace Transform of periodic functions.</p> <p>2.9 Convolution Theorem:</p> <p>2.9.1 Understand and apply the Convolution Theorem for Laplace Transforms.</p> <p>2.10 Applications to Differential Equations:</p> <p>2.10.1 Use Laplace Transforms to solve simple linear and simultaneous differential equations.</p>	<p>2</p> <p>2</p> <p>2</p> <p>2</p> <p>2</p> <p>2</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p>

III. Fourier Series and Fourier Transform	
<p>General Learning Objective: To understand and apply the concepts of Fourier Series and Fourier Transform in analyzing periodic functions and their properties, including specific waveforms, convergence, and practical applications.</p> <p>3.1 Periodic Functions:</p> <p>3.1.1 Understand the properties of periodic functions. 3.1.2 Differentiate between even and odd functions and understand their properties. 3.1.3 Analyze special waveforms such as square wave, rectified sine wave, saw tooth wave, and triangular wave.</p> <p>3.2 Definition and Properties:</p> <p>3.2.1 Define periodic functions and understand their properties, including periodicity and fundamental period.</p>	2
<p>3.3 Even and Odd Functions:</p> <p>3.3.1 Define even and odd functions. 3.3.2 Understand the properties of even and odd functions:</p> <p>3.4 Special Waveforms:</p> <p>3.4.1 Analyze special waveforms: 3.4.2 Square Wave: Understand its periodic nature and representation. 3.4.3 Rectified Sine Wave: Analyze the periodic extension of the sine wave. 3.4.4 Saw tooth Wave: Understand its linear increase and sharp drop. 3.4.5 Triangular Wave: Analyze its linear increase and decrease.</p> <p>3.5 Euler's Formulae for Fourier Series:</p> <p>3.5.1 Derive and understand Euler's formulae for Fourier Series. 3.5.2 Compute the Fourier Series for functions with period 2π.</p> <p>3.6 Dirichlet's Conditions and Sum of Fourier Series:</p> <p>3.6.1 Understand Dirichlet's conditions for the convergence of Fourier Series. 3.6.2 Compute the sum of a Fourier series.</p> <p>3.7 Convergence Theorem of Fourier Series:</p> <p>3.7.1 Understand the statement of the theorem for the convergence of Fourier Series.</p> <p>3.8 Fourier Series of Functions with Periodic Extension:</p> <p>3.8.1 Compute the Fourier series of a function with its periodic extension.</p> <p>3.9 Half Range Fourier Series:</p> <p>3.9.1 Construct the Half Range Sine Series for a given function. 3.9.2 Apply Parseval's identity (statement only).</p> <p>3.10 Examples and Applications:</p> <p>3.10.1 Solve examples to illustrate the application of Fourier Series and Fourier Transform. 3.10.2 Apply these concepts to practical problems.</p>	2 2 2 2 2 1 1
<p>IV. Fourier Transform</p> <p>General Learning Objective: To understand the concepts and applications of Fourier Transforms, including the Fourier Integral Theorem, Fourier Sine and Cosine Transforms, properties of Fourier Transforms, and the Inverse Fourier Transform.</p>	

<p>4.1 Fourier Integral Theorem: 4.1.1 Understand the statement of the Fourier Integral Theorem. 4.1.2 Compute the Fourier Transform of standard functions</p> <p>4.2 Fourier Transform of a Function: 4.2.1 Understand and compute the Fourier Transform of a given function.</p> <p>4.3 Fourier Sine and Cosine Integral Theorem: 4.3.1 Understand the statements of the Fourier Sine and Cosine Integral Theorems.</p> <p>4.4. Fourier Sine and Cosine Transforms: 4.4.1 Understand and compute the Fourier Sine and Cosine Transforms of functions.</p> <p>4.5 Properties of Fourier Transforms: 4.5.1 Understand and apply the properties of Fourier Transforms, including linearity, shifting, and scaling.</p> <p>4.6 Convolution Theorem: 4.6.1 Understand the statement of the Convolution Theorem for Fourier Transforms.</p> <p>4.7 Inverse Fourier Transform: 4.7.1 Understand and compute the Inverse Fourier Transform of a given function.</p> <p>4.8 Applications and Examples: 4.8.1 Solve problems and provide examples to illustrate the use of Fourier Transforms and their properties.</p>	<p>2</p> <p>1</p> <p>1</p> <p>1</p> <p>2</p> <p>1</p> <p>2</p>
V. Numerical Solution of Algebraic, Transcendental & Ordinary Differential Equations	
<p>General Learning Objective: To understand and apply numerical methods for solving algebraic, transcendental, and ordinary differential equations, including iterative methods for linear systems and techniques for differential equations.</p> <p>5.1 Solution of Algebraic & Transcendental Equations: 5.1.1 Understand and apply the Regula Falsi method. 5.1.2 Understand and apply the Newton-Raphson method. 5.1.3 Understand and apply iterative methods. 5.1.4 Understand and apply the Secant method.</p> <p>5.2 Solution of Simultaneous Linear Equations: 5.2.1 Understand and apply the Gauss Elimination method. 5.2.2 Understand and apply the Gauss Jordan method. 5.2.3 Understand and apply the Jacobi iterative method. 5.2.4 Understand and apply the Gauss-Seidel iterative method.</p> <p>5.3 Solution of Ordinary Differential Equations: 5.3.1 Understand and apply Picard's method. 5.3.2 Understand and apply the Modified Euler's method. 5.3.3 Understand and apply the Runge-Kutta method.</p>	<p>4</p> <p>4</p> <p>4</p>

Subject Name/Code Introduction to Computers & Python Programming/UG11T5202

Instructional Hours:

Lecture	: 45 hours
Tutorial	: 15 hours
Total contact hours	: 60 hours
Credits	: 4

Teaching Methods

The course shall be conducted in a combination of classroom/online lectures, tutorial and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments)	: 30%
Final Written Exam	: 70%

Text Book:

1. Let us Python, Aditya Kanetkar Yashavant Kanetkar, BPB latest edition.
2. Ripley, B. Venables, W.N., Venables, W.S programming. Germany: Springer.

Reference:

1. McKinney, W. Python for Data Analysis. Taiwan: O'Reilly Media, Incorporated.
2. Ripley, B. D., Venables, W. N. Modern Applied Statistics with S-PLUS. Springer Science + Business Media
New York
3. Adler, J.R in a Nutshell: A Desktop Quick Reference. United State: O'Reilly Media.
4. McKinney, W. Python for Data Analysis. Taiwan: O'Reilly Media, Incorporated.
5. <https://cran.r-project.org/manuals.html>
6. <https://docs.python.org/3/>

Table of Topics

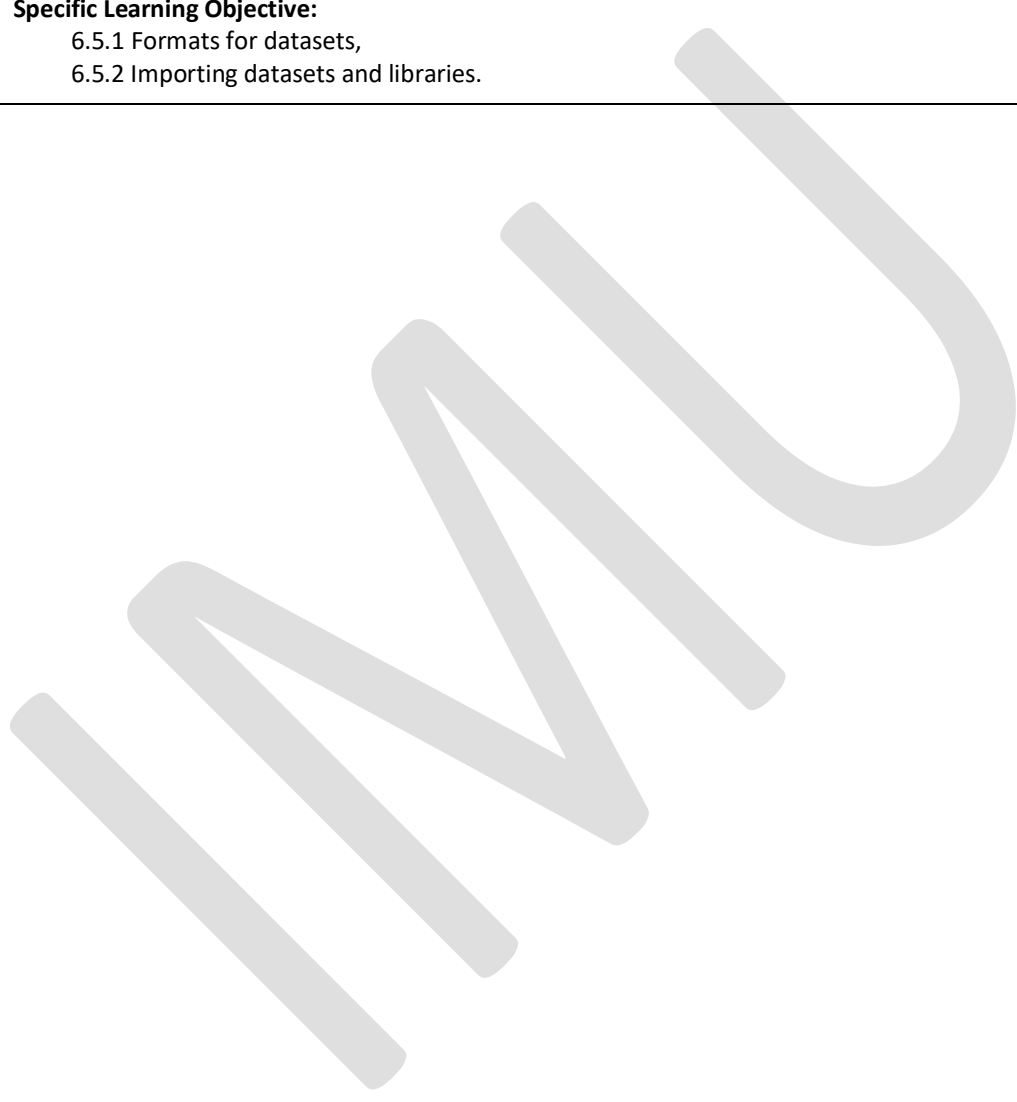
Unit	Topic	Hour (L)
I	R: Using R under Linux / Windows	7
II	Python: Data Science	11
III	Distribution and Data Summaries / Univariate Statistics, Linear Statistical Models, Generalized Linear Models, Robust Statistics	10
IV	Non-Linear and Smooth Regression, Multivariate analysis, Tree – based methods, Random and mixed effects:	12
V	Modern Regression, Exploratory multivariate analysis, Classification:	8
VI	Survival analysis, Time series analysis, Spatial statistics, Optimization, Datasets, software and Libraries	12
Total		60

Learning Objectives	L
<p>General Learning Objective:</p> <p>The course is intended to enable the students learn to use Python and R (Plus) programming for statistics and data visualization. Using R or Python, students can open manipulate, plot and save data, perform data analysis, modelling and perform statistical analyses. The topics build up foundation to advanced topics in AI, Automation and programming.</p>	
<p>Sub-sub topics:</p> <p>I. R: Using R under Linux / Windows</p> <p>Specific Learning Objective: Learn using R in Linux or Windows operating systems – downloading, checking, installing, basics, installing packages, use of libraries, use R with statistics, use data visualization packages and use it.</p> <ol style="list-style-type: none"> 1.1 Introduction: Overview of R, Using R. Concise description of R objects, calling conventions for functions, arithmetical expressions, reading data, model formulae, character vector operations, finding R objects, indexing vectors, matrices and arrays, matrix operations, Input / Output facilities, customizing R environment, history and audit trails, batch operations. 1.2 Data Manipulation: Objects, connections, data manipulation, tables and cross-classification 1.3 The R Language: Language layout, R objects, Arithmetical expressions, character vector operations, formatting and printing, Calling conventions for functions, model formulae, control structures, array and matrix operations, introduction to classes and methods. 1.4 Graphics: Graphics devices, basic plotting functions, enhancing plots, fine control of graphics, Trellis graphics, Object oriented editable graphics. 1.5 Programming in R: Control structures, vectorized calculations and loop avoidance functions, writing your own functions, introduction to object orientation, editing, correcting and documenting functions, calling the operating system, recursion and handling vectorization, frames. 	7
<p>II. Python: Data Science</p> <p>Specific Learning Objective: Learn using Python in Linux or Windows operating systems – downloading, checking, installing, basics, installing packages, use of python toolkits / libraries, use Python with statistics, data visualization and generation of various graphs, plots.</p> <ol style="list-style-type: none"> 2.1 Ipython: Basics, using the command history, interacting with the operating system, advanced Ipython features – making own classes, profiles and configuration. 2.2 NumPy basics: Arrays and vectorized computation – the NumPy ND array, universal functions, data processing using arrays, file input and output with arrays, 2.3 Pandas: Introduction to Pandas data structures, essential functionality, summarizing and computing descriptive statistics, handling missing data, hierarchical indexing 2.4 Data Loading, storage and file formats: reading and writing data in text format, binary data formats, interacting with HTML and web APIs, interacting with databases 2.5 Data wrangling: Clean, Transform, Merge, reshape – combining and merging data sets, reshaping and pivoting, data transformation, string manipulation 2.6 Plotting and Visualization: Matplotlib API Primer – figures, subplots, colours, markers and line styles, ticks, labels and legends, annotations and drawing on a subplot, saving plots to file, Matplotlib configuration, plotting with pandas – line, bar plots; histograms and density plots, scatter plots, python visualization tool ecosystem. 2.7 Data aggregation and group operations – Group by mechanics, data aggregation, group-wise operations and transformations, pivot tables and cross tabulation 	11

<p>III. Distribution and Data Summaries / Univariate Statistics: Specific Learning Objective: 3.1.1 Probability distributions, 3.1.2 Generating random data, 3.1.3 Data summaries, 3.1.4 Classical univariate statistics, 3.1.5 Density estimation, 3.1.6 Bootstrap and 3.1.7 Permutation methods.</p>	2
<p>3.2 Linear Statistical Models: Specific Learning Objective: 3.2.1 Linear regression example, model formulae and model matrices, 3.2.2 Regression diagnostics, 3.2.3 Safe prediction, 3.2.4 Factorial designs and designed experiments, 3.2.5 An unbalanced four-way layout, 3.2.6 An analysis of covariance example, 3.2.7 Model formulae and model matrices, 3.2.8 Robust and resistant regression, 3.2.9 Bootstrapping linear models, 3.2.10 Predicting computer performance, multiple comparisons</p>	3
<p>3.3 Generalized Linear Models: Specific Learning Objective: 3.3.1 Functions for generalized linear modelling, 3.3.2 Binomial data, Poisson and multinomial models, 3.3.3 A negative binomial family, 3.3.4 Over dispersion in binomial and Poisson 3.3.5 GLMs</p>	2
<p>3.4 Robust Statistics: Specific Learning Objective: 3.4.1 Univariate samples, 3.4.2 Median polish, 3.4.3 Robust regression, 3.4.4 Resistant regression, 3.4.5 Multivariate location and scale.</p>	3
<p>IV. Non-Linear and Smooth Regression: Specific Learning Objective: 4.1.1 Introduction with examples, 4.1.2 Fitting non-linear regression models, 4.1.3 Non-linear fitted model objects and method functions, 4.1.4 Taking advantage of linear parameters, 4.1.5 Confidence intervals for parameters, 4.1.6 Assessing the linear approximation, 4.1.7 Profiles 4.1.8 Constrained non-linear regression, 4.1.9 General optimization and maximum likelihood estimation, 4.1.10 One-dimensional curve-fitting, 4.1.11 Additive models, 4.1.12 Projection pursuit regression, 4.1.13 Neural networks.</p>	3

<p>4.2 Multivariate analysis: Specific Learning Objective: 4.2.1 Graphical methods, 4.2.2 Cluster analysis, 4.2.3 Discriminant analysis, 4.2.4 Factor analysis.</p>	2
<p>4.3 Tree – based methods: Specific Learning Objective: 4.3.1 Partitioning methods, 4.3.2 Cutting trees down to size, 4.3.3 Implementation in part, 4.3.4 Implementation in tree</p>	2
<p>4.4 Random and mixed effects: Specific Learning Objective: 4.4.1 Random effects and variance components, 4.4.2 multi-stratum models, 4.4.3 Linear models, classic nested designs, 4.4.4 Non-linear mixed effects models, 4.4.5 Generalized linear mixed models, 4.4.6 GEE Models,</p>	3
<p>V. Modern Regression: Specific Learning Objective: 5.1.1 Additive models and scatterplot smoothers, 5.1.2 project pursuit regression, 5.1.3 response transformation models, 5.1.4 neural networks</p>	3
<p>5.2 Exploratory multivariate analysis: Specific Learning Objective: 5.2.1 Visualization methods, 5.2.2 Cluster analysis, 5.2.3 Factor analysis, 5.2.4 Discrete multivariate analysis,</p>	3
<p>5.3 Classification: Specific Learning Objective: 5.3.1 Discriminant analysis, 5.3.2 Classification theory, 5.3.3 non-parametric rules, 5.3.4 Neural networks, 5.3.5 Support vector machines, 5.3.6 Calibration plots</p>	2
<p>VI. Survival analysis: Specific Learning Objective: 6.1.1 Estimators of survivor curves, 6.1.2 Parametric models, 6.1.3 Cox proportional hazards model and examples</p>	2
<p>6.2 Time series analysis: Specific Learning Objective: 6.2.1 Second-order summaries, 6.2.2 ARIMA Models, seasonality, 6.2.3 Nottingham Temperature Data, 6.2.4 Regression with Auto correlated errors, 6.2.5 Models for financial series</p>	3

6.3 Spatial statistics: Specific Learning Objective: 6.3.1 Spatial interpolation and smoothing, 6.3.2 Kriging, 6.3.3 Point process analysis.	2
6.4 Optimization: Specific Learning Objective: 6.4.1 Univariate functions, 6.4.2 Special-purpose optimization functions, 6.4.3 General optimization	3
6.5 Datasets, software and Libraries: Specific Learning Objective: 6.5.1 Formats for datasets, 6.5.2 Importing datasets and libraries.	2



Subject: Name/Code: Thermodynamics /UG11T5203

Instructional hours

Lecture	: 45 hours
Tutorial	: 15 hours
Total contact hours	: 60 hours
Credits	: 4

Teaching Methods

The course shall be conducted in a combination of classroom/online lectures, tutorials and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments)	: 30%
Final Exam	: 70%

Text Book:

1. Basic Thermodynamics, P K Nag; McGraw Hill.
2. Çengel, Y. A., Boles. (2014). Thermodynamics: An Engineering Approach. India: McGraw Hill Education.

Reference:

1. Bailey, M. B., Boettner, D.D., Moran, M.J., Shapiro, H.N. Fundamentals of Engineering Thermodynamics. United Kingdom: Wiley.
2. Sonntag, R.E., Borgnakke, C. Borgnakke's Fundamentals of Thermodynamics. United State: Wiley.
3. Harrington (Editor) Marine Engineering. United State: Society of Naval Architects and Marine Engineers. (For Tutorials, this book may be used).
4. Keenan, J.H., Hatsopoulos, G.N. Principles of general thermodynamics. United Kingdom: Wiley. - www.archive.org
5. Karamchandani, C.J., Patel, R.C. Elements of Heat Engines. Acharya Book Depot.

Table of Topics

Unit	Topic	Hour (L)
I	Basic Concepts and Application Areas of Thermodynamics in Maritime Industry	9
II	Energy, Energy Transfer and General Energy Analysis	9
III	Energy Analysis of Closed Systems	9
IV	Mass and Energy Analysis of Control Volumes	7
V	The Second Law of Thermodynamics	8
VI	Entropy and Properties of Pure Substances	11
VII	Gas Power Cycles	7
	Total	60

Learning Objectives	L
<p>I. Basic Concepts and Application Areas of Thermodynamics in Maritime Industry</p> <p>General Learning Objective: Understand fundamental principles, conservation laws and rate processes of the physical sciences, Laws of Nature, Fundamental engineering knowledge and systematic analysis of systems, processes, engines, machinery, energy, energy conversion, power plant</p>	
<p>Specific Learning Objectives:</p> <p>1.1 Explain how thermodynamic fundamentals help in understanding engines, pumps, compressors, air conditioning / refrigeration plants, heat transfer / exchangers, fuel estimation etc. (Note: Suggested tutorial from 'Marine Engineering' by Harrington)</p> <p>1.2 Explain the basic concepts of thermodynamics such as system, state, state postulate, equilibrium, process, and cycle</p> <p>1.3 Discuss properties of a system</p> <p>1.4 Explain the following:</p> <p> 1.4.1 Systems and control volumes</p> <p> 1.4.2 State and Equilibrium</p> <p> 1.4.3 Processes and cycles</p> <p> 1.4.4 Temperature and the Zeroth Law of Thermodynamics</p>	9
<p>II. Energy, Energy Transfer and General Energy Analysis</p>	
<p>Specific Learning Objectives:</p> <p>2.1. Explain the concept of energy and define its various forms</p> <p>2.2. Discuss the nature of internal energy Define the concept of heat and the terminology associated with energy transfer by heat</p> <p>2.3. Define the concept of work, including electrical work and several forms of mechanical work</p> <p>2.4. Introduce the first law of thermodynamics, energy balances and mechanisms of energy transfer to or from a system</p> <p>2.5. Determine that a fluid flowing across a control surface of a control volume carries energy across the control surface in addition to any energy transfer across the control surface that may be in the form of heat and/or work</p> <p>2.6. Discuss the implications of energy conversion on the environment</p>	9

III. Energy Analysis of Closed Systems:		
<p>Specific Learning Objectives:</p> <p>3.1. Examine the moving boundary work or P dV work commonly encountered in reciprocating devices such as automotive engines and compressors</p> <p>3.2. Identify the first law of thermodynamics as simply a statement of the conservation of energy principle for closed (fixed-mass) systems</p> <p>3.3. Develop the general energy balance applied to closed systems</p> <p>3.4. Define the specific heat at constant volume and the specific heat at constant pressure Relate the specific heats to the calculation of the changes in internal energy and enthalpy of ideal gases</p> <p>3.5. Describe incompressible substances and determine the changes in their internal energy and enthalpy</p> <p>3.6. Solve energy balance problems for closed (fixed-mass) systems that involve heat and work interactions for general pure substances, ideal gases, and incompressible substances</p>	9	
IV. Mass and Energy Analysis of Control Volumes		
<p>Specific Learning Objectives:</p> <p>4.1. Develop the conservation of mass principle</p> <p>4.2. Apply the conservation of mass principle to various systems.</p> <p>4.3. Apply the first law of thermodynamics as the statement of the conservation of energy principle to control volumes, Identify the energy carried by a fluid stream crossing a control surface as the sum of internal energy, flow work, kinetic energy, and potential energy of the fluid and to relate the combination of the internal energy and the flow work to the property enthalpy</p> <p>4.4. Solve energy balance problems for common steady-flow devices such as nozzles, compressors, turbines, throttling valves, mixing chambers, and heat exchangers</p>	7	
V. The Second Law of Thermodynamics		
<p>Specific Learning Objectives:</p> <p>5.1. State the second law of thermodynamics Identify valid processes as those that satisfy both the first and second laws of thermodynamics</p> <p>5.2. Discuss thermal energy reservoirs, reversible and irreversible processes, heat engines, refrigerators, and heat pumps</p> <p>5.3. Describe the Kelvin–Planck and Clausius statements of the second law of thermodynamics</p> <p>5.4. Discuss the concepts of perpetual-motion machines</p> <p>5.5. Apply the second law of thermodynamics to cycles and cyclic devices</p> <p>5.6. Apply the second law to develop the absolute thermodynamic temperature scale</p> <p>5.7. Describe the Carnot cycle</p> <p>5.8. Examine the Carnot principles, idealized Carnot heat engines, refrigerators, and heat pumps</p> <p>5.9. Determine the expressions for the thermal efficiencies and coefficients of performance for reversible heat engines, heat pumps, and refrigerators</p>	8	
VI. Entropy and Properties of Pure Substances		
<p>Specific Learning Objectives:</p> <p>6.1. Apply the second law of thermodynamics to processes</p> <p>6.2. Define a new property called entropy to quantify the second-law effects</p> <p>6.3. Establish the increase of entropy principle</p> <p>6.4. Calculate the entropy changes that take place during processes for pure substances, incompressible substances, and ideal gases</p> <p>6.5. Examine a special class of idealized processes, called isentropic processes.</p> <p>6.6. Derive the reversible steady-flow work relations</p> <p>6.7. Explain the concept of a pure substance Discuss the physics of phase change processes</p> <p>6.8. Illustrate the P-v, T-v, and P-T property diagrams and P-v-T surfaces of pure substances</p> <p>6.9. Describe the hypothetical substance ‘ideal gas’ and the ideal-gas equation of state.</p>	11	
VII. Gas Power Cycles		
<p>Specific Learning Objectives</p> <p>7.1 Engine cycles – Otto cycle, Diesel Cycle, Dual Cycle, Comparison of Otto, Diesel and Dual Cycles.</p> <p>7.2 Solve problems based on the Otto, Diesel, cycles, Dual Cycle.</p>	7	

Subject Name/Code: Engineering Mechanics/UG11T5204

Instructional Hours:

Lecture	: 45 hours
Tutorial	: 15 hours
Total Contact Hours	: 60 hours
Credits	: 4

Teaching Methods

The Course shall be conducted in a combination of Classroom/online lectures, tutorials and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments)	: 30%
Final Exam	: 70%

Text Book:

1. Applied Mechanics, IBPrasad, Khanna Publishers.
2. Engineering Mechanics by S Timoshenko, D.H Young, Tata Mc Graw hill, latest edition

Reference:

1. Reeds Volume 2: Applied Mechanics for Engineers; By William Embleton; Revised by J.T. Gunn; Publisher Sunderland Tyne and Wear) Thomas Reed.1983: ISBN0900335874.
2. Applied Mechanics, J. Hanna hand M. J. Hiller, Longman, 1998, ISBN: 9780582256323.
3. Engineering Mechanics Statics and Dynamics by Rajasekaran S and Sankara subramanian G.
4. A textbook of Engineering Mechanics by RS Khurmi.
5. A textbook of Engineering Mechanics by Dr.R K Bansal.

Table of Topics

Unit	Topic	Hour (L)
I	Introduction to Mechanics Subtopics: scalar and vector quantities, Define force, graphical representation of force, characteristics of force, system of forces.	4
II	Composition and Resolution of forces Subtopics: Resultant force, resolution of forces, composition of forces, triangle law of forces, law of parallelogram of forces, polygon law of forces, equilibrium of forces, free body diagrams, Lami's theorem, equilibrium conditions for coplanar concurrent forces Lifting Machines Subtopics: Introduction, importance, mechanical advantage, velocity ratio, efficiency,	12
III	Moment of force, couple and support reactions Subtopics: Moment of force about a point, principle of moments, couple, moment of couple, types of supports, equilibrium conditions for non-coplanar, non-concurrent force system.	8
IV	Introduction to friction and its application Subtopics: Principles of friction, equilibrium of body on rough surface, application of friction	8
V	Properties of Lines, Surfaces and Physical Bodies Subtopics: Centroid, center of mass and centre of gravity, analytical expressions of centroids, centroids of lines and curves, centroids of composite shapes, Pappus- Guldinus Theorems, second moment of area, radius of gyration, perpendicular axis theorem for second moment of area, parallel axis theorem,	10
VI	Kinematics and kinetics of linear motion Subtopics: kinematic parameters in linear motion, displacement, velocity, acceleration, time relationships, equations of linear motion with constant acceleration and variable acceleration, relative velocity, De Alembert's principle of dynamic equilibrium.	9
VII	Kinematics of curvilinear motion Subtopics: kinematic parameters in curvilinear motion, normal, tangential and total acceleration, projectile motion analysis.	9
Total		60

Learning Objectives	L
I. Introduction to Mechanics	
General Learning Objective: To understand the fundamental concepts of mechanics, including scalar and vector quantities, the definition and characteristics of force, and the analysis of systems of forces.	
1.1 Scalar and Vector Quantities: 1.1.1 Differentiate between scalar and vector quantities. Understand and apply the basic operations on vectors such as addition, subtraction, and multiplication.	0.5
1.2 Definition of Force: 1.2.1 Define force and understand its significance in mechanics. 1.2.2 Differentiate between different types of forces (e.g., gravitational, frictional, normal).	0.5
1.3 Graphical Representation of Force: 1.3.1 Represent forces graphically using vectors. 1.3.2 Understand the concepts of magnitude and direction in force vectors.	1
1.4 Characteristics of Force: 1.4.1 Identify and explain the characteristics of force, including magnitude, direction, and point of application. 1.4.2 Understand the concept of force as a vector quantity.	1
1.5 System of Forces: 1.5.1 Analyze different types of systems of forces, including concurrent, parallel, and non-Concurrent systems. 1.5.2 Understand the principles of equilibrium and the conditions necessary for a system of forces to be In equilibrium.	1
II. Composition and Resolution of forces	
General Learning Objective: To understand and apply the principles of composition and resolution of forces, and analyze the equilibrium of forces using various laws and theorems.	
2.1 Resultant Force: 2.1.1 Understand the concept of resultant force. 2.1.2 Calculate the resultant of multiple forces acting on a body.	
2.2 Definition: 2.2.1 Define the resultant force as the single force that represents the combined effect of two or more forces acting on a body.	1
2.3 Calculation: 2.3.1 Calculate the resultant force using both graphical methods (e.g., vector addition) and analytical methods (e.g., summation of components)	
2.4 Resolution of Forces: 2.4.1 Resolve a single force into its components along specified axes. 2.4.2 Apply trigonometric methods to resolve forces.	
2.5 Theory and Application: 2.5.1 Resolve a force into its horizontal and vertical components using trigonometric functions (sine and cosine).	1
2.6 Practical Application: 2.6.1 Apply the resolution of forces to solve problems involving inclined planes and other practical scenarios.	
2.7 Composition of Forces: 2.7.1 Combine multiple forces to find their resultant using graphical and analytical methods.	
2.8 Graphical Methods: 2.8.1 Combine multiple forces graphically using the head-to-tail method and parallelogram method.	1
2.9 Analytical Methods: 2.9.1 Combine multiple forces analytically by summing their components.	
2.10 Triangle Law of Forces: 2.10.1 Understand and apply the triangle law of forces for the addition of two forces.	2

<p>2.11 Theory: 2.11.1 State the triangle law of forces: If two forces acting at a point can be represented in magnitude and direction by the two sides of a triangle taken in order, then their resultant is represented by the third side of the triangle taken in the opposite order.</p>	
<p>2.12 Application: 2.12.1 Apply the triangle law of forces to solve problems involving two forces.</p>	
<p>2.13 Polygon Law of Forces: 2.13.1 Understand and apply the polygon law of forces for the addition of more than two forces.</p>	
<p>2.14 Theory: 2.14.1 State the polygon law of forces: If multiple forces acting on a particle can be represented in magnitude and direction by the sides of a polygon taken in order, their resultant is represented by the closing side of the polygon taken in the opposite order.</p>	1
<p>2.15 Application: 2.15.1 Apply the polygon law of forces to solve problems involving more than two forces.</p>	
<p>2.16 Equilibrium of Forces: 2.16.1 Understand the conditions for equilibrium of forces. 2.16.2 Analyze problems involving the equilibrium of forces.</p>	
<p>2.17 Conditions for Equilibrium: 2.17.1 State the conditions for the equilibrium of a particle: the vector sum of all forces acting on the particle must be zero.</p>	1
<p>2.18 Application: 2.18.1 Analyze and solve equilibrium problems involving multiple forces.</p>	
<p>2.19 Free Body Diagrams: 2.19.1 Draw free body diagrams to visualize forces acting on a body. 2.19.2 Use free body diagrams to solve equilibrium problems.</p>	
<p>2.20 Drawing FBDs: 2.20.1 Draw free body diagrams to represent all forces acting on a single body.</p>	1
<p>2.21 Problem Solving: 2.21.1 Use free body diagrams to solve equilibrium problems and calculate unknown forces</p>	
<p>2.22 Lami's Theorem: 2.22.1 Understand and apply Lami's theorem to solve problems involving three concurrent forces in equilibrium.</p>	
<p>2.23 Theory: 2.23.1 State Lami's theorem: If three concurrent forces acting on a particle keep it in equilibrium, then each force is proportional to the sine of the angle between the other two forces.</p>	1
<p>2.24 Application: 2.24.1 Apply Lami's theorem to solve problems involving three concurrent forces in equilibrium.</p>	
<p>2.25 Equilibrium Conditions for Coplanar Concurrent Forces: 2.25.1 Understand and apply the conditions for equilibrium of coplanar concurrent forces.</p>	
<p>2.26 Theory: 2.26.1 State the equilibrium conditions for coplanar concurrent forces: the sum of all horizontal forces must be zero, and the sum of all vertical forces must be zero.</p>	2
<p>2.27 Application: 2.27.1 Apply these conditions to analyze and solve problems involving the equilibrium of coplanar concurrent forces.</p>	
<p>2.28 Lifting Machines</p>	
<p>General Learning Objective: To understand the principles and applications of lifting machines, including their mechanical advantage, velocity ratio, and efficiency.</p>	
<p>2.29 Introduction to Lifting Machines: 2.29.1 Understand the basic concepts and importance of lifting machines.</p>	
<p>2.30 Basic Concepts: 2.30.1 Define lifting machines and explain their purpose in mechanical applications.</p>	2
<p>2.31 Importance: 2.31.1 Understand the importance of lifting machines in various industries and applications.</p>	
<p>2.32 Mechanical Advantage: 2.32.1 Define mechanical advantage and understand its significance in lifting machines.</p>	2
<p>2.33 Definition:</p>	

2.33.1 Define mechanical advantage (MA) as the ratio of the load lifted to the effort applied.	
2.34 Significance: 2.34.1 Understand the significance of mechanical advantage in the design and operation of lifting machines.	
2.35 Velocity Ratio: 2.35.1 Define velocity ratio and understand its significance in lifting machines.	
2.36 Definition: 2.36.1 Define velocity ratio (VR) as the ratio of the distance moved by the effort to the distance moved by the load.	3
2.37 Significance: 2.37.1 Understand the significance of velocity ratio in the efficiency and performance of lifting machines.	
2.38 Efficiency: 2.38.1 Define efficiency and understand its significance in lifting machines. 2.38.2 Calculate the efficiency of different lifting machines.	
2.39 Definition: 2.39.1 Define efficiency (η) as the ratio of the useful work output to the total work input, usually expressed as a percentage.	3
2.40 Calculation: 2.40.1 Calculate the efficiency of lifting machines using the formula:	
III. Moment of force, couple and support reactions	
General Learning Objective: To understand the concepts of moments and couples, analyze the equilibrium of non-coplanar, non-concurrent force systems, and determine support reactions in various structures.	
3.1 Moment of Force about a Point: 3.1.1 Define and calculate the moment of a force about a point. 3.1.2 Understand the significance and applications of moments in engineering.	
3.2 Definition: 3.2.1 Define the moment of a force about a point as the tendency of the force to rotate an object about that point.	
3.3 Calculation: 3.3.1 Calculate the moment of a force using the formula: 3.3.2 $M = F \times d$ where F is the force and d is the perpendicular distance from the point to the line of action of the force.	1
3.4 Applications: 3.4.1 Apply the concept of moments to solve practical problems in engineering, such as determining the torque on a beam or lever.	
3.5 Principle of Moments: 3.5.1 State and apply the principle of moments to solve problems involving forces and torques.	
3.6 Theory: 3.6.1 State the principle of moments: For a system to be in equilibrium, the sum of the clockwise moments about any point must be equal to the sum of the counterclockwise moments about that point.	0.5
3.7 Application: 3.7.1 Apply the principle of moments to solve problems involving multiple forces acting on a body.	
3.8 Couple: 3.8.1 Define a couple and understand its properties. 3.8.2 Calculate the moment of a couple	
3.9 Definition: 3.9.1 Define a couple as a pair of equal and opposite forces acting on a body, separated by a distance, creating a rotational effect without translation.	2
3.10 Properties: 3.10.1 Understand that the net force of a couple is zero, but it produces a pure moment.	
3.11 Calculation: 3.11.1 Calculate the moment of a couple using the formula: $M = F \times d$ where F is the magnitude of one of the forces and d is the perpendicular distance between the forces.	
3.12 Moment of Couple: 3.12.1 Understand the concept of the moment of a couple and how it affects the equilibrium of	2

structures.	
3.13 Concept: 3.13.1 Understand that the moment of a couple is constant regardless of the point of reference.	
3.14 Applications: 3.14.1 Apply the concept of couples to analyze the rotational effects in mechanical systems, such as gears and Levers	
3.15 Types of Supports: 3.15.1 Identify and describe different types of supports used in structures. 3.15.2 Understand how supports contribute to the equilibrium of structures.	1
3.16 Identification and Description: 3.16.1 Identify and describe different types of supports, including: 3.16.2 Fixed Support: Prevents all translational and rotational movement. 3.16.3 Pinned Support: Prevents translational movement but allows rotation. 3.16.4 Roller Support: Allows translation in one direction and rotation but prevents translation in the perpendicular direction.	
3.17 Reactions at Supports: 3.17.1 Understand how each type of support provides reactions to maintain equilibrium in structures 3.17.2 Equilibrium Conditions for Non-Coplanar, Non-Concurrent Force Systems: 3.17.3 Analyze the equilibrium conditions for non-coplanar, non-concurrent force systems. 3.17.4 Solve problems involving the equilibrium of such force systems.	
3.18 Theory: 3.18.1 State the conditions for equilibrium for non-coplanar, non-concurrent force systems: the sum of all forces and the sum of all moments about any point must be zero.	1
3.19 Applications: 3.19.1 Analyze and solve problems involving the equilibrium of non-coplanar, non-concurrent force systems.	
3.20 Problem-Solving Techniques: 3.20.1 Use techniques such as free body diagrams, vector analysis, and equilibrium equations to solve complex problems involving multiple forces and moments.	
3.21 Examples and Practical Applications: Examples: 3.21.1 Solve a variety of examples to reinforce understanding of moments, couples, and support reactions.	0.5
3.22 Practical Applications: 3.22.1 Apply these concepts to real-world problems in structural engineering, mechanical systems, and other Fields	
IV. Introduction to friction and its application	
General Learning Objective: To understand the principles of friction, analyze the equilibrium of bodies on rough surfaces, and apply the concepts of friction in practical scenarios.	
4.1 Principles of Friction: 4.1.1 Define friction and understand its causes and effects. 4.1.2 Distinguish between static and kinetic (dynamic) friction. 4.1.3 Understand the laws of friction and the coefficients of friction.	2
4.2 Definition: 4.2.1 Define friction as the resistance to motion that occurs when two surfaces are in contact.	
4.3 Causes: 4.3.1 Explain the causes of friction, including surface roughness and molecular adhesion.	
4.4 Types of Friction: 4.4.1 Distinguish between static friction (friction that prevents relative motion) and kinetic friction (friction that acts during relative motion).	
4.5 Laws of Friction: First Law: 4.5.1 State that the force of friction is directly proportional to the normal force. Second Law: 4.5.2 State that the force of friction is independent of the apparent area of contact, given the surfaces	

are in good contact. Third Law: 4.5.3 State that the force of kinetic friction is independent of the velocity of sliding, within certain limits.	
4.6 Coefficients of Friction: 4.6.1 Static and Kinetic Coefficients: 4.6.2 Define and distinguish between the coefficient of static friction (μ) and the coefficient of kinetic friction (μ_k).	
4.7 Calculation: 4.7.1 Calculate the force of friction using the formula: $F_f = \mu \times N$ where F_f is the force of friction, μ is the coefficient of friction, and N is the normal force.	
4.8 Equilibrium of Body on Rough Surface: 4.8.1 Analyze the equilibrium conditions for a body resting on a rough surface. 4.8.2 Calculate the forces of friction acting on a body on a rough surface. 4.8.3 Apply the concepts of friction to solve problems involving bodies on inclined planes and other rough surfaces.	2
4.9 Theory: 4.9.1 State the conditions for equilibrium: the sum of all forces and the sum of all moments acting on the body must be zero.	
4.10 Analysis: 4.10.1 Analyze the equilibrium of a body on a rough surface, considering both normal and frictional forces. Inclined Plane Problems: 4.10.2 Solve problems involving bodies on inclined planes, calculating the forces of friction and normal forces to determine equilibrium conditions	
4.11 Force of Friction: Calculation: 4.11.1 Calculate the force of static friction using the maximum static friction formula: $F_{f_{max}} = \mu_s \times N$ 4.11.2 Calculate the force of kinetic friction using the kinetic friction formula: $F_k = \mu_k \times N$ 4.12 Application of Friction: 4.12.1 Understand the practical applications of friction in everyday life and engineering. 4.12.2 Analyze and solve problems involving the use of friction in various mechanical systems.	2
4.13 Practical Applications: Everyday Applications: 4.13.1 Discuss the role of friction in everyday applications such as walking, braking in vehicles, and gripping objects. Engineering Applications: 4.13.2 Analyze the application of friction in mechanical systems like clutches, brakes, belt drives, and bearings. Problem-Solving: 4.13.3 Solve problems involving the application of friction in various mechanical systems and devices. Examples and Practical Applications: Examples: 4.13.4 Work through a variety of examples to reinforce understanding of friction, including static and kinetic scenarios. Practical Problems: 4.13.5 Apply these concepts to real-world problems in engineering and physics, such as designing braking systems or analyzing frictional forces in machinery.	2
V. Properties of Lines, Surfaces and Physical Bodies	
General Learning Objective: To understand and analyze the properties of lines, surfaces, and physical bodies, focusing on concepts such as centroid, center of mass, center of gravity, and second moment of area.	

<p>5.1 Centroid, Center of Mass, and Center of Gravity: 5.1.1 Define centroid, center of mass, and center of gravity. 5.1.2 Understand the differences and similarities between these concepts. 5.1.3 Calculate the centroid, center of mass, and center of gravity for various shapes and bodies.</p> <p>5.2 Definitions: Centroid: 5.2.1 Define the centroid as the geometric center of a plane figure.</p> <p>5.3 Center of Mass: 5.3.1 Define the center of mass as the point where the mass of an object is concentrated.</p> <p>5.4 Center of Gravity: 5.4.1 Define the center of gravity as the point where the gravitational force acts on an object.</p> <p>5.5 Calculations: Centroid: 5.5.1 Calculate the centroid for common geometric shapes (triangles, rectangles, circles).</p>	1
<p>5.6 Center of Mass and Gravity: 5.6.1 Determine the center of mass and center of gravity for uniform and non-uniform bodies.</p> <p>5.7 Analytical Expressions of Centroids: 5.7.1 Derive and use analytical expressions to find the centroids of simple geometric shapes. 5.7.2 Apply these expressions to find the centroids of more complex and composite shapes.</p>	1
<p>5.8 Centroids of Lines and Curves: 5.8.1 Calculate the centroids of lines and curves using integral calculus. 5.8.2 Understand the applications of centroids in engineering and physics.</p> <p>5.9 Centroids of Composite Shapes: 5.9.1 Determine the centroids of composite shapes by breaking them into simpler components. 5.9.2 Use the method of composite areas to find centroids of complex shapes.</p>	1
<p>5.10 Pappus-Guldinus Theorems: 5.10.1 State and apply Pappus-Guldinus theorems for determining surface areas and volumes of revolution.</p>	1
<p>5.11 Second Moment of Area: 5.11.1 Define the second moment of area (also known as the area moment of inertia). 5.11.2 Calculate the second moment of area for various shapes. 5.11.3 Understand the importance of the second moment of area in structural analysis.</p>	1
<p>5.12 Radius of Gyration: 5.12.1 Define the radius of gyration and its relation to the second moment of area. 5.12.2 Calculate the radius of gyration for different shapes and bodies.</p>	1
<p>5.13 Perpendicular Axis Theorem: 5.13.1 State and apply the perpendicular axis theorem for calculating the second moment of area for planar shapes.</p>	1
<p>5.14 Parallel Axis Theorem: 5.14.1 State and apply the parallel axis theorem for finding the second moment of area about any axis parallel to an axis through the centroid.</p> <p>5.15 Examples and Practical Applications: Examples: 5.15.1 Work through examples calculating centroids, moments of area, and applying theorems. Practical Applications: 5.15.2 Apply these concepts to real-world problems in structural engineering, mechanical design, and other fields.</p>	1
<p>VI. Kinematic Parameters in Linear Motion:</p>	
<p>General Learning Objective: To understand and analyze the kinematic and kinetic parameters of linear motion, including displacement, velocity, acceleration, and their time relationships, as well as the principles of dynamic equilibrium using D'Alembert's principle.</p>	
<p>6.1 Kinematic Parameters in Linear Motion: 6.1.1 Define and understand the basic kinematic parameters: displacement, velocity, and acceleration. 6.1.2 Differentiate between scalar and vector quantities in kinematics.</p>	1

<p>6.2 Displacement, Velocity, and Acceleration:</p> <p>6.2.1 Define displacement and understand its significance in linear motion.</p> <p>6.2.2 Define and calculate average and instantaneous velocity.</p> <p>6.2.3 Define and calculate average and instantaneous acceleration.</p> <p>6.2.4 Time Relationships and Equations of Linear Motion:</p> <p>6.2.5 Derive and apply the equations of linear motion for cases of constant acceleration.</p> <p>6.2.6 Understand and apply the equations of motion for variable acceleration.</p>	4
<p>6.3 Relative Velocity:</p> <p>6.3.1 Define and understand the concept of relative velocity.</p> <p>6.3.2 Solve problems involving relative velocity in linear m</p> <p>6.3.3 D'Alembert's Principle of Dynamic Equilibrium:</p> <p>6.3.4 Understand D'Alembert's principle and its application to dynamic equilibrium.</p> <p>6.3.5 Apply D'Alembert's principle to solve problems in kinetics of linear motion.</p>	4
VII. Kinematic Parameters in Curvilinear Motion:	
General Learning Objective:	
To understand and analyze the kinematic parameters of curvilinear motion, including normal, tangential, and total acceleration, and to perform detailed analysis of projectile motion.	
<p>7.1 Kinematic Parameters in Curvilinear Motion:</p> <p>7.1.1 Define and understand the basic kinematic parameters specific to curvilinear motion.</p> <p>7.1.2 Differentiate between scalar and vector quantities in curvilinear kinematics.</p>	2
<p>7.2 Normal and Tangential Acceleration:</p> <p>7.2.1 Define and calculate the normal and tangential components of acceleration.</p> <p>7.2.2 Understand the significance of normal and tangential acceleration in curvilinear motion.</p>	2
<p>7.3 Total Acceleration:</p> <p>7.3.1 Derive and calculate the total acceleration as a combination of normal and tangential components.</p>	2
<p>7.4 Projectile Motion Analysis:</p> <p>7.4.1 Understand the principles of projectile motion.</p> <p>7.4.2 Derive and apply the equations governing projectile motion.</p> <p>7.4.3 Analyze projectile motion in terms of range, maximum height, time of flight, and trajectory.</p>	3

Subject: Name/Code: Maritime Awareness/UG11T5205

Instructional hours:

Lecture	: 45 hours
Total contact hours	: 45 hours
Credits	: 3

Teaching Methods

The course shall be conducted in a combination of classroom/online lectures, tutorials and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments)	: 30%
Final Exam	: 70%

Text Book:

1. Sea Trading- Vol 1 (The Ships)- William V. Packard.
2. Sea Transport. – Patrick M. Alderton.

Reference:

1. Glossary of maritime Technology – N.S. Swindells.
2. Ship Construction – D. J. Eyres.
3. Basic seamanship, Marine Engineering & human relation for seafarers, P. P. Chugani.

Table of Topics

Unit	Topic	Hour (L)
I	International Trade Discussion on International Trade, Factor Condition, Different mode of transportation & their Merits & Demerits, World Seaborne trade & Major cargo Movement	7
II	Map Work & Geographical Features affecting Shipping Location of seas & oceans, Location of gulfs & straits, Indian port & their cargo, Important ports of the world, Important trade routes, Location of major ports for coal, Iron ore & crude oil, Location of major bunkering ports, Factors affecting Sea transport, Time zone & International Date lines, Concept of load lines	9
III	Ports & Related Activity and Organization & personnel connected with shipping Definitions (Harbour, Berth, Jetty, SBM etc.), Shipyard & scrapyard, Canals-Suez Or Panama, IMO, DGS, MMD, Shipping Master, FOSMA	7
IV	Familiarization with Ship Terms & Ship Types Ship Sketch & important Parts, Familiarization of Ship Terms, Introduction to ship Types,	7
V	Familiarization with ship Construction, Ship Manning & Organization onboard ship Principal Dimension of the ship, Ship Terms, Various Structural Member, Organization charts, Descriptions of duties of ship staff- List the functions of Fleet Personnel Department, Technical Management Department, Commercial Management Department, Safety & Quality Management Department, and Designated Person Ashore Describe the functions of the Deck Department, Engine Department, and Saloon Department List/Explain the functions and responsibilities of shipboard staff including Watch Keeping System: Master, Chief Officer, Second Officer, Third Officer, Deck Cadet, Bosun, Chief Engineer Officer, Second Engineer Officer, Third Engineer Officer, and Electro-Technical Officer Explain cadets' role on board and expectations from them.	15
Total		45

Learning Objectives		L
I. International Trade		7
General Learning Objective Understand International Trade, importance of international trade, Different modes of the transportation & significance of the shipping for the international trade		
Specific Learning Objectives: 1.1 Discussion on International Trade 1.1.1 Explain the importance of shipping for the International Trade		
Specific Learning Objectives: 1.2 Factor condition 1.2.1 Describe different factors which lead to international trade		

<p>Specific Learning Objectives:</p> <p>1.3 Air Transportation & their Merits & De merits</p> <p>1.3.1 Describe Air transportation</p> <p>1.3.2 Describe merits of air transportation</p> <p>1.3.3 Describe the De merits of air transportation</p>	
<p>Specific Learning Objectives:</p> <p>1.4 Road Transportation & their Merits & De merits</p> <p>1.4.1 Describe Road Transportation</p> <p>1.4.2 Describe merits of Road transportation</p> <p>1.4.3 Describe the De merits of Road transportation</p>	
<p>Specific Learning Objectives:</p> <p>1.5 Sea Transportation & their Merits & De merits</p> <p>1.5.1 Describe sea Transportation</p> <p>1.5.2 Describe merits of sea transportation</p> <p>1.5.3 Describe the De merits of sea transportation</p>	
<p>Specific Learning Objectives:</p> <p>1.6 Development of sea borne trade</p> <p>1.6.1 Describe the development in sea borne trade</p>	
<p>Specific Learning Objectives:</p> <p>1.7 Major Cargo transported through sea trade</p> <p>1.7.1 Describe the different types of cargo which is possible to be transported by sea</p>	
<p>II. Map work & Geographical features affecting shipping</p>	
<p>General Learning Objective: Understand location of various ports, oceans, seas, Major ports in India and world. Understand various geographical features affecting shipping & various concepts on time zones, international date line</p>	
<p>Specific Learning Objectives:</p> <p>2.1 Location of sea</p> <p>2.1.1 Mark location of the seas on the world Map</p>	
<p>Specific Learning Objectives:</p> <p>2.2 Location of oceans</p> <p>2.2.1 Mark the location of the oceans on the world Map</p>	
<p>Specific Learning Objectives:</p> <p>2.3 Location of gulf</p> <p>2.3.1 Map the location of the gulf on the world map</p>	
<p>Specific Learning Objectives:</p> <p>2.4 Location of straits</p> <p>2.4.1 Map location of the straits on the world map</p>	
<p>Specific Learning Objectives:</p> <p>2.5 Indian Ports</p> <p>2.5.1 Map location of all Indian ports on the India map</p>	9
<p>Specific Learning Objectives:</p> <p>2.6 Indian Port Cargo</p> <p>2.6.1 Describe different Indian port cargo & their significance because of geographical Location</p>	
<p>Specific Learning Objectives:</p> <p>2.7 Important World Ports</p> <p>2.7.1 Map important world ports on the world Map</p> <p>2.7.2 Describe the importance of some of the Important world port</p>	
<p>Specific Learning Objectives:</p> <p>2.8 Important Trade Routes for Ship</p> <p>2.8.1 Map the important trade routes for the ship</p> <p>2.8.2 Describe the importance of the trade routes</p>	
<p>Specific Learning Objectives:</p> <p>2.9 Major ports for the Coal</p> <p>2.9.1 Describe the Major ports for coal</p>	

<p>Specific Learning Objectives: 2.10 Major ports for the Iron ore 2.10.1 Describe the Major ports for iron ore</p>	
<p>Specific Learning Objectives: 2.11 Major ports for the crude oil 2.11.1 Describe the Major ports for crude oil</p>	
<p>Specific Learning Objectives: 2.12 Major Bunkering ports 2.12.1 Describe the major bunkering ports</p>	
<p>Specific Learning Objectives: 2.13 Climate 2.13.1 Explain how climate affects sea transport</p>	
<p>Specific Learning Objectives: 2.14 Tides 2.14.1 Explain how tides affect sea transport</p>	
<p>Specific Learning Objectives: 2.15 Winds 2.15.1 Explain how winds affect sea transport</p>	
<p>Specific Learning Objectives: 2.16 Currents 2.16.1 Explain how current affects sea transport</p>	
<p>Specific Learning Objectives: 2.17 Time zones Describe the time changes as per time zones & understand the concept behind change in timing</p>	
<p>Specific Learning Objectives: 2.18 International date line 2.18.1 Describe in brief on international date line</p>	
<p>Specific Learning Objectives: 2.19 Load line Marking on ship 2.19.1 Describe the load line Marking on ship 2.19.2 Describe the load line Marking significance</p>	
<p>III. Ports & Related Activity and Organization & personnel connected with shipping</p>	
<p>General Learning Objective: Understand in brief various terms related to ports & port activity, shipyard & scrapyard. Understand different organization & personnel connected to Shipping Industry & its Importance</p>	
<p>Specific Learning Objectives: 3.1 Harbour 3.1.1 Describe Harbour</p>	
<p>Specific Learning Objectives: 3.2 Berth 3.2.1 Describe Berth</p>	
<p>Specific Learning Objectives: 3.3 Jetty 3.3.1 Explain Jetty</p>	7
<p>Specific Learning Objectives: 3.4 Shipyard 3.4.1 Describe Shipyard</p>	
<p>Specific Learning Objectives: 3.5 Scrapyard 3.5.1 Describe scrapyard</p>	
<p>Specific Learning Objectives: 3.6 Suez Canal 3.6.1 Describe Suez Canal and mark its location on the world Map</p>	

<p>Specific Learning Objectives: 3.7 Panama Canal 3.7.1 Describe Panama Canal and mark its location on the world Map</p>	
<p>Specific Learning Objectives: 3.8 IMO 3.8.1 Describe IMO</p>	
<p>Specific Learning Objectives: 3.9 DGS 3.9.1 Describe DGS</p>	
<p>Specific Learning Objectives: 3.10 MMD 3.10.1 Describe MMD</p>	
<p>Specific Learning Objectives: 3.11 Shipping Master 3.11.1 Describe Shipping Master</p>	
<p>Specific Learning Objectives: 3.12 FOSMA 3.12.1 Describe FOSMA</p>	
<p>IV. Familiarization of ship terms & Ship Types</p>	
<p>General Learning Objective: Understand various terms related to ship so that students will identify the various spaces in the ship & know the function of important parts. Understand different types of ship & their general arrangements</p>	
<p>Specific Learning Objectives: 4.1 Longitudinal Sketch 4.1.1. Sketch longitudinal section of the ship 4.1.2 Identify major parts in the Longitudinal section of the Ship and describe the function of major parts</p>	
<p>Specific Learning Objectives: 4.2 Transverse Sketch 4.2.1 Sketch Transverse section of the ship 4.2.2 Identify major parts in the Transverse section of the Ship and describe the function of major parts</p>	
<p>Specific Learning Objectives: 4.3 Ballasting 4.3.1 Explain Ballasting 4.3.2 Describe the importance of ballasting</p>	7
<p>Specific Learning Objectives: 4.4. Double Bottom 4.4.1 Describe about Double bottom 4.4.2 Describe the importance of Double Bottom</p>	
<p>Specific Learning Objectives: 4.5 Trim & List 4.5.1 Describe Trim & List 4.5.2 Describe the importance of Trim & List</p>	
<p>Specific Learning Objectives: 4.6 General Cargo ship 4.6.1 Sketch the General cargo ship's longitudinal view and label various parts like cargo holds, engine room, peak tank, Double bottom tanks, Position of bulkheads & Crane</p>	
<p>Specific Learning Objectives: 4.7 Oil Tanker 4.7.1 Sketch the Oil tanker ship's longitudinal view and label various parts like bulkheads, cargo tanks, engine room</p>	

<p>Specific Learning Objectives: 4.8 Plan View of oil Tanker Ship 4.8.1 Sketch the plan view of oil tanker showing the arrangements of cargo, ballast tanks & accommodation space</p>	
V. Familiarization with ship construction, Ship Manning & Organization onboard ship	
<p>General Learning Objective: Understand Principal Dimensions of the ship & various terms related to ship construction. Understand organization onboard ship, Duties of ship staff & Watch keeping system on board ship</p>	
<p>Specific Learning Objectives: 5.1 Length overall 5.1.1 Define Length Overall 5.1.2 Show Length overall on simple sketch</p>	
<p>Specific Learning Objectives: 5.2 Forward Perpendicular 5.2.1 Define Forward Perpendiculars 5.2.2 Show Forward Perpendiculars on simple sketch</p>	
<p>Specific Learning Objectives: 5.3 Length on waterline 5.3.1 Define Length on waterline 5.3.2 Show Length on waterline on simple sketch</p>	
<p>Specific Learning Objectives: 5.4 Base Line 5.4.1 Define base line 5.4.2 Show base line on simple sketch</p>	
<p>Specific Learning Objectives: 5.5 Moulded Depth 5.5.1 Define Moulded Depth 5.5.2 Show Moulded Depth on simple sketch</p>	
<p>Specific Learning Objectives: 5.6 Moulded Beam 5.6.1 Define Molded beam 5.6.2 Show Moulded Beam on simple sketch</p>	15
<p>Specific Learning Objectives: 5.7 Moulded Draft 5.7.1 Define Moulded Draft 5.7.2 Show Moulded Draft on simple sketch</p>	
<p>Specific Learning Objectives: 5.8 Extreme Depth 5.8.1 Define Extreme Depth 5.8.2 Show Extreme Depth on simple sketch</p>	
<p>Specific Learning Objectives: 5.9 Beam 5.9.1 Define Beam 5.9.2 Show Beam on simple sketch</p>	
<p>Specific Learning Objectives: 5.10 Draft 5.10.1 Draft 5.10.2 Show Draft on simple sketch</p>	
<p>Specific Learning Objectives: 5.11 Camber 5.11.1 Define camber 5.11.2 Show camber on simple sketch 5.11.3 Describe the importance of camber</p>	

<p>Specific Learning Objectives:</p> <p>5.12 Rise of floor</p> <p>5.12.1 Define Rise of floor</p> <p>5.12.2 Show Rise of floor on simple sketch</p> <p>5.12.3 Describe the importance of Rise of floor</p>	
<p>Specific Learning Objectives:</p> <p>5.13 Tumblehome</p> <p>5.13.1 Define Tumblehome</p> <p>5.13.2 Show Tumblehome on simple sketch</p> <p>5.13.3 Describe the importance of Tumblehome</p>	
<p>Specific Learning Objectives:</p> <p>5.14 Flare</p> <p>5.14.1 Define Flare</p> <p>5.14.2 Show Flare on simple sketch</p> <p>5.14.3 Describe the importance of Flare</p>	
<p>Specific Learning Objectives:</p> <p>5.15 Sheer</p> <p>5.15.1 Define Sheer</p> <p>5.13.2 Show sheer on simple sketch</p> <p>5.13.4 Describe the importance of Sheer</p>	
<p>Specific Learning Objectives:</p> <p>5.16 Rake</p> <p>5.16.1 Define Rake</p> <p>5.16.2 Show Rake on simple sketch</p> <p>5.16.3 Describe the importance of Rake</p>	
<p>Specific Learning Objectives:</p> <p>5.17 Parallel Middle Body</p> <p>5.17.1 Define Parallel Middle Body</p> <p>5.17.2 Show Parallel Middle Body on simple sketch</p> <p>5.17.3 Describe the importance of Parallel Middle Body</p>	
<p>Specific Learning Objectives:</p> <p>5.18 Entrance</p> <p>5.18.1 Define Entrance</p> <p>5.18.2 Show Entrance on simple sketch</p> <p>5.18.3 Describe the importance of Entrance</p>	
<p>Specific Learning Objectives:</p> <p>5.19 Run</p> <p>5.19.1 Define Run</p> <p>5.19.2 Show Run on simple sketch</p> <p>5.19.3 Describe the importance of Run</p>	
<p>Specific Learning Objectives:</p> <p>5.20 Shell</p> <p>5.20.1 Describe shell</p>	
<p>Specific Learning Objectives:</p> <p>5.21 Deck</p> <p>5.21.1 Describe Deck</p>	
<p>Specific Learning Objectives:</p> <p>5.22 Tank Top</p> <p>5.22.1 Describe Tank top</p> <p>5.22.2 Identify tank top in the diagram</p>	
<p>Specific Learning Objectives:</p> <p>5.23 Bulkheads</p> <p>5.23.1 Describe Bulkheads</p>	
<p>Specific Learning Objectives:</p> <p>5.24 Stiffeners</p> <p>5.24.1 Describe Stiffeners</p>	
<p>Specific Learning Objectives:</p> <p>5.25 Pillars</p> <p>5.25.1 Describe Pillars</p>	

<p>Specific Learning Objectives: 5.26 Bulwarks 5.26.1 Describe Bulwarks & its importance</p>	
<p>Specific Learning Objectives: 5.27 Rudder 5.27.1 Describe Rudder & its importance</p>	
<p>Specific Learning Objectives: 5.28 propeller 5.28.1 Describe Propeller & its importance</p>	
<p>Specific Learning Objectives: 5.29 Hull 5.29.1 Describe Hull</p>	
<p>Specific Learning Objectives: 5.30 Sounding Pipe 5.30.1 Describe Sounding Pipe 5.30.2 Describe the importance of the sounding pipe</p>	
<p>Specific Learning Objectives: 5.31 Air Pipe 5.31.1 Describe Air pipe 5.31.2 Describe the importance of the Air pipe</p>	
<p>Specific Learning Objectives: 5.32 Ventilators 5.32.1 Describe Ventilators</p>	
<p>Specific Learning Objectives: 5.33 Deck Department Chart 5.33.1 Make deck department chart 5.33.2 Describe the general role of the person mentioned in the deck department Chart</p>	
<p>Specific Learning Objectives: 5.34 Engine Department Chart 5.34.1 Make Engine department chart 5.34.2 Describe the general role of the person mentioned in the Engine department Chart</p>	
<p>Specific Learning Objectives: 5.35 Engine Staff 5.35.1 Describe the Duties & responsibilities of the engine staff</p>	
<p>Specific Learning Objectives: 5.36 Deck Staff 5.36.1 Describe the Duties & responsibilities of the deck staff</p>	
<p>Specific Learning Objectives: 5.37 Watch keeping at sea 5.37.1 Describe watch keeping system & timings at sea</p>	
<p>Specific Learning Objectives: 5.38 Watch keeping at Harbour 5.38.1 Describe watch keeping system & timings at Harbour 5.38.2 List the functions of Fleet Personnel Department, Technical Management Department, Commercial Management Department, Safety & Quality Management Department, and Designated Person Ashore Describe the functions of the Deck Department, Engine Department, and Saloon Department List/Explain the functions and responsibilities of shipboard staff including Watch Keeping System: Master, Chief Officer, Second Officer, Third Officer, Deck Cadet, Bosun, Chief Engineer Officer, Second Engineer Officer, Third Engineer Officer, and Electro-Technical Officer Explain cadets' role on board and expectations from them</p>	

Subject Name/Code: Indian Traditional Knowledge and Its Maritime Linkage/UG11T5206

Instructional Hours

Lecture : 15 hours

Total contact hours : 15 hours

Credits : Nil

Teaching Methods

The course shall be conducted in a combination of classroom lectures and self-learning.

Assessment Methods Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Continuous Class Assessments (Written tests/MCQs/Projects/Assignments) : 100%

Text Book:

1. S. C. Chatterjee & D. M. Datta , An Introduction to Indian Philosophy.

Reference:

1. V. N. Jha: Language, Thought and Reality.
2. Pramod Chandra, India Arts, Howard Univ. Press.
3. Krishna Chaitanya, Arts of India, Abhinav Publications
4. R. Nagaswamy, Foundations of Indian Art, Tamil Arts Academy.
5. Rig Veda Hymn 1, Hymn 2 Translation by Ralph T H Griffith
6. Bertrand Russell, The Problems of Philosophy
7. Vijnananand Saraswati - Yog Vijyan, Yoga Niketan Trust, Rishikesh.
8. Rajkumari Pandey-Bhartiya Yoga Parampara Ke Vividh Ayam, Radha Publication, ND.
9. Swami Vivekanand - Jnan, Bhakti, Karma Yoga & Rajyoga, Advait Ashram, Culcutta.
10. Kamakhya Kumar -Yoga Mahavigyan, Standard Publisher, New Delhi.
11. Kalyan (Yogank)- Gita Press Gorakhpur.
12. L. N. Rangarajan, Kautilya: The Arthashastra, Penguin Books India (P) Limited

Table of Topics

Unit	Topic	Hour (L)
I	The basic structure of Indian Knowledge System Subtopics: Names of 4 Vedas, Up Vedas, 6 Vedangas	1
II	Fundamentals of Human Biology & Yoga Subtopics: General information, and Effect of yogic practices	2
III	Evolution of India through its Languages Subtopics: The Language Families of India	1
IV	Kautilya – The Artha shastra Subtopics: The Kautilyan State and Society	1
V	Formation of Indian Sub-Continent & Early Maritime Settlements	10
	Total	15

Learning objectives		L
I. Basic structure of Indian Knowledge System		
General Learning Objective Understand the basic structure of the Indian Knowledge System. 1.1 Basic Structure of Indian Knowledge System Sub-sub topics & SLOs 1.1.1 Difference between “Shruti” and “Smriti” 1.1.2 Names of 4 Vedas 1.1.3 Names of 4 Upvedas 1.1.4 Names of 6 Vedanga		1
1.2. Foundation of Yoga Sub-sub topics & SLOs 1.2.1 Origin of Yoga 1.2.2 Definition and Meaning of Yoga 1. 2.3 Aims and Objectives, Historical Development of Yoga 1.2.4 Relevance of Yoga in modern age and scope 1.2.5 Misconceptions about Yoga 1. 2.6 Life sketch and their contribution to Yoga		1
II. Fundamentals of Human Biology & Yoga		
Sub-sub topics & SLOs 2.1 Human Body- Meaning and its Importance in Yoga 2.2 Definition of Anatomy and Physiology 2.3 General information, Different parts, Structure, Function and Effect of yogic practices		1

III. Evolution of India through its Languages	
Specific Learning Objectives: 3.1 The Language Families of India 3.2 The Indo-Aryan Languages 3.3 The Dravidian Languages	1
IV. Specific Learning Objectives: 4.1 The Kautilyan State and Society	1
V. Formation of Indian Sub-Continent & Early Maritime Settlements 5.1 Subtopics: The evolution of India Early and Medieval India's Maritime linkage 5.2 Subtopics: Different kingdoms that were spread over India Colonial threats in Indian water and indigenous resistance 5.3 Subtopics: Resistance movement against colonialism Industrial effects on the Marine Industry of India 5.4 Subtopics: Industrial Revolution & British Imperialism; Sail to steam and diesel ships; Ship Construction Indian Maritime Power in Evolution 5.5 Subtopics: Growth of Indian Navy Emerging Maritime Rise 5.6 Subtopics: The rise of Indian Maritime power and dominance	10

Subject Name/Code: Constitution of India and Merchant Shipping Act /UG11T5207

Instructional Hours

Lecture : 15 hours

Total contact hours : 15 hours

Credits: : Nil

Teaching Methods

The course shall be conducted in a combination of classroom/online lectures, group discussion, individual/group presentation, writing assignments and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Continuous Class Assessments (Written tests/MCQs/Projects/Assignments) : 100%

Text Book:

1. D.Basu, Introduction to the Constitution of India, 2021.

Reference:

1. A Singh and K. Murari, Constitutional Government and Democracy in India, Pearson Education, 2019.

2. THE MERCHANT SHIPPING ACT.

<<https://www.dgshipping.gov.in/Content/MerchantShippingAct.aspx>>[Accessed 30 March 2024].

3. M.Laxmikant, Indian Polity, Chennai: McGrawHill, 2020.

4. P.Mallali, Constitution of India, Professional Ethics and Human Rights, New Delhi: SAGE Text.

5. S.Kashyap, Constitution of India- A handbook for students, New Delhi: Vitasta Publishing Pvt. Ltd.

Table of Topics

Unit	Topics	Hour (L)
I	Introduction to Indian Constitution Subtopics: (i) Introduction to Government of India Act 1919, Government of India Act 1935, and Indian Independence Act of 1947 (ii) Framing of Indian Constitution	3
II	Union, State and Local Governments Subtopics: Working Of The Union, state and local governments	3
III	Rights and Duties Subtopics: Fundamental Rights, Fundamental Duties and Directive Principles	3
IV	Selected Statutory Institutions Subtopics: Importance of selected statutory institutions of India, viz. Election Commission of India, National Human Rights Commission and National Commission for Women	3
V	The Merchant Shipping Act, 1958 Subtopics: Select Provisions of the Merchant Shipping Act- Establishment and functions of National Shipping Board, Process of registration of Indian Ships, Certificates of Officers. Provisions related to seamen, Functions of National Welfare Board for Seafarers	3
Total		15

Learning Objectives	L
I. Introduction to Indian Constitution	
General Learning Objective: Understand the background and the main features of the Constitution of India	
Specific Learning Objectives: 1.1 Evolution of the Indian Constitution: Government of India Act 1919, Government of India Act 1935 and Indian Independence Act of 1947 1.1.1 Outline the historical background of the Indian Constitution 1.1.2 List the main features of the Government of India Act 1919, the Government of India Act 1935 and the Indian Independence Act of 1947 1.1.3 Explain Whether Democratic Societies Need a constitution 1.1.4 Explain How a Constitution Is Different from Ordinary Law	1
Specific Learning Objectives: 1.2 Framing of Indian constitution 1.2.1 Explain the role of the Constituent Assembly 1.2.2 List the functions of the Constituent Assembly	1
Specific Learning Objectives: 1.3 Fundamental features of the Indian Constitution 1.3.1 Interpret the Preamble of the Constitution of India 1.3.2 Summarize the salient feature of the Constitution of India 1.3.3 Outline the making of the 1950 Constitution 1.3.4 Explain whether the Preamble helps us interpret the constitution	1
II. Union, State and Local Governments	
General Learning Objective: Understand the working of the union, state and local governments	
Specific Learning Objectives: 2.1 Union Government 2.1.1 Outline the functions of the Union Executive 2.1.2 Explain the role of the President and the Vice President in India 2.1.3 Describe the function of the Indian Parliament 2.1.4 Explain the role of the Judiciary in maintaining the sanctity of the Constitution of India	1
Specific Learning Objectives: 2.2 State Government 2.2.1 Outline The Functions of the State Governments 2.2.2 Explain the role of the Governor in a state 2.2.3 Describe the functions of the Legislative Assembly and Legislative Council	1
Specific Learning Objectives: 2.3 Local Government 2.3.1 Explain the role of Panchayati Raj Institutions in India 2.3.2 Show how the Urban Governments function	1
III. Rights and Duties	
General Learning Objective: Understand The Fundamental rights and duties under the Constitution	
Specific Learning Objectives: 3.1 Fundamental Rights and their limitations 3.1.1 List the Fundamental Rights 3.1.2 Explain the limitations of the Fundamental Rights 3.1.3 Explain how to protect these rights when they are violated?	1
Specific Learning Objectives: 3.2 Fundamental Duties and their significance 3.2.1 List the Fundamental Duties 3.2.2 Describe the limitations of the Fundamental Duties 3.2.3 Explain the criticism of Fundamental Duties	1

<p>Specific Learning Objectives:</p> <p>3.3 Directive Principles</p> <p>3.3.1 Describe the Importance and relevance Direct Principles of State Policy</p> <p>3.3.2 Explain the conflict between Fundamental Rights and Directive Principles of State Policy (DPSPs)</p>	1
IV. Selected Statutory Institutions	
<p>General Learning Objective:</p> <p>Understand The Importance of Selected statutory institutions India</p>	
<p>Specific Learning Objectives:</p> <p>4.1 Election Commission of India</p> <p>4.1.1 List the functions of Election Commission of India</p> <p>4.1.2 Explain the powers of the Election Commission</p> <p>4.1.3 Explain the Electoral Process in India</p>	1
<p>Specific Learning Objectives:</p> <p>4.2 National Human Rights Commission</p> <p>4.2.1 Elaborate Human Rights and Values</p> <p>4.2.2 Describe the role of the National Human Rights Commission of India</p> <p>4.2.3 List them a in features of the Protection of Human Rights (Amendment)Act,2019</p>	1
<p>Specific Learning Objectives:</p> <p>4.3 National Commission for Women</p> <p>4.3.1 Describe the constitution the National Commission for Women</p> <p>4.3.2 Explain the functions of the Commission</p> <p>4.3.3 Outline the Main features of the National Commission for Women (Procedure) Regulations, 2016forDealing with Complaints NRI Cell</p>	1
V. Merchant Shipping Act	
<p>General Learning Objective:</p> <p>Understand the importance of MS Act</p>	
<p>Specific Learning Objectives</p> <p>5.1.1 Evolution of the Act Significance</p> <p>5.1.2 State Enactment Period Etc.</p> <p>5.1.3 Describe the framework of the Merchant Shipping Act</p> <p>5.1.4 List the important Elements and their Functions (National Shipping Board; National Welfare Board for Seafarers etc.)</p> <p>5.1.5 Explain Registration of Ships, Certification/Welfare of Seafarers Etc.</p> <p>5.1.6 Explain the provisions related to seamen- Classification of Seamen, Engagement Seamen, Discharge of Seamen, Payment of Wages, Health, Accommodation, etc.</p>	1
<p>Specific Learning Objectives</p> <p>5.2 ImportancetoShippingandalignmentwithInternationalRules/Conventions</p> <p>5.2.1 Describe Safety, Load Line, Stability Aspects</p> <p>5.2.2 Explain importance of Collision, Pollution Responsibilities (International Oil Pollution Compensation Fund Etc.)</p>	1
<p>Specific Learning Objectives</p> <p>5.3 Changes to MS Act</p> <p>5.3.1 Explain Why Changes Are Needed</p> <p>5.3.2 Explain efforts taken by GoI/MoPSW/DGS</p>	1

Subject Name/Code: Engineering Machine Shop Practice/ UG11P5201

Instructional Hours:

Practical : 45 hours

Total Contact Hours : 45 hours

Credits : 1.5

Teaching Methods

The Practical Training Will Be Hands-on with focus on safety and skills.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Season for Actual Allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments) : 50%

Final Exam : 50%



Table Topics

Unit	Topic	Hour (P)
I	Lathe Machine and Operations Sub-Topics: Introduction, function, classification specification of lathe machine, Main parts and accessories and General operations	24
II	Drilling and Allied Operations Sub-Topics: Drill Machine Parts and accessories and Demonstrate drilling procedure	3
III	Shaping Machine & Operations Sub-Topics: Specification, classification of Shaping Machine, General Constructions, mechanism and General operations	6
IV	Milling machine and Operations Sub-Topics: Milling Machine, General Construction, Main Parts & accessories and General operations and Milling processes	9
V	Abrasive machining Processes Sub-Topics: Grinder Machine and its parts, Safe working practices and checks while operating grinding machine and Demonstrate Pedestal and Hand Grinding machine operation	3
Total		45

Learning Objectives	P
I. Lathe Machine and Operations	24
General Learning Objective (IMO7.04,2014, F3/3.16) P137 Understand Lathe machine construction, their classification, mechanism, and different operations that are performed by different lathe Sub-topic: Lathe Machine and Operations Sub-subtopics & SLOs 1.1 Introduction, function, classification specification of lathe machine 1.2 Main Parts and accessories 1.3 General Operations	
Specific Learning Objectives: 1.1 Introduction, function, classification, and Specifications of lathe machine 1.1.1 Demonstrate safe working practices while working on the lathe machine.	2
1.2 Main Parts and accessories. 1.2.1 Identify and explain different parts and accessories of the lathe machine. (Head stock, tail stock, carriage, chuck, face plate etc.)	2
1.3 General Operations 1.3.1 Demonstrate various operations which are carried out on a lathe machine (facing, Turning, Drilling, Taper turning, step turning, thread cutting, chamfering, knurling etc.). 1.3.2 Demonstrate making of jobs on lathe performing different lathe operations as specified.	20
II. Drilling and Allied operations	3
General Learning Objective (IMO7.04,2014, F3/3.16) P137 Understand Drilling Machine Construction, their classification, mechanism, and different operations that are performed by different Drilling machines. Sub-topic: Drilling machine and operations Sub-subtopics & SLOs 2.1 Drill Machine Parts and accessories 2.2 Demonstrate Drilling, boring, reaming procedures.	
Specific Learning Objectives: 2.1 Drill Machine Parts and accessories 2.1.1 Demonstrate safe working practices while working on a drilling machine. 2.1.2 Identify and explain different parts and accessories of the Drilling machine.	1
2.2 Demonstrate Drilling Procedure 2.2.1 Demonstrate job making on Drilling machine, performing different Drilling, reaming operations as specified.	2
III. Shaping Machine & Operations	6
General Learning Objective (IMO7.04,2014, F3/3.16) P137 Understand Shaping Planning machine construction, their classification, mechanism, and different operations that are performed by different Shaping & Planning machines. Sub-topic: Shaping Machine & Operations Sub-subtopics & SLOs 3.1 Specification, classification of Shaping machine, General constructions, and mechanism. 3.2 General Operations	
Specific Learning Objectives: 3.1 Specification, classification of Shaping machine, General constructions, and mechanism. 3.1.1 Explain and demonstrate safe working practices while working on a Shaping Machine. 3.1.2 Identify and explain the different parts of the shaping Machine.	1

<p>3.2 General Operations</p> <p>3.2.1 Demonstrate Shaping Machine Operation Beveling/planning operation</p> <p>3.2.2 Demonstrate making of a job on Shaper performing different shaping operations as specified.</p>	5
<p>IV. Milling Machine and Operations</p>	9
<p>General Learning Objective (IMO7.04,2014, F3/3.16) P137 Understand Milling machine construction, their classification, mechanism, and different operations that are performed by different milling machine.</p> <p>Sub-topic: Milling machine and Operations</p> <p>Sub-subtopics & SLOs</p> <p>4.1 Milling Machine, General Construction, Main Parts Accessories.</p> <p>4.2 General operations and Milling Processes.</p>	
<p>Specific Learning Objectives:</p> <p>4.1 Milling Machine general construction, Main Parts & Accessories.</p> <p>4.1.1 Demonstrate safe working practices on Milling Machine.</p> <p>4.1.2 Identify different Main parts and accessories of milling machine</p> <p>4.1.3 Identify Different Tools of Milling Machine</p>	1
<p>4.2 General operations and Milling processes</p> <p>4.2.1 Demonstrate making a job such as hexagon / keyway/spur gear cutting operation on a milling machine.</p>	8
<p>V. Abrasive Machining Processes</p>	3
<p>General Learning Objective (IMO7.04,2014, F3/3.16) P136 Understanding Bench and hand Grinding machine construction, their mechanism and different operations that are performed by different Bench & hand grinding machine.</p> <p>Sub-topic: Abrasive machining Processes</p> <p>Sub-subtopics & SLOs</p> <p>5.1 Grinder Machine and its parts, Safe Working practices and check while operating the grinding machine.</p> <p>5.2 Demonstrate Pedestal and Hand Grinding Machine Operation</p> <p>5.2.1 Demonstrate making job like tool grinding rough surface grinding, Buffing Polishing Etc.</p>	2

Subject Name/Code: English Communication Lab/UG11P5202

Instructional Hours:

Practical	: 45 hours
Total Contact hours	: 45 hours
Credits	: 1.5

Teaching Methods

The practical training will be hands-on with focus on safety and skills.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Practical Internal Assessment	: 50%
Practical External Assessment	: 50%

Text Book:

1. M Ashraf Rizvi. Effective Technical Communication, McGraw Hill.
2. Sanjay Kumar and Pushp Lata. Communication Skills: A Workbook. Oxford University Press.

Reference:

1. Balasubramanian, T. English Phonetics for Indian Students. Laxmi Publications.
2. IMO Standard Marine Communication Phrases. International Maritime Organization.
3. Jones, Daniel. Cambridge English Pronouncing Dictionary. Cambridge University Press.
4. Koneru, Aruna. Professional Speaking Skills. Oxford University Press.
5. Kumar, Sanjay, and Pushp Lata. English for Effective Communication. Oxford University Press.
6. M. Swan, Practical English usage, New York: Oxford University Press.

Table of Topics

Unit	Topic	Hour (P)
I	Introduction to English Phonology Subtopics: Speech Sounds, Consonant Clusters, Word Stress, Intonation, Sentence Stress	6
II	Introduction to Maritime English Subtopics: Maritime English, Standard Marine Communication Phrases(SMCP)	9
III	Developing Vocabulary Subtopics: Adjectives of nationality, Verbs describing routine operations on board; Phrases connected with Watch keeping duties, Adjectives indicating preferences, Basic galley equipment, cooking utensils, adjectives describing physical appearance and personality, phrases for greeting and introducing people; nouns connected with planning, idioms	6
IV	Developing Listening Skills Subtopics: Listening training: speeches of people of different backgrounds and regions, preferably native speakers of English, Maritime communication Listening exercises: listening for general content, listening to fill up the information, Intensive listening, listening for specific information.	6
V	Developing Speaking Skills Subtopics: Speaking activities in various contexts, Making a Presentation, Facing a job Interview, Group Communication	18
Total		45

Learning Objectives	P
I - Introduction to English Phonology	
General Learning Objectives Understand and use the sounds in English effectively Subtopics & SLO: 1.1 Speech Sounds- Vowels and Consonants 1.2 Consonant Clusters, Word Stress, Intonation, Sentence Stress	
Specific Learning Objectives: 1.1 Speech Sounds- Vowels and Consonants 1.1.1 Describe the term 'phonology' and its application in communication 1.1.2 List the speech sounds with one example of each 1.1.3 Differentiate between Consonant, Monophthong, and Diphthong with examples 1.1.4 Identify commonly mispronounced sounds/words and rectify 1.1.5 Identify the different accents and record the sounds in your own voice in the language lab	3
Specific Learning Objectives: 1.2 Consonant Clusters, Word Stress, Intonation, Sentence Stress 1.2.1 Describe the following terms with examples: Syllable, Consonant clusters, Word stress, Intonation, and Sentence Stress 1.2.2 Transcribe the phonetics into words and vice versa 1.2.3 Listen to the recorded speech and repeat 1.2.4 Understand the different accents and repeat 1.2.5 Read a paragraph loudly and record your own voice in the language lab 1.2.6 Listen and make language corrections	3

II - Introduction to Maritime English		
General Learning Objectives Understand and use SMCP effectively in maritime communication Subtopics & SLO: 2.1 Maritime English 2.2 Standard Marine Communication Phrases (SMCP):		
Specific Learning Objectives: 2.1 Maritime English 2.1.1 Recall, describe and identify the fundamentals of maritime English 2.1.2 Compare General English and Maritime English 2.1.3 Define the terms related to maritime English 2.1.4 Locate parts of a ship and describe their functions 2.1.5 Identify parts of the ship in a drawing		3
Specific Learning Objectives: 2.2 Standard Marine Communication Phrases (SMCP): 2.2.1 Explain the importance of SMCP in maritime practice 2.2.2 Identify and use SMCP related to procedure, spelling, message markers, responses, Urgency/safety signals, corrections, readiness, repetition etc. 2.2.3 List the spelling of letters, Message Markers, Distress, Urgency and Safety Signals. 2.2.4 Identify and use SMCP terms related to numbers, positions, bearing, courses, distances, speed, times, geographical names, ambiguous words, omission of 'may, might, should, could etc. 2.2.5 List and describe the Ambiguous words in SMCP 2.2.6 Use SMCP using a walky-talky device		6
III - Developing Vocabulary		
General Learning Objectives Understand and use a wide range of vocabulary in day-to-day conversations as well as in the maritime sector Subtopics & SLO: 3.1 Adjectives of nationality, Verbs describing routine operations on board; Phrases connected with engine room duties, Adjectives indicating preferences, Basic galley equipment, cooking utensils, adjectives describing physical appearance and personality, phrases for greeting and introducing people; nouns connected with planning, idioms		
Specific Learning Objectives: 3.1 Adjectives of nationality, Verbs describing routine operations on board; Phrases connected with engine room duties, Adjectives indicating preferences, Basic galley equipment, Cooking utensils, adjectives describing physical appearance and personality, phrases for greeting and introducing people; nouns connected with planning, idioms 3.1.1 Use the techniques of improving vocabulary. 3.1.2 Find the error(s) in the sentence/paragraph. 3.1.3 Underline the error(s) in the sentence/paragraph and rewrite. 3.1.4 Select the correct option. 3.1.5 Select the wrong pair from the given pairs. 3.1.6 Fill the gap(s) in the sentence/paragraph. (Cloze test) 3.1.7 Match Part-A with Part-B in the given exercises		6
IV - Developing Listening Skills		
General Learning Objectives Understand spoken English of speakers from different nationalities and work-related instructions on board Subtopics & SLO: 4.1 Listening training: speeches of people of different backgrounds and regions, preferably native speakers of English, Maritime communication 4.2 Listening exercises: listening for general content, listening to fill up the information, Intensive listening for specific information		
Specific Learning Objectives: 4.1 Listening training: speeches of people of different backgrounds and regions, preferably native speakers of English, Maritime communication 4.1.1 Listen to a speech and analyse it. (Tone, diction, and pronunciation) 4.1.2 Compare the speeches made by the speakers of different backgrounds and regions.		

<p>Specific Learning Objectives:</p> <p>4.2 Listening exercises: listening for general content, listening to fill up the information, Intensive listening, listening for specific information</p> <p>4.2.1 Listen to an audio/video clip and answer the questions</p> <p>4.2.2 Understand orders from the bridge</p> <p>4.2.3 Identify VHF communications regarding distress, urgency, safety and bunkering operations</p> <p>4.2.4 Listen to an audio/video clip for different purposes (for general content, filling up the information, intensive listening, specific information, etc.)</p>	3
V - Developing Speaking Skills	
<p>General Learning Objectives</p> <p>Understand and express confidently in English language in various professional situations</p> <p>Subtopics & SLO:</p> <p>5.1 Speaking activities in various contexts: Describing objects/situations/people, Agreeing and Disagreeing, Extempore Speeches</p> <p>5.2 Making a Presentation: individual and group presentation, Content Structuring, Preparation & Planning Facing a job Interview</p> <p>5.3 Group Communication: Group Discussion (GD), Role Play</p>	
<p>5.1 Speaking activities in various contexts: Describing objects/situations/people, Agreeing and Disagreeing, Extempore Speeches</p> <p>5.1.1 Describe and discuss an object, a situation, a person</p> <p>5.1.2 Describe the purpose of a safety device</p> <p>5.1.3 Narrate engine failure/accident reports</p> <p>5.1.4 Narrate a past voyage or marine accident</p> <p>5.1.5 Describe the functions of engines and propulsion systems</p> <p>5.1.6 Describe personal likes, dislikes and leisure time on board</p> <p>5.1.7 Make a speech on a given topic- Making Requests and Seeking Permissions, Giving Directions and Guidelines</p>	3
<p>5.2 Making a Presentation: individual and group presentation, Content Structuring, Preparation & Planning</p> <p>5.2.1 Explain the importance of body language in a presentation</p> <p>5.2.2 Plan and Make a group presentation on a given topic</p> <p>5.2.3 Conduct and participate in a webinar for your class</p> <p>5.2.4 Facing a job Interview</p> <p>5.2.5 Explain the process for an interview</p> <p>5.2.6 List the frequently asked questions in a job interview and answer them</p> <p>5.2.7 Organize and participate in a mock interview</p>	9
<p>5.3 Group Communication: Group Discussion (GD), Role Play</p> <p>5.3.1 Define Group Discussion and explain its objectives.</p> <p>5.3.2 Describe the types of Group Discussion- Issue-based, Abstract, Role Play, and Case Study</p> <p>5.3.3 Participate in group discussion activities</p> <p>5.3.4 Compare Group Discussions and debates</p> <p>5.3.5 Participate in role-play activities</p> <p>5.3.6 Conduct an online meeting/seminar</p>	6

Subject Name/Code: Marine Drawing Skills /UG11P5203

Instructional hours:

Practical	: 45 hours
Total contact hours	: 45 hours
Credits	: 1.5

Teaching Methods

The practical training will be hands-on with focus on safety and skills.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments)	: 50%
Final Exam	: 50%

Text Book:

1. Machine Drawing, K.L Narayana
2. Engineering Drawing for Marine Engineers, H.G. Beck. – Reeds series Vol 11.

Reference:

1. Simmonds, C.H and Maguire D.E., Progressive Engineering Drawing for T.E.C Students, London, Hodder and Stoughton Ltd, (ISBN: 9780080966526)
2. MacGibbon's Pictorial Drawing Book for Marine Engineers- H. Barr & J.G. Holburn
3. Reeds Volume II- Engineering Drawing for Marine Engineers - H. G. Beck
4. M. B. Shah and B.C. Rana, "Engineering Drawing ", Pearson Education.
5. N.D. Bhatt, "Engineering Drawing" Charotar Publishing House.
6. S.C. Sharma, "Machine Drawing" Std publishers' distributors, Delhi

Table of Topics

Unit	Topic	Hour (P)
I	Introduction	3
II	Screws threads and conventional representation	4
III	Thread Formation, Nuts, Bolts and Studs	6
IV	Worked Examples in Machine Drawing (Minimum six)	22
V	Sectional views (Minimum 2)	10
Total		45

Learning Objectives		P
<p>I. Introduction Understand the purpose of component drawing, general arrangement drawing and assembly drawing</p> <p>Sub-Topics/SLOs:</p> <ul style="list-style-type: none"> 1.1 Understand purpose of component drawings, 1.2 Understand purpose of a general arrangement drawing, 1.3 Understand purpose of assembly drawings, lists the standard/routine information and references commonly given on drawings scales, 	3	
<p>II. Screws threads and conventional representation Understand and identify different types of thread profiles used in engineering drawing</p> <p>Sub-Topics/SLOs:</p> <ul style="list-style-type: none"> 2.1 Screw threads terminology 2.2 Applications of thread 2.3 Types of thread profiles 2.4 V-threads and square thread details 2.5 Drafting conventions associated with internal and external threads, 2.6 Multiple start threads, 	4	
<p>III. Thread Formation, Nuts, Bolts and Studs Understand and draw orthographic projection of nut, bolt and washer using empirical relations</p> <p>Sub-Topics/SLOs:</p> <ul style="list-style-type: none"> 3.1 Draw orthographic projection of bolts, studs, nuts, washers using empirical relations 	6	
<p>IV. Worked Examples in Machine Drawing (Minimum six) Draw orthographic projection of small assemblies using 1st angle projection method</p> <p>Sub-Topics/SLOs:</p> <ul style="list-style-type: none"> 4.1 Main / Auxiliary Engine parts 4.2 Flange coupling 4.3 Non return valve, 4.4 Blow off cock, 4.5 Cylinder relief valve, 4.6 Bilge suction strainer valve, 4.7 Ship Side discharge valve 	22	
<p>V. Sectional views (Minimum 2) Draw sectional FV/TV/LHSV or RHSV using 1st angle projection method</p> <ul style="list-style-type: none"> 5.1 Plummer block, 5.2 Bush bearing, 5.3 Thrust block 	10	

Subject Name/Code: Mechanics and Thermal Engineering Lab /UG11P5204

Instructional Hours:

Practical	: 45 hours
Total Contact Hours	: 45 hours
Credits	: 1.5

Teaching Methods

The Practical Training Will Be Hands-on with focus on safety and skills.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Season for Actual Allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments)	: 50%
Final Exam	: 50%



Table of Topics

Unit	Topic	Hour (P)
I	Mechanics Practical Exercises	18
II	Fuels and Combustion	10
III	Heat transfer studies	17
Total		45

Learning Objectives	P
I. Mechanics Practical Exercises	18
General Learning Objective Understand the basic concepts used in mechanics and their applications B1. Sub-Topic: Fundamentals Laws of mechanics and their applications Sub-Sub Topics 1.1 Triangle Law of Forces 1.2 Polygon Law of Forces 1.3 Analysis of forces in Derrick crane 1.4 Analysis of forces in shear leg apparatus 1.5 Support reactions of a loaded beam 1.6 Moment of Inertia and radius of Gyration of flywheel 1.7 Coefficient of friction between leather and metal	
Specific Learning Objectives: 1.1 Triangle Law of forces 1.1.1 Explain triangle law of forces 1.1.2 Verify the triangle law of forces	3
Specific Learning Objectives: 1.2 Polygon Law of forces 1.2.1 Explain polygon law of forces 1.2.2 Verify the polygon law of forces	3
Specific Learning Objectives: 1.3 Analysis of forces in Derrick crane	2
Specific Learning Objectives: 1.4 Analysis of forces in shear leg apparatus	2

<p>Specific Learning Objectives:</p> <p>1.5 Support reactions of a loaded beam</p> <p>1.5.1 Explain Moment and Principle of moment</p> <p>1.5.2 Explain different types of Beams and their applications</p> <p>1.5.3 Study types of support and support reactions</p> <p>1.5.4 Experimental and theoretical determination of support reactions in simply supported beam</p> <p>1.5.5 Experimental and theoretical determination of support reactions in Bell Crank Lever</p>	4
<p>Specific Learning Objectives:</p> <p>1.6 Moment of Inertia and radius of Gyration of flywheel</p> <p>1.6.1 Flywheel: Explain concept, design and applications</p> <p>1.6.2 Explain the concept of moment of inertia</p> <p>1.6.3 Define radius of Gyration</p> <p>1.6.4 Determination of moment of Inertia and radius of gyration</p>	2
<p>Specific Learning Objectives:</p> <p>1.7 Coefficient of friction between leather and metal</p> <p>1.7.1 Explain Coulomb's Law of dry friction</p> <p>1.7.2 Experimentally Calculate the coefficient of friction between leather and metal by using inclined plane apparatus</p>	2
II Fuels and Combustion	10
<p>Tests regarding Fuels: General Learning Objectives</p> <p>Understand Flash point of fuels</p> <p>Understand Calorific value of fuels Sub-Topics:</p> <p>2.1 Test a sample for Flash point</p> <p>2.2 Test a sample for Higher Calorific Value</p> <p>2.3 Test a sample for Lower Calorific Value</p>	
<p>2.1 Flash Point of Fuels</p> <p>2.1.1 Explain the action: The lowest temperature of the sample, corrected to a barometric pressure of 101.3 kPa, at which, application of a test flame causes the vapour of the sample to ignite under the specified conditions of test</p> <p>2.1.2 Explain the action: The sample, suitably cooled, is placed in the cup of the Abel apparatus and heated at a prescribed rate. A small test flame is directed into the cup at regular intervals, and the flash point is taken as the lowest temperature at which application of the test flame causes the vapour above the sample to ignite with a distinct flash inside the cup</p>	3
<p>2.2 Higher Calorific Value of Fuels</p> <p>2.2.1 Explain the action: The gross heat of combustion of a fuel at constant volume is the number of heat units measured as being liberated at 25°C when unit mass of the fuel is burned in oxygen saturated with water vapour in a bomb under standard conditions. The resultant materials in the bomb are considered. as being gaseous oxygen, carbon dioxide, sulphur dioxide, nitrogen, liquid water in equilibrium with its vapour and saturated with carbon dioxide, other compounds in solution, and solid ash</p>	3
<p>2.3 Lower Calorific Value of Fuels</p> <p>2.3.1 Explain the action: The net heat of combustion of a fuel at constant pressure is the number of heat units measured as being liberated at 25°C when unit mass of fuel is burned in oxygen at constant pressure such that the heat released is equal to the gross heat of combustion of the fuel at constant pressure less than latent heat of evaporation at 25°C and constant pressure of the water both originally contained in the fuel and formed by its combustion</p>	4
III Heat transfer studies	17
<p>3.1. To determine the Thermal Conductivity of good conductors.</p> <p>3.2. To determine the Thermal Conductivity of Insulating materials.</p> <p>3.3. Heat transfer Through Fins or extended surface.</p> <p>3.4. Heat Transfer through Forced Convection</p>	

SEMESTER – III

Subject Name/Code: Fluid Mechanics and Hydraulic Machinery/UG11T5301

Instructional Hours:

Lecture	: 45 hours
Tutorial	: 15 hours
Total contact hours	: 60 hours
Credits	: 4

Teaching Methods

The course shall be conducted in a combination of classroom/online lectures, practical in laboratory and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments):	30%
Final Written Exam	: 70%

Text Book:

1. Hydraulics and Fluid Mechanics – P. N. Modi and S. M. Seth
2. Fluid Mechanics by Frank White McGraw Hill-Latest edition

Reference:

1. Fluid Mechanics and Hydraulic Machines – R. K. Rajput
2. Fluid Mechanics (Part 1 and Part 2) – J. F. Douglas
3. Fluid Mechanics and Hydraulic Machines – R. K. Bansal
4. Mechanics of Fluids – Bernard Massey and John Ward Smith
5. Fundamentals of Fluid Mechanics – G. S. Sawhney

Table of Topics

Unit	Topic	Hour (L)
I	Fluid Properties & Measurements	10
II	Hydraulics	12
III	Fluid Flow	14
IV	Centrifugal Pumps	12
V	Positive displacement pumps	12
Total		60

Learning objectives		L
I. Fluid Properties & Measurements		10
General Learning Objective: To demonstrate knowledge and understanding of fluid mechanics concepts, hydraulic machines and systems.		
1.0 Fluid Properties (Ref: IMO 7.04 Appendix 1 Section 1.4 Page 244) Specific Learning Objective: To demonstrate a knowledge and understanding of fluid flow and fluid properties like density, specific gravity, viscosity etc.		
1.1 Fluid Flow (Ref: IMO 7.04 Appendix 1 Section 1.4 Page 244) 1.1.1 Define fluid flow 1.1.2 State Newton's law of viscosity 1.1.3 Newtonian and Non-Newtonian Fluid 1.1.4 Ideal and Real fluids 1.1.5 Define mass density, weight density and specific gravity 1.2 Dynamic and Kinematic Viscosity (Ref: IMO 7.02 Competence 1.2 section 2.6 Page 47) 1.2.1 Definition and equation of dynamic viscosity 1.2.2 Unit of dynamic viscosity 1.2.3 Definition and equation of kinematic viscosity 1.2.4 Unit of kinematic viscosity 1.2.5 Relation between dynamic and kinematic viscosity 1.2.6 Effect of temperature on viscosity		4

<p>1.3 Fluid Pressure (Ref: IMO 7.04 Appendix 1 Section 1.4 Page 244) Specific Learning Objective: To demonstrate knowledge and understanding of pressure exerted by fluid on different surfaces and pressure measurement</p>	
<p>1.4 Properties of Pressure (Ref: IMO 7.04 Appendix 1 Section 1.4 Page 244) 1.4.1 Define pressure, i.e., force (newton's) / area (metres²) 1.4.2 State that the unit of pressure is the Pascal (Pa) 1.4.3 State that a practical unit of pressure is 10⁵ Newton/m² and is 1 bar 1.4.4 State that atmospheric pressure is approximately 1 bar 1.4.5 Solve problems involving force, area and pressure 1.4.6 Explain in simple terms what is meant by: atmospheric pressure, vacuum, partial vacuum, absolute zero pressure, gauge pressure 1.4.7 Convert between absolute and gauge pressure</p> <p>1.5. Pressure Variation (Ref: IMO 7.04 Appendix 1 Section 1.4 Page 244) 1.5.1 state that the pressure at any level in a fluid is equal in all directions (Pascal's law) 1.5.2 state that pressure acts in a direction normal to a surface 1.5.3 state that the pressure at any level in a liquid depends upon the vertical height to the liquid surface (its head) and the density of the liquid 1.5.4 solve simple problems involving $9.8 \times \text{head} \times \text{density}$</p> <p>1.6 Pressure Measurement (Ref: IMO 7.04 Appendix 1 Section 1.4 Page 244) 1.6.2. construction and working of piezometer with simple diagram 1.6.3. construction and working of manometer with simple diagram 1.6.4. construction and working of simple barometer with simple diagram</p>	6
II. Hydraulics	12
<p>Specific learning objective: (Ref: IMO 7.04 Appendix 4 Section 1.4 Page 255) To demonstrate knowledge and understanding of (a) different energies stored in a liquid when in motion as potential energy, pressure energy and kinetic energy and (b) mass and volume flow rate</p>	
<p>2.1 Head of Liquid (Ref: IMO 7.04 Appendix 4 Section 1.4 Page 255) 2.1.1. Define the "head of a liquid" 2.1.2. State the energy components in a moving liquid in terms of its head as potential head, kinetic head and pressure head</p>	2
<p>2.2. Flow Rate (Ref: IMO 7.04 Appendix 4 Section 1.4 Page 255) 2.2.1. State the expression to give the volumetric flow of liquid as velocity \times cross-sectional area, measured in m³/second 2.2.2. State the expression to give the mass flow of liquid as its velocity \times cross-sectional area \times density, measured in kilogram/second 2.2.3. State and derive continuity equation 2.2.4. Simple problems concerning the above objectives</p>	4
<p>2.3. Bernoulli's equation (Ref: IMO 7.02 Competence 1.2 section 2.6 Page 47) 2.3.1. Statement and derivation of Bernoulli's equation 2.3.2. Assumptions made in Bernoulli equation 2.3.3. Bernoulli's equation for ideal and real fluids 2.3.4. Simple numerical based on Bernoulli's equation</p>	2
<p>2.4. Venturi meter (Ref: IMO 7.02 Competence 1.2 section 2.6 Page 47) 2.4.1. Working principle of venturi meter 2.4.2. Derive equation of coefficients of discharge 2.4.3. Venturi meter in horizontal vertical and inclined position</p>	2
<p>2.5. Reynolds' number (Ref: IMO 7.02 Competence 1.2 section 2.6 Page 47) 2.5.1. Definition of Reynolds' number 2.5.2. Derivation of Reynold's number 2.5.3. Determine laminar and turbulent flow from Reynold's number 2.5.4. Determine friction coefficient from Reynold's number</p>	2
III. Fluid Flow (Ref: IMO 7.02 Competence 1.2 section 2.6 Page 47)	14
3.1 Flow losses in pipes and fittings (Ref: IMO 7.02 Competence 1.2 section 2.6 Page 47)	

<p>Specific Learning Objective: To demonstrate knowledge and understanding of loss of Energy in fluid flow due to major and minor losses</p> <p>3.1.1. Determine direction of flow and losses occurring in flow</p> <p>3.1.2. Major loss and minor losses</p> <p>3.1.3. Frictional loss in flow through pipes</p> <p>3.1.4. Darcy's formula for frictional loss in pipes</p> <p>3.1.5. Loss due to sudden expansion</p> <p>3.1.6. Loss due to sudden contraction</p> <p>3.1.7. Entry and exit loss</p> <p>3.1.8. Other minor losses due to fittings, obstruction, bends etc</p> <p>3.1.9. Simple numerical exercises on flow through pipes considering major and minor losses</p>	6
<p>3.2. Jets (Ref: IMO 7.02 Competence 1.2 section 2.6 Page 47)</p> <p>3.2.1. Force exerted by jet on stationary and moving flat plates</p> <p>3.2.2. Force exerted by jet on stationary and moving curved plates</p> <p>3.2.3. Simple numerical exercises on force exerted by jets</p>	5
<p>3.3. Orifice coefficients (Ref: IMO 7.02 Competence 1.2 section 2.6 Page 47)</p> <p>3.3.1. Orifice and orifice meter</p> <p>3.3.2. Coefficient of discharge</p> <p>3.3.3. Coefficient of contraction</p> <p>3.3.4. Coefficient of velocity</p>	3
<p>IV. Centrifugal pumps (Ref: IMO 7.02 Competence 1.2 section 2.6 Page 47)</p>	12
<p>4.1 Pump Operations (Ref: IMO 7.02 Competence 1.2 section 2.6 Page 47)</p> <p>Specific Learning Objective: To demonstrate knowledge and understanding of working of centrifugal pump</p> <p>4.1.1. Priming of centrifugal pump</p> <p>4.1.2. Minimum speed for starting centrifugal pump</p> <p>4.1.3. Net positive suction head</p> <p>4.1.4. Cavitation in centrifugal pump</p>	3
<p>4.2 Centrifugal Pump Practical (Ref: IMO 7.02 Competence 1.2 section 2.6 Page 47)</p> <p>4.2.1. Determine operational characteristics of a given centrifugal pump</p>	3
<p>4.3 Name the types of pumps generally used on ships and the purposes for which they are normally used.</p> <p>4.3.1 Explain the basic action of a displacement pump.</p> <p>4.3.2 Explain the necessity for a relief valve to be fitted in the discharge of any displacement pump.</p> <p>4.3.3 State the reason for the discharge from the relief valve to be contained within the pumping system when a pump is handling oil or other hazardous material.</p>	3
<p>4.4. Described with the aid of diagrams, the functioning of a reciprocating displacement pump works.</p> <p>4.4.1 Explain the purpose of an air vessel fitted to the discharge.</p> <p>4.4.2 Describe the characteristics of a reciprocating pump, referring to:</p> <ul style="list-style-type: none"> Suction lift Priming Discharge pressure Vapour or gas, in the fluid being pumped <p>4.4.3 Explain the principle of rotary displacement pumps.</p> <p>Sketch a single line diagram to show the principal parts of:</p> <ul style="list-style-type: none"> A gear pump A rotary vane pump A screw-displacement pump Variable delivery pump <p>4.4.4 Describe the principles of operation of an axial-flow pump.</p> <p>Describe the type of duty best suited to an axial-flow pump.</p>	3

V. Positive Displacement Pumps	12
General Learning Objective Understand the design features and the operative mechanism of the various Auxiliary Machineries so that the related machinery are maintained and operated in a safe, economical and efficient manner onboard.	
Specific Learning Objectives: (IMO 7.04,2014: F1/1.4.1.6) 5.1 Pump Principles 5.1.1 Explain the Components & function of a pump as a machinery to transfer fluid between two given Points. 5.1.2 List the losses of head in a pumping system.	6
5.2 State the reason for the viscosity of the fluid to be pumped to be within the range specified in the pump design. 5.2.1 State the permissions that should be obtained before any fluids are moved with reference to their effect on stability of the ship and pollution overboard.	6

Subject Name/Code: Solid Mechanics/UG11T5302

Instructional Hours:

Lecture : 45 hours
Tutorial : 15 hours

Credits : 4

Teaching Methods

The course shall be conducted in a combination of classroom/online lectures, practical in workshops and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Season for Actual Allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments) : 30%

Final Exam :70%

Text Book:

1. Strength of Materials, Ramamrutham S, Dhanpat Rai Publishing, New Delhi.
2. Engineering Mechanics of Solids, Popov, PHI Learning, New Delhi, Latest edition

Reference:

1. Strength of Materials, G. H. Ryder, Macmillan Pub, India.
2. Strength of Materials, Rajput R.K, S. Chand Publishing, New Delhi.

Table Topics

Unit	Topic	Hour (L)
I	Materials under the load	11
II	Stress and strain	15
III	Combined stress	13
IV	Torsion	11
V	Truss and frames	10
Total		60

Learning Objectives		L
General Learning Objective: Understand fundamental concepts related to mechanical behavior of materials under the load, stresses, strains, Strain energy, principle stresses and principle planes, torsional moment and trusses and frames		
I. Material Under the Load. (IMO7.04,2014:3.1.3.1)		
Specific Learning Objective: Understand mechanical behavior of materials under the load		
1.1 Describe Three Types of Loading as: tensile, compressive and shear (IMO7.04,2014:3.1.3.1) 1.1.1 Classification of Loads		
1.2 Illustrate with the aid of simple sketch, a material under each of the applied loadings given in the below objectives, using arrows to indicate load and stress and dotted lines indicate deformation (IMO7.04,2014:3.1.3.1)		1
1.3 Define stress as the internal resistance per unit area of a material to an externally applied load (IMO 7.04,2014:3.1.3.1) 1.3.1 Definition of Stress 1.3.2 Types of stress		2
1.4 Define strain as the deformation produced in a material by an externally applied load (IMO7.04,2014:3.1.3.1) 1.4.1 Definition of Strain 1.4.2 Types of Strain		3
1.5 Explain how stress and strain can be calculated in terms of loading and material dimensions, for the cases the above objectives (IMO7.04,2014:3.1.3.1) 1.5.1 Principle of Superposition 1.5.2 Analysis of Bars Varying Section 1.5.3 Numerical		3

<p>1.6 Define, for an elastic material subjected to a tensile load: elastic limit, yield point, ultimate strength, breaking strength (IMO7.04,2014:3.1.3.1)</p> <p>1.7 Show, on a sketched graph of load to a base of corresponding extension values, the behavior of elastics materials under tensile loading and indicates the condition points listed above (IMO7.04,2014:3.1.3.1)</p> <p>1.7.1 Stress-strain diagram for a ductile material under tension</p> <p>1.7.2 Define The Terms:</p> <ul style="list-style-type: none"> ● Limit of Proportionality ● Elastic Limit ● Upper Yield Point ● Lower Yield Point ● Ultimate Strength ● Breaking Strength <p>1.8 State the significance in engineering practice physical properties the above objective (IMO7.04,2014:3.1.3.1)</p> <p>1.8.1 State The Significance In engineering practice</p>	2
<p>1.9 State That, within the elastic limit, Hooke's Law Will Apply. (IMO7.04,2014:3.1.3.1)</p> <p>1.10 Define Hooke's Law stress/strain=constant. (IMO7.04,2014:3.1.3.1)</p> <p>1.11 Define the constant contained in Hooke's Law as Modulus of Elasticity (IMO7.04,2014:3.1.3.1)</p> <p>1.11.1 Define Elastic constant as Modulus of Elasticity</p> <p>1.11.2 Define Elastic constant as Modulus of Rigidity</p> <p>1.11.3 Define Elastic Constants Bulk Modulus</p> <p>1.11.4 Relationship between Modulus of Elasticity, Modulus of Rigidity and Bulk Modulus</p> <p>1.11.5 State The Significance in Engineering Practice</p> <ul style="list-style-type: none"> ● Generalized Hooke's law for tri axial stress condition 	3
<p>II. Stress and Strain. (IMO7.02,2014:1.2.3)</p> <p>Specific Learning Objective: Understanding fundamental concept related to stresses, strains, and Strain energy</p> <p>2. 1 Stress in compound bars</p> <p>2.2 Thermal Stress</p> <p>2.3 Stress and strain relationships in thin cylindrical and spherical shells</p>	
<p>2.1 Stress in compound bars (IMO7.02,2014:1.2.3)</p> <p>2.1.1 Analysis of Stresses in Compound Bars, Numerical</p>	3
<p>2.2 Thermal Stress (IMO7.02,2014:1.2.3)</p> <p>2.2.1 Define Thermal Stresses and Strain</p> <p>2.2.2 Thermal stresses in composite bars, Numerical</p>	3
<p>2.3 Stress and strain relationships in thin cylindrical and spherical shells. (IMO7.02,2014:1.2.3)</p> <p>2.3.1 Define A Thin Cylindrical Shell</p> <p>2.3.2 Failure of thin cylindrical shell due to internal fluid pressure</p> <p>2.3.3 Assumptions thin cylindrical shell parameter calculations Stresses in thin cylindrical shell: Circumferential stress, Longitudinal stress and maximum shear stress</p> <p>2.3.4 Built Cylindrical Shell</p> <p>2.3.5 Change in dimensions of a thin cylindrical shell</p> <p>2.3.6 Spherical Shell Subjected to An Internal Fluid Pressure</p>	8
<p>III. Combined Stress (IMO7.02,2014:1.2.5)</p> <p>Specific Learning Objective: Understand fundamental concept of combined stresses In structure element</p> <p>3.1 Explain Stresses on an Oblique Plane</p> <p>3.2 Explain state of a Material subjected to mutually perpendicular stresses</p> <p>3.3 Explain Mohr's stress circle, principal stresses and strains</p>	

<p>3.1 Stresses on an Oblique Plane (IMO7.02,2014:1.2.5)</p> <p>3.1.1 Define Complex Stress</p> <p>3.1.2 Define Principal stresses and principal planes</p> <p>3.1.3 Method for the stresses on an Oblique section of a body: Analytical Method and Graphical Method (Mohr's Circle method)</p> <p>3.1.4 Uni-axial State of Stress: stresses on an oblique section of a body subjected to direct stress in plane by analytical method</p> <p>3.1.5 Numerical</p>	3
<p>3.2 Material subjected to two mutually perpendicular stresses (IMO7.02,2014:1.2.5)</p> <p>3.2.1 Direct stresses in two mutually perpendicular directions by analytical method</p> <p>3.2.2 Simple Shear Stress by Analytical Method</p> <p>3.2.3 Numerical</p>	8
<p>3.2.3 Direct stress in One Plane & accompanied by a Simple Shear Stress Y analytical method</p> <p>3.2.4 Direct stresses in two mutually perpendicular Directions Accompanied by Simple Shear Stress by analytical method</p> <p>3.2.5 Numerical</p>	
<p>3.3 Mohr's Stress Circle, principal stresses and strains (IMO7.02,2014:1.2.5)</p> <p>3.3.1 Define Mohr's circle</p> <p>3.3.2 Uniaxial State of stress: stresses on an oblique section of a body subjected to direct stress in plane by Mohr's Circle method</p> <p>3.3.3 Numerical</p> <p>3.3.4 Direct stresses in two mutually perpendicular directions by Mohr's Circle Method</p> <p>3.3.5 Direct stress in one Plane & accompanied by a simple Shear Stress by Mohr's Circle Method</p> <p>3.3.6 Direct stresses in two mutually perpendicular directions accompanied by a Simple Shear Stress by Mohr's Circle Method</p> <p>3.3.7 Numerical</p>	6
<p>IV. Torsion (IMO7.02,2014:1.2.4)</p> <p>Specific Learning Objective: Understand Concept of Torsional Moment in structure elements</p> <p>4.1 Explain Stress, strain and Strain energy due to torsion</p> <p>4.2 Explain Fundamental torsion equation</p>	
<p>4.1 Stress, strain and Strain energy due to torsion (IMO7.02,2014:1.2.4)</p> <p>4.1.1 Define Torsional Resilience</p> <p>4.1.2 Derivation Strain energy due to torsion</p>	5
<p>4.2 Fundamental Torsion Equation (IMO7.02,2014:1.2.4)</p> <p>4.2.1 Define Torsion of Shaft</p> <p>4.2.2 Assumptions in Torsion Equation</p> <p>4.2.3 Derivation of Torsion Equation</p> <p>4.2.4 Numerical</p> <p>4.2.5 Comparison of Solid and Hollow Shafts</p> <p>4.2.6 Shafts Are Connected in Series and Parallel</p> <p>4.2.7 Numerical</p>	10
<p>V. Truss and Frames</p> <p>Subtopics:</p> <p>5.1 Introduction, truss</p> <p>5.2 Elements of a truss</p> <p>5.3 Types of trusses, assumptions for truss analysis</p> <p>5.4 Methods of analysis of truss</p> <p>5.5 Method of joints, method of sections</p> <p>5.6 Frames</p> <p>5.7 Method of analysis of frame., Numerical</p>	13

Subject Name/ Code: Electrical Machines/UG11T5303

Instructional Hours:

Lecture	: 45 hours
Tutorial	: 15 hours
Total contact hours	: 60 hours
Credits	: 4

Teaching Methods

The course shall be conducted in a combination of classroom/online lectures, practical in laboratory and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments):	30%
Final Written Exam	: 70%

Text Book:

1. A textbook of Electrical Technology, Vol.2, AC and DC Machines, S Chand Publication by B L Theraja, and A. K. Theraja
2. Electrical Machines, I.J. Nagrath D.P.Kothari, McGraw Hill

Reference Book:

1. Electrical Machinery Dr. P. S. Bimbhra, Khanna Publishers
2. Electrical Machines, A. Hussain, Dhanpatrai publications
3. Electrical Machines Fundamentals of Electromechanical Energy Conversion by Gieras Jacek F., Taylor & Francis

Table of Topics

Unit	Topics	Hour (L)
I	Transformer: Single phase transformer: Construction, Equivalent Circuit, Phasor Diagram, Voltage Regulation, efficiency, Losses, Open Circuit and Short Circuit Tests, Single Phase Auto Transformer. 3 phase transformers: construction, connections (YY, DD, YD, DY) and voltage, current relationships between primary and secondary - basic numerical	14
II	D.C. Machines Construction, operation, e.m.f equation, characteristics of dc generator. Working principle of Motor, Back E.M.F., Types of DC Motors, Equivalent Circuit of a D.C. Motor, Torque and speed of DC Motor, Characteristics of a shunt and Series Motor, Speed Control of DC Motors, starters-- basic numerical	14
III	Induction Machines: Three-phase induction motors: Construction, rotating magnetic field, Principle of operation, types, slip, emf equation, rotor frequency, torque developed, to-- basic numerical torque-speed characteristics, power flow diagram Single phase induction motors, starting, application.	12
IV	Synchronous Machines: Construction, types & operating principle of synchronous generator, equivalent circuit, voltage regulation, conditions of parallel operation, synchronization, hunting & damping Synchronous Motor, principle, starting, synchronous condenser for power factor correction-basic numerical	14
V	Special Purpose Motors: Stepper Motor, Universal Motor, Shaded-pole Motor, Permanent magnet motors	6
Total		60

Learning Objectives		L
I. Transformer		14
General Learning Objective: To understand the principles, construction, operation, and analysis of single-phase and three-phase transformers, including their equivalent circuits, phasor diagrams, efficiency, losses, and testing methods.		9
1.1 Single-Phase Transformer: 1.1.1 Understand the construction and working principles of a single-phase transformer. 1.1.2 Develop and analyze the equivalent circuit of a single-phase transformer. 1.1.3 Interpret the phasor diagram and understand its significance. 1.1.4 Calculate and analyze voltage regulation, efficiency, and losses. 1.1.5 Perform and analyze open circuit and short circuit tests. 1.1.6 Understand the construction and operation of single-phase auto transformers. 1.1.7 Construction and Working Principles:		
1.2 Core and Windings: 1.2.1 Describe the construction of a single-phase transformer, including core types (e.g., core type, shell type), and windings (primary and secondary). 1.2.2 Explain the working principle based on Faraday's Law of Electromagnetic Induction.		

<p>1.3 Equivalent Circuit: Model Development: 1.3.1 Develop the equivalent circuit of a single-phase transformer. 1.3.2 Understand the parameters involved in the equivalent circuit (e.g., resistance, reactance, leakage impedance).</p>	
<p>1.4 Phasor Diagram: Phasor Representation: 1.4.1 Draw and interpret the phasor diagram of a single-phase transformer under different loading conditions (no load, full load). 1.4.2 Understand the significance of each phasor and their relationships.</p>	
<p>1.5 Voltage Regulation: 1.5.1 Definition and Calculation: 1.5.2 Define voltage regulation and its importance in transformer performance. 1.5.3 Calculate voltage regulation using the equivalent circuit parameters:</p>	
<p>1.6 Efficiency and Losses: 1.6.1 Efficiency Calculation: 1.6.2 Define transformer efficiency and distinguish between full-load and all-day efficiency. 1.6.3 Calculate efficiency using the formula: Efficiency=Output Power/Input Power×100% Efficiency= Input Power / Output Power ×100%</p>	
<p>1.7 Types of Losses: 1.7.1 Identify and explain core losses (hysteresis and eddy current losses) and copper losses (I^2R losses). 1.7.2 Open Circuit and Short Circuit Tests:</p>	
<p>1.8 Test Procedures: 1.8.1 Perform and analyze the open circuit (OC) test to determine core losses and no-load parameters. 1.8.2 Perform and analyze the short circuit (SC) test to determine copper losses and equivalent impedance. 1.8.3 Use test data to derive equivalent circuit parameters and predict performance.</p>	
<p>1.9 Single-Phase Auto Transformer: 1.9.1 Construction and Operation: 1.9.2 Explain the construction and operation of a single-phase auto transformer. 1.9.3 Discuss the advantages and disadvantages compared to conventional transformers. 1.9.4 Calculate the voltage and current transformation ratios.</p>	
<p>1.10 Three-Phase Transformers: 1.10.1 Understand the construction and operation of three-phase transformers. 1.10.2 Learn the various connections (YY, DD, YD, DY) and their applications. 1.10.3 Analyze voltage and current relationships between primary and secondary windings. 1.10.4 Solve basic numerical problems involving three-phase transformers.</p>	
<p>1.11 Construction and Operation: Core and Windings: 1.11.1 Describe the construction of three-phase transformers, including core configurations and winding arrangements. 1.11.2 Explain the operation and applications of three-phase transformers.</p>	
<p>1.12 Connections (YY, DD, YD, DY): Types of Connections: 1.12.1 Explain the different types of three-phase transformer connections: star-star (YY), delta-delta (DD), star-delta (YD), and delta-star (DY). 1.12.2 Discuss the advantages and disadvantages of each connection type.</p>	3
<p>1.13 Voltage and Current Relationships: 1.13.1 Derive and analyze the voltage and current relationships for each connection type. 1.13.2 Understand the phase shift introduced by the YD and DY connections.</p>	
<p>1.14 Basic Numerical Problems: Problem-Solving: 1.14.1 Solve basic numerical problems involving three-phase transformers, including calculations of voltage, current, and power for different connections. 1.14.2 Analyze the effects of loading conditions and connection types on transformer</p>	

performance.	
<p>1.15 Examples and Practical Applications:</p> <p>Examples:</p> <p>1.15.1 Work through examples calculating voltage regulation, efficiency, and losses for single-phase transformers.</p> <p>1.15.2 Perform numerical analysis of three-phase transformer connections and relationships.</p> <p>Practical Applications:</p> <p>1.15.3 Apply these concepts to real-world scenarios, such as power distribution, industrial applications, and electrical systems design.</p>	2
II. D.C. Machines	14
<p>General Learning Objective:</p> <p>To understand the construction, principles, operation, and characteristics of DC machines, including generators and motors, and to perform basic numerical analysis related to their performance and control.</p>	
<p>2.1 DC Generators:</p> <p>2.1.1 Understand the construction and working principles of a DC generator.</p> <p>2.1.2 Derive and apply the e.m.f. equation.</p> <p>2.1.3 Analyze the characteristics of different types of DC generators.</p> <p>2.1.4 Construction and Operation:</p>	
<p>2.2 Components:</p> <p>2.2.1 Describe the main components of a DC generator, including the armature, field windings, commutator, and brushes.</p> <p>2.2.2 Explain the role of each component in the operation of the generator.</p>	
<p>2.3 Principle of Operation:</p> <p>2.3.1 Explain the principle of electromagnetic induction as it applies to DC generators.</p> <p>2.3.2 Describe how mechanical energy is converted into electrical energy in a DC generator.</p>	
<p>2.4 E.M.F. Equation:</p> <p>2.4.1 Derivation:</p> <p>2.4.2 Derive the e.m.f. equation for a DC generator:</p> $E = P \frac{\Phi Z N}{60 A}$ <p>where E is the generated e.m.f, P is the number of poles, Φ is the flux per pole, Z is the total number of armature conductors, N is the rotational speed in rpm, and A is the number of parallel paths in the armature.</p> <p>2.4.3 Applications:</p> <p>2.4.4. Use the e.m.f. equation to calculate the generated voltage for given machine parameters.</p>	6
<p>2.5 Characteristics of DC Generators:</p> <p>2.5.1 Types and Characteristics</p> <p>2.5.2 Explain the different types of DC generators (series, shunt, compound).</p> <p>2.5.3 Plot and interpret the characteristic curves (open-circuit, load, and external characteristics) for each type of DC generator.</p>	
<p>2.6 DC Motors:</p> <p>2.6.1 Explain the working principle of DC motors and the concept of back E.M.F.</p> <p>2.6.2 Understand the types of DC motors and their equivalent circuits.</p> <p>2.6.3 Analyze the torque-speed characteristics of shunt and series DC motors.</p> <p>2.6.4 Learn methods for speed control of DC motors.</p> <p>2.6.5 Understand the function and operation of DC motor starters.</p> <p>2.6.6 Solve basic numerical problems related to DC motors.</p>	4
<p>2.7 Working Principle and Back E.M.F.:</p> <p>2.7.1 Principle of Operation:</p> <p>2.7.2 Explain the working principle of a DC motor, emphasizing the interaction between the magnetic field and the armature current.</p>	

<p>2.8 Back E.M.F.:</p> <p>2.8.1 Define back e.m.f. and its role in the operation of a DC motor.</p> <p>2.8.2 Derive the equation for back e.m.f.:</p> $E_b = P \frac{\Phi Z N}{60 A}$ <p>2.8.3 Explain how back e.m.f. affects the motor's performance and current draw.</p>	
<p>2.9 Types of DC Motors:</p> <p>Classification:</p> <p>2.9.1 Describe the different types of DC motors (series, shunt, and compound).</p> <p>2.9.2 Explain the constructional differences and typical applications of each type.</p>	
<p>2.10 Equivalent Circuit of a DC Motor:</p> <p>2.10.1 Circuit Representation:</p> <p>2.10.2 Draw and explain the equivalent circuit of a DC motor.</p> <p>2.10.3 Identify and explain the significance of each component (armature resistance, field resistance, back e.m.f.).</p>	
<p>2.11 Torque and Speed of DC Motors:</p> <p>2.11.1 Torque Equation:</p> <p>2.11.2 Derive the torque equation for a DC motor:</p> $T = k\Phi I_a$ <p>where T is the torque, k is a constant, Φ is the flux per pole, and I_a is the armature current.</p>	
<p>2.12 Speed Equation:</p> <p>2.12.1 Derive the speed equation:</p> $N = \frac{V - I_a R_a}{k\Phi}$ <p>where N is the speed, V is the supply voltage, I_a is the armature current, and R_a is the armature resistance.</p>	
<p>2.13 Characteristics of Shunt and Series Motors:</p> <p>2.13.1 Performance Curves:</p> <p>2.13.2 Plot and interpret the torque-speed characteristics for shunt and series DC motors.</p> <p>2.13.3 Discuss the implications of these characteristics for practical applications.</p>	
<p>2.14 Speed Control of DC Motors:</p> <p>Methods:</p> <p>2.14.1 Describe various methods for controlling the speed of DC motors, including armature voltage control, field flux control, and armature resistance control.</p> <p>2.14.2 Explain the advantages and limitations of each method.</p>	4
<p>2.15 Starters:</p> <p>2.15.1 Function and Operation:</p> <p>2.15.2 Explain the need for starters in DC motors.</p> <p>2.15.3 Describe the construction and operation of different types of starters (e.g., three-point starter, four-point starter).</p> <p>2.16 Examples and Practical Applications:</p> <p>Examples:</p> <p>2.16.1 Solve numerical problems involving the emf equation for DC generators.</p> <p>2.16.2 Perform calculations for torque and speed of DC motors under different conditions.</p> <p>2.16.3 Analyze speed control scenarios for DC motors.</p> <p>Practical Applications:</p> <p>2.16.4 Apply these concepts to real-world scenarios, such as motor selection for specific applications, performance optimization, and troubleshooting.</p>	
<p>III. Induction Machines</p>	12
<p>General Learning Objective:</p> <p>To understand the construction, principles, operation, and characteristics of three-phase and single-phase induction motors, including their starting methods, applications, and performance analysis.</p>	

<p>3.1 Three-Phase Induction Motors:</p> <p>3.1.1 Understand the construction and working principles of three-phase induction motors.</p> <p>3.1.2 Explain the concept of a rotating magnetic field and its significance.</p> <p>3.1.3 Analyze the types of three-phase induction motors and their applications.</p> <p>3.1.4 Derive and apply the slip, emf equation, and rotor frequency.</p> <p>3.1.5 Understand and calculate the torque developed and analyze torque-speed characteristics.</p> <p>3.1.6 Interpret the power flow diagram and solve basic numerical problems related to three-phase induction motors.</p>	
<p>3.2 Construction:</p> <p>3.2.1 Components:</p> <p>3.2.2 Describe the main components of a three-phase induction motor, including the stator, rotor (squirrel cage and wound rotor), and frame.</p> <p>3.2.3 Explain the function of each component in the operation of the motor.</p> <p>Rotating Magnetic Field:</p> <p>3.2.3 Principle:</p> <p>3.2.4 Explain the concept of a rotating magnetic field produced by the three-phase stator windings.</p> <p>3.2.5 Describe how the interaction between the rotating magnetic field and the rotor induces motion.</p>	4
<p>3.3 Principle of Operation:</p> <p>3.3.1 Electromagnetic Induction:</p> <p>3.3.2 Explain the principle of operation of a three-phase induction motor based on electromagnetic induction.</p> <p>3.3.3 Describe the process of energy conversion from electrical to mechanical energy.</p> <p>3.4 Types of Three-Phase Induction Motors:</p> <p>3.4.1 Squirrel Cage and Wound Rotor:</p> <p>3.4.2 Compare the construction and operation of squirrel cage and wound rotor induction motors.</p> <p>3.4.3 Discuss the typical applications and advantages of each type.</p>	
<p>3.5 Slip, EMF Equation, and Rotor Frequency:</p> <p>3.5.1 Slip:</p> <p>3.5.2 Define slip and derive the slip equation:</p> $s = \frac{N_s - N_r}{N_s}$ <p style="text-align: center;"> </p> <p>where s is the slip, N_s is the synchronous speed, and N_r is the rotor speed.</p> <p>EMF Equation:</p> <p>3.5.3 Derive the emf equation for the rotor:</p> $E_r = sE_s$ <p>where E_r is the rotor emf, s is the slip, and E_s is the stator emf.</p> <p>Rotor Frequency:</p> <p>3.5.4 Derive the rotor frequency equation:</p> $f_r = sf$ <p>where f_r is the rotor frequency, s is the slip, and f is the stator frequency.</p> <p>Torque Developed:</p> <p>3.5.5 Torque Equation:</p> <p>3.5.6 Derive the torque equation for a three-phase induction motor:</p> $T = \frac{P_r}{\omega_s}$ <p>where T is the torque, P_r is the rotor power, and ω_s is the synchronous angular speed.</p> <p>Torque-Speed Characteristics:</p> <p>3.5.7 Plot and interpret the torque-speed characteristics curve.</p> <p>3.5.8 Discuss the different regions of the curve (starting, running, and breakdown).</p> <p>3.6 Power Flow Diagram:</p> <p>3.6.1 Power Distribution:</p> <p>3.6.2 Draw and explain the power flow diagram of a three-phase induction motor, showing input power, stator losses, rotor losses, and output power.</p> <p>3.6.3 Calculate efficiency and losses using the power flow diagram.</p>	4

<p>3.7 Single-Phase Induction Motors:</p> <p>3.7.1 Understand the construction and operation of single-phase induction motors.</p> <p>3.7.2 Explain the different starting methods and their applications.</p> <p>3.7.3 Discuss various applications of single-phase induction motors.</p> <p>Construction and Operation:</p> <p>Components:</p> <p>3.7.4 Describe the main components of a single-phase induction motor.</p> <p>3.7.5 Explain the principle of operation and why a single-phase motor requires a starting mechanism.</p>	
<p>3.8 Starting Methods:</p> <p>3.8.1 Methods:</p> <p>3.8.2 Explain the different starting methods used in single-phase induction motors, including split-phase, capacitor-start, and shaded-pole methods.</p> <p>3.8.3 Discuss the advantages and applications of each starting method.</p>	4
<p>3.9 Applications:</p> <p>3.9.1 Common Uses: Identify common applications of single-phase induction motors in household appliances, industrial equipment, and other settings.</p> <p>3.9.2 Examples and Practical Applications:</p> <p>Examples:</p> <p>3.9.3 Solve numerical problems involving slip, emf, rotor frequency, and torque calculation for three-phase induction motors.</p> <p>3.9.4 Analyze torque-speed characteristics and solve basic numerical problems related to motor performance.</p> <p>Practical Applications:</p> <p>3.9.5 Apply these concepts to real-world scenarios, such as selecting appropriate motors for specific applications, troubleshooting motor issues, and optimizing motor performance.</p>	
<p>IV. Synchronous Machines</p>	14
<p>General Learning Objective:</p> <p>To understand the construction, types, and operating principles of synchronous machines, including synchronous generators and motors, and to perform basic numerical analysis related to their performance, synchronization, and applications in power systems.</p>	
<p>4.1 Synchronous Generators:</p> <p>4.1.1 Understand the construction and working principles of synchronous generators.</p> <p>4.1.2 Explain the equivalent circuit and voltage regulation of synchronous generators.</p> <p>4.1.3 Learn the conditions for parallel operation and synchronization.</p> <p>4.1.4 Understand the phenomena of hunting and damping.</p>	
<p>4.2 Construction and Types:</p> <p>4.2.1 Components:</p> <p>4.2.2 Describe the main components of a synchronous generator, including the rotor, stator, field windings, and armature windings.</p> <p>Types:</p> <p>4.2.3 Explain the different types of synchronous generators (salient pole and cylindrical rotor) and their typical applications.</p> <p>4.3 Operating Principle:</p> <p>4.3.1 Electromagnetic Induction:</p> <p>4.3.2 Explain the principle of operation of a synchronous generator based on electromagnetic induction.</p> <p>4.3.3 Describe how mechanical energy is converted into electrical energy in a synchronous generator.</p> <p>Equivalent Circuit:</p> <p>4.3.4 Draw and explain the equivalent circuit of a synchronous generator, including the representation of armature resistance, synchronous reactance, and induced emf.</p> <p>4.4 Impedance and Reactance:</p> <p>4.4.1 Define synchronous reactance and explain its impact on generator performance.</p>	4

<p>4.5 Voltage Regulation:</p> <p>4.5.1 Definition and Calculation: 4.5.2 Define voltage regulation and explain its importance in generator operation. 4.5.3 Calculate voltage regulation using the synchronous generator equivalent circuit and the formula:</p> $\text{Voltage Regulation} = \frac{E_{\text{no load}} - V_{\text{full load}}}{V_{\text{full load}}} \times 100\%$ <p>4.5.4 Parallel Operation and Synchronization: 4.5.5 Conditions for Parallel Operation: 4.5.6 List and explain the conditions necessary for the parallel operation of synchronous generators, including voltage, frequency, phase sequence, and phase angle.</p>	4
<p>4.6 Synchronization:</p> <p>4.6.1 Describe the methods of synchronizing a synchronous generator to the power grid, such as the lamp method and synchro scope method.</p>	
<p>4.7 Hunting and Damping:</p> <p>Hunting:</p> <p>4.7.1 Define hunting and explain its causes and effects on synchronous generators.</p> <p>Damping:</p> <p>4.7.2 Describe the use of damper windings to mitigate hunting and enhance the stability of synchronous generators.</p>	
<p>4.8 Synchronous Motors:</p> <p>4.8.1 Understand the operating principles and starting methods of synchronous motors. 4.8.2 Explain the concept of synchronous condensers for power factor correction. 4.8.3 Solve basic numerical problems related to synchronous machines.</p> <p>Principle and Operation:</p> <p>4.8.4 Operating Principle: 4.8.5 Explain the principle of operation of a synchronous motor, emphasizing the role of the rotating magnetic field and the synchronous speed.</p> <p>Constant Speed:</p> <p>4.8.6 Discuss the constant speed characteristics of synchronous motors and their implications for industrial applications.</p> <p>Starting Methods:</p> <p>4.8.7 Methods: 4.8.8 Describe different methods for starting synchronous motors, such as using pony motors, damper windings, and variable frequency drives (VFDs).</p>	6
<p>4.9 Synchronous Condenser:</p> <p>4.9.1 Power Factor Correction: 4.9.2 Explain the concept of a synchronous condenser and its use in power systems for power factor correction. 4.9.3 Discuss how a synchronous motor operating at a leading power factor can be used to improve the power factor of the system.</p> <p>Examples and Problem-Solving</p> <p>4.9.4 Examples and Practical Applications: Examples: 4.9.5 Solve numerical problems involving the calculation of voltage regulation, synchronization conditions, and power factor correction using synchronous condensers.</p> <p>Practical Applications:</p> <p>4.9.6 Apply these concepts to real-world scenarios, such as selecting and operating synchronous generators and motors in power plants and industrial settings, ensuring proper synchronization, and improving power system efficiency through power factor correction.</p>	6
<p>V. Special Purpose Motors</p>	6
<p>General Learning Objective:</p> <p>To understand the construction, operating principles, characteristics, and applications of various special purpose motors, including stepper motors, universal motors, shaded-pole motors, and permanent magnet motors.</p>	

<p>5.1 Stepper Motors:</p> <p>5.1.1 Understand the construction and working principles of stepper motors.</p> <p>5.1.2 Explain the types of stepper motors and their operating characteristics.</p> <p>5.1.3 Discuss the applications and advantages of stepper motors.</p> <p>5.2 Construction and Working Principles:</p> <p>5.2.1 Components:</p> <p>5.2.2 Describe the main components of a stepper motor, including the stator, rotor, and windings.</p> <p>5.3 Operation:</p> <p>5.3.1 Explain the principle of operation, detailing how stepper motors move in discrete steps.</p> <p>5.4 Types of Stepper Motors:</p> <p>5.5 Variable Reluctance, Permanent Magnet, and Hybrid:</p> <p>5.5.1 Describe the differences between variable reluctance, permanent magnet, and hybrid stepper motors.</p> <p>5.5.2 Explain the operating characteristics of each type.</p>	2
<p>5.5 Operating Characteristics:</p> <p>5.5.1 Step Angle and Resolution:</p> <p>5.5.2 Define step angle and resolution, and explain their importance in stepper motor applications.</p> <p>Torque and Speed Characteristics:</p> <p>5.5.3 Discuss the torque and speed characteristics of stepper motors and their impact on performance.</p> <p>Applications and Advantages:</p> <p>5.5.4 Typical Applications:</p> <p>5.5.5 Identify common applications of stepper motors, such as in CNC machines, printers, and robotics.</p> <p>Advantages:</p> <p>5.5.6 Discuss the advantages of using stepper motors, including precise control and reliability.</p>	1
<p>5.6 Universal Motors:</p> <p>5.6.1 Understand the construction and working principles of universal motors.</p> <p>5.6.2 Explain the characteristics and typical applications of universal motors.</p> <p>5.6.3 Discuss the advantages and limitations of universal motors.</p> <p>Construction and Working Principles:</p> <p>5.6.4 Components:</p> <p>5.6.5 Describe the main components of a universal motor, including the stator, rotor (armature), commutator, and brushes.</p> <p>Operation:</p> <p>5.6.6 Explain the principle of operation, detailing how universal motors can operate on both AC and DC power.</p> <p>5.6.7 Characteristics and Applications:</p> <p>5.6.8 Performance Characteristics:</p> <p>5.6.9 Discuss the speed-torque characteristics of universal motors.</p> <p>Typical Applications:</p> <p>5.6.10 Identify common applications, such as in portable power tools, household appliances, and vacuum cleaners.</p> <p>Advantages and Limitations:</p> <p>Advantages:</p> <p>5.6.11 Discuss the advantages of universal motors, including high starting torque and variable speed.</p> <p>Limitations:</p> <p>5.6.12 Explain the limitations, such as noise, brush wear, and maintenance requirements.</p>	1

<p>5.7 Shaded-Pole Motors:</p> <p>5.7.1 Understand the construction and working principles of shaded-pole motors.</p> <p>5.7.2 Explain the characteristics and typical applications of shaded-pole motors.</p> <p>5.7.3 Discuss the advantages and limitations of shaded-pole motors.</p> <p>Construction and Working Principles:</p> <p>5.7.4 Components:</p> <p>5.7.5 Describe the main components of a shaded-pole motor, including the stator, rotor, and shading coils.</p> <p>Operation:</p> <p>5.7.6 Explain the principle of operation, focusing on the role of shading coils in producing a rotating magnetic field.</p> <p>Characteristics and Applications:</p> <p>5.7.7 Performance Characteristics:</p> <p>5.7.8 Discuss the performance characteristics of shaded-pole motors, such as low starting torque and low efficiency.</p> <p>Typical Applications:</p> <p>5.7.9 Identify common applications, such as in small fans, hair dryers, and timers.</p> <p>Advantages and Limitations:</p> <p>Advantages:</p> <p>5.7.10 Discuss the advantages of shaded-pole motors, including simplicity, low cost, and reliability.</p> <p>Limitations:</p> <p>5.7.11 Explain the limitations, such as low starting torque and limited power output.</p>	1
<p>5.8 Permanent Magnet Motors:</p> <p>5.8.1 Understand the construction and working principles of permanent magnet motors.</p> <p>5.8.2 Explain the types and characteristics of permanent magnet motors.</p> <p>5.8.3 Discuss the applications and advantages of permanent magnet motors.</p> <p>Construction and Working Principles:</p> <p>5.8.4 Components:</p> <p>5.8.5 Describe the main components of a permanent magnet motor, including the stator, rotor, and permanent magnets.</p> <p>Operation:</p> <p>5.8.6 Explain the principle of operation, focusing on how permanent magnets create a constant magnetic field.</p> <p>Types and Characteristics:</p> <p>5.8.7 DC and Synchronous Permanent Magnet Motors:</p> <p>5.8.8 Differentiate between DC permanent magnet motors and synchronous permanent magnet motors.</p> <p>5.8.9 Discuss the operating characteristics of each type.</p> <p>Applications and Advantages:</p> <p>Typical Applications:</p> <p>5.8.10 Identify common applications of permanent magnet motors, such as in electric vehicles, computer peripherals, and industrial automation.</p> <p>Advantages:</p> <p>5.8.11 Discuss the advantages of permanent magnet motors, including high efficiency, high torque-to-weight ratio, and reliability.</p>	1

Subject Name/Code: Engineering Materials /UG11T5304

Instructional hours:

Lecture : 45 hours

Total contact hours : 45 hours

Credits : 3

Teaching Methods

The course shall be conducted in a combination of classroom lectures, and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments) : 30%

Final Written Exam : 70%

Text Book:

1. Material Science, S K Hajra Choudhury, Media Book.
2. Raghavan V, Material Science and Engineering A first course, Prentice Hall of India.
3. Materials for marine machinery, S. H. Frederick and H. Capper; Institute of Marine Engineers; ISBN: 0900976-42-x.

Reference:

1. William D Callister & David G Rethweisch, Materials science and Engineering an Introduction, John Wiley and Sons.
2. Narula G.K., Narula K.S., & Gupta V.K., (2007), Material science, Tata Mc Graw Hill.
3. Shenoj and J.F. Wellicome, Composite Materials in Maritime Structures: Volume 1 Fundamental Aspects, Cambridge University Press.
4. Rajendran.V, Material Science, Tata Mc Graw Hill.
5. Robert L. Reuben, Materials in Marine Technology, Springer-Verlag.

Table of Topics

Unit	Topics	Hour (L)
I	Crystal Structure	9
II	Solid Solutions and Phase diagrams	11
III	Heat Treatment	9
IV	Alloy Elements	7
V	Materials in Marine Industry	9
Total		45

Learning Objectives	L
I. Crystal Structure Competence 3.1 (IMO/ 7.04 / 2014 1.1) Pg.123 -131	9
General Learning Objective Understand the employment of different materials and their uses in marine industry including material selection, treatment techniques, corrosion control and Composites.	
Specific Learning Objectives Explain the following: 1.1 Atomic structure- atomic bonding in solids, Unit cells and Space lattices, Crystal structures 1.2 Concept of amorphous, single, and polycrystalline structures 1.3 Miller Indices, Crystal Defects, point, line, surface, and volume defects 1.4 Allotropy of Carbon – Structure of Diamond, Graphite, C-60.	9
II. Solid Solution and Phase Diagram	11
Specific Learning Objectives Explain the following: 2.1 Types of Solid solutions – Hume-Rothery ratio – Intermediate phases – Solid solution alloys 2.2 Phase Diagrams- Introduction –Cooling curves 2.3 Gibbs Phase rule – Classification of equilibrium diagrams 2.4 Eutectic – Peritectic reactions – Equilibrium diagram for common non-ferrous alloys and ferrous alloys 2.5 Micro constituents of iron - Iron–Carbon equilibrium diagram, TTT diagram	11
III. Heat Treatment Competence 3.1 (IMO / 7.04 / 2014 / 2.1) pg.131	9
Specific Learning Objectives Explain the following: 3.1. Definition – Purpose of heat treatment 3.2 Effect of thermal cycles on their micro-structure Heat treatment techniques 3.3 Annealing – Normalizing – Hardening –Tempering 3.4 Mar tempering – Austempering 3.5 Case Hardening and Surface Treatment 3.6 Carburizing - Cyaniding – Nitriding, Flame Hardening etc.	9
IV. Alloy Elements	7
V. Materials in Marine Industry Competence 3.1 (IMO / 7.04 / 2014 / 2.1) pg.123 -13)	9
Specific Learning Objectives Explain the following: 5.1 Chromium, Ceramic, Titanium, PTFE in Shipboard Systems. Characteristics of above materials 5.2 Introduction to different types of materials used in shipbuilding 5.3 Selection of Materials in Shipbuilding and Marine Engineering: Boilers, Steam and Gas turbine, Purifiers and Diesel engine components, Pumping Machinery, Components and Piping System, Engine seating. Propellers and Rudders. Composition, Strength value and other requirement for materials used	9

Subject Name/Code: Marine Boilers /UG11T5305

Instructional Hours:

Lecture	: 45 hours
Tutorial	: 15 hours
Total contact hours	: 60 hours
Credits	: 4

Teaching Methods

The course shall be conducted in a combination of classroom/online lectures, practical in workshops and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments:	30%
Final Written Exam	: 70%

Text Book:

1. Marine steam boilers -J.H.Milton
2. Steam Engineering Knowledge for Marine Engineers - Reeds Volume:9

Reference:

1. Marine boilers - G.T.H. Flanagan
2. Running & Maintenance of Marine Machinery - Cowley, I.M.E Publication
3. Boiler Control System - David Lindsley
4. Steam – Its generation and Use - Babcock Engineering
5. Boiler Plant Instrumentation - Kent Gunn

Table of Topics

Unit	Topics	Hour (L)
I	Marine boiler fundamentals & construction	10
II	Marine boiler mountings &Boiler water treatment	14
III	Steam boiler fuel atomization and combustion	12
IV	Boiler and Associated Auxiliaries, and Steam Systems	14
V	Boiler Operation and Auto-shut down	10
Total		60

Learning Objectives		L
I. Marine boiler construction- (IMO 7.04,2014: F1/1.4.1.4)		10
1.0 General Learning Objective Understand the design features and the operative mechanism of the Marine Boiler and associated auxiliaries along with the Steam service system so that the related machinery is maintained and operated in a safe, economical and efficient manner on-board		
Specific Learning Objectives: (IMO 7.04,2014: F1/1.4.1.4)		
What is the purpose of fitting a boiler on board diesel engine ships? Draw the outline of a boiler system listing associated systems including their components		3
With reference to pressure vessels explain why a. shells of cylindrical form give a higher strength/weight ratio than other shapes b. the cylindrical shell can be sited vertically or horizontally c. dished or spherical end-plates give a higher strength than flat end-plates of similar thickness d. all flat surfaces must be properly stayed to resist deformation e. stays can have the form of solid bars, thick tubes or plate girders corrugated furnaces provide higher strength and flexibility than plain furnaces of similar thickness 1.1.1 Describe the material commonly used for construction in a fire-tube boiler 1.1.2 Explain the relationship between a boiler and exhaust gas economizer 1.1.3 Explain ignition system 1.1.4 Explain feed water system 1.1.5 Describe the means used to minimize the possibility of oil contaminating the boiler feed Water		4
II. Marine boiler mountings &Boiler water treatment		14
2.1 Marine boiler mountings and steam distribution- (IMO 7.04,2014: F1/1.4.1.4)		
2.1.1 Identify the following boiler fittings and position on boiler shell (supply shell diagram for fitting to be married/drawn and identified): 2.1.2 Discuss the significance of the following boiler mountings		6

<ul style="list-style-type: none"> a. main steam outlet (or "stop") valve b. auxiliary steam stop valve c. safety valves and easing gear d. water level gauges e. feed inlet valve f. blow-down valve g. scumming valve h. soot blowers i. air release valve j. sampling valve <p>State the function of safety valve and how to adjust the setting point to blow</p>	
<p>2.1.3 Explain the purpose of a reducing valve. Describe the operation of a reducing valve, using a single line sketch</p> <p>2.1.4 Explain simply and briefly, with the aid of a diagram a fire-tube boiler.</p> <p>2.1.5 Explain simply and briefly, with the aid of a diagram a water-tube boiler.</p> <p>2.1.6 Explain simply and briefly, with the aid of diagram a composite boiler</p>	4
<p>2.2 Boiler Water Treatment: Specific Learning Objective: (IMO Model course 7.04 – Appendix 5) Explain the following:</p> <ul style="list-style-type: none"> 2.2.1 Impurities in boiler feed water 2.2.2 Condensate systems corrosion 2.2.3 Priming of the boiler 2.2.4 Water carryover in steam 2.2.5 Removal of Oxygen from the boiler feed water 2.2.6 Water treatment - Chemicals used Dosage calculations 	4
<p>III. Steam boiler fuel atomization and combustion</p>	12
<p>3.1 Boiler Combustion</p> <p>3.1.1 State the theoretical air/fuel ratio for a typical boiler fuel</p> <ul style="list-style-type: none"> a. State the actual air/fuel ratio allowing for normal excess air in the furnace of a steam boiler b. State the effect of sulphur dioxide coming into contact with a low-temperature surface, production of sulphuric acid and the corrosion it will cause. c. Explain how the effect of the above objective can be minimized. <p>3.1.2 Describe the significance of the following:</p> <ul style="list-style-type: none"> a. swirl vanes b. the flame stabilizer c. air-flow control valves d. the burner e. State typical values of the pressure drop and of the velocity of combustion air in the register f. Explain why the thorough and rapid mixing of atomized fuel and combustion air is important g. Describe the furnace conditions which indicate good combustion 	5
<p>3.1.3 Sketch a section through the nozzle assembly of a pressure-jet burner</p> <ul style="list-style-type: none"> a. Explain the process of atomization produced by the fuel, at high pressure, passing through a small orifice in the burner nozzle b. Describe the attention required by burner atomizer tips. 	3
<p>3.1.4 Describe with the aid of sketch a rotary-cup burner.</p>	2
<p>3.1.5 Sketch a typical Fuel oil pipeline system for an Auxiliary System burning Fuel Oil and Low sulphur Gas Oil.</p>	2
<p>3.1.6 Explain the process of changing over from High sulphur heavy fuel Oil to Low sulphur Gas Oil.</p>	
<p>IV. Boiler and Associated Auxiliaries, and Steam Systems</p>	14
<p>4.1 Boiler and Associated Auxiliaries, and Steam Systems - (IMO 7.04, 2014: F1/1.4.3.2)</p> <p>4.1.1 State the procedure for igniting the burner manually and automatically</p> <p>4.1.2 State the procedure to build up the steam pressure and to put boiler into service</p> <p>4.1.3 Explain the precautions and necessary measures to be taken when getting up steam</p> <p>4.1.4 Explain the benchmark for building up steam pressure.</p>	2
<p>4.1.5 Explain operation methods of boiler and economizer when vessel under way</p> <p>4.1.6 Explain precautions for using exhaust gas economizer</p>	2
<p>4.1.6 Describe the method used to ensure that all pipes, cocks, valves and other fittings</p>	4

used for indicating water level are clear and in good working order. 4.1.7 Describe the correct procedure for checking the water level in steaming boilers 4.1.8 Explain the treatment of boiler water including examination of properties of boiler Water. 4.1.9 Explain surface and bottom blowing of boiler water. 4.1.10 Describe the danger of oil entering a boiler with the feed water	
4.1.11 What is meant by soot blowing? Sketch and explain the function of soot blowers. 4.1.12 State the precautions for opening high temperature steam valves.	2
4.1.13 Explain the procedure keep boiler in cold condition while it is out of service 4.1.14 Describe the correct procedure for operating steaming boilers in parallel on load	2
4.1.15 What is meant by "blow-back"? 4.1.16 Explain how blow-back can be avoided 4.1.17 Explain why the temperature of boiler exhaust gases should be maintained above a minimum value	2
V. Boiler Operation and Auto-shut down	10
5.1 Boiler Operation -(IMO 7.04,2014: F1/3.2.3.10) 5.1.1 Explain the need for cleaning the fire side of a boiler and the procedure to do it. 5.1.2 Describe the procedure to inspect the fire side of a boiler and repair/maintenance	3
5.1.3 Explain the need of cleaning up the water side of a boiler and the procedure to do it 5.1.4 Describe the procedure to inspect the water side of a boiler and the repair/maintenance.	2
5.1.5 Describe the flashing up of boiler up from cold after cleaning up the fire/water side. 5.1.6 Describe the procedure to repair the firebrick wall of a furnace.	2
5.2 Main Boiler Auto-shut down-(IMO 7.04,2014: F1/1.4.2.2) 5.2.1 Explain main boiler auto-shut down taking a typical system as an example in terms of the following: <ul style="list-style-type: none"> ● specific conditions ● processes appearing until shut down ● impact on the plant when vessel under way and in port ● procedures for recovery (eliminating causes, reigniting burner, etc.,) 	3

Subject Name/Code: Marine Environment Pollution and Protection /UG11T5306

Instructional Hours

Lecture : 45 hours

Total contact hours : 45 hours

Credits : 3

Teaching Methods

The course shall be conducted in a combination of classroom/online lectures and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments: 30%

Final Written Exam : 70%

Text Book:

1. MARPOL 73/78 (IMO) Consolidated Edition 2022.
2. Manual on oil pollution, Section 1 - prevention (IMO sales no.557)

Reference:

1. International convention for the safety of life at sea (SOLAS), as amended (IMO)
2. International safety management code (ISM code)
3. International safety guide for oil tankers and terminals. (ICS/OCIMF. London, wither by& co).
4. Marine Engineering Practice - IMEI Publication
5. General Engineering Knowledge for Marine Engineers - Reeds Volume:8
6. Marine Machineries- Operation & Maintenance – T.B. Srinivasan, IMEI Publication.
7. The Running & Maintenance of Marine Machinery – J. Cowley by IMEI Publication.
8. Regulations for the prevention of pollution by oil – Annex 1, MARPOL 73/78 (IMO)
9. Guidelines for the implementation of Annex V of MARPOL 73/78 (in IMO sales no. 520)

Table of Topics

Unit	Topics	Hour (L)
I	MARPOL 73/78	15
II	Oil Pollution Preparedness, Response & Cooperation Convention (OPRC) as amended (OPRCHNS Protocol) & OPA – 90	8
III	Oil Record Book (Part I - Machinery Space Operations and Part II – Cargo/Ballast Operations)	6
IV	Shipboard Oil Pollution Emergency Plan (SOPEP) including Shipboard Marine Pollution Emergency Plans (SMPEP) for Oil and/or Noxious Liquid Substances and Vessel Response Plan (VRP)	6
V	Volatile Organic Compound (VOC) Management Plan, Anti-fouling systems & Ballast Water Management and their discharge criteria	10
Total		45

Learning objectives		L
I. MARPOL 73/78 (IMO 7.04,2014: F4/4.1.1/1.1)		15
General Learning Objective Demonstrate a knowledge and understanding of the precautions to be taken to prevent pollution of the marine environment, anti-pollution procedures and all associated equipment and proactive measures to protect the marine environment. Specific Learning Objectives: (IMO 7.04,2014: F4/4.1.1, 4.1.2, 4.1.3)		
1.1 Introduction to MARPOL 1.1.1 Define, for the purpose of MARPOL 73/78: <ul style="list-style-type: none"> ● Harmful substance ● Discharge ● Ship ● Incident 1.1.2 State that violations of the Convention are prohibited and that sanctions should be established for violations, wherever they occur by the Administration of the ship concerned.		1
1.2 Annex I-Oil-continued 1.2.1 Describe conditions in which processed bilge water from machinery spaces may be discharged in a special area. 1.2.2 Describe the exceptional circumstances in which the regulations on the discharge of oil or oily mixtures do not apply. 1.2.3 Explain the exceptions in which ballast may be carried in cargo tanks. 1.2.4 Explain that a new chapter 8 – STS operations has been added to MARPOL Annex 1 to prevent marine pollution during some ship-to-ship (STS) oil transfer operations.		2

<p>1.3 Annex II - Noxious Liquid Substances in Bulk</p> <p>1.3.1 Describe the requirements of Annex II apply to all ships carrying noxious liquid substances in bulk.</p> <p>1.3.2 State that noxious liquid chemicals are divided into four categories, X, Y, Z and OS such that substances in category X pose the greatest threat to the marine environment and those in category Z the least.</p> <p>1.3.3 State that the conditions for the discharge of any effluent containing substances falling in those categories are specified.</p> <p>1.3.4 State that more stringent requirements apply in special areas, which for the purposes of Annex II are the Antarctic area.</p> <p>1.3.5 State that each ship which is certified for the carriage of noxious liquid substances in bulk should be provided with a Procedures and Arrangements Manual.</p>	2
<p>1.4 Annex II - Noxious Liquid Substances in Bulk-continued</p> <p>1.4.1 State that each ship should be provided with a Cargo Record Book which should be completed, on a tank-by-tank basis, whenever any operations with respect to a noxious liquid substance take place.</p> <p>1.4.2 State that the certificate issued on satisfactory completion of the survey is an international Pollution Prevention Certificate for the Carriage of Noxious Liquid Substances in Bulk.</p>	2
<p>1.5 Annex III-Harmful Substances Carried by Sea in Packaged Forms, or in Freight Containers, Portable Tanks or Road and Rail Tank Wagons</p> <p>1.5.1 State that packaging, containers and tanks should be adequate to minimize Hazard to the marine environment.</p> <p>1.5.2 Describe the requirements for marking and labelling packages, freight containers, tanks and wagons.</p>	2
<p>1.6 Annex III – continued</p> <p>1.6.1 Describe the notification procedures for loading/unloading harmful substances as per MARPOL Annex III.</p> <p>1.6.2 Describe the documentation relating to the carriage or harmful substances by sea.</p>	2
<p>1.7 Annex IV – Sewage-continued</p> <p>1.7.1 State that Annex IV contains a set of regulations regarding the discharge of sewage into the sea, ships' equipment and systems for the control of sewage discharge, the provision of facilities at ports and terminals for the reception of sewage, and requirements for survey and certification.</p>	2
<p>1.8 Annex V – Garbage</p> <p>1.8.1 State that the provisions of Annex V apply to all ships</p> <p>1.8.2 State that the special areas for the purposes of Annex V as the Mediterranean Sea, Baltic Sea, Black Sea, Red Sea, "Gulfs" area, North Sea, Antarctic area (south of latitude 60 degrees south, Wider Caribbean region including the Gulf of Mexico and the Caribbean Sea</p>	2
<p>1.9 Annex VI – Air Pollution</p> <p>1.9.1 Describe the provision for the issuance of International Air Pollution Prevention certificate</p> <p>1.9.2 Describe the regulation regarding NOX in Regulation 13 of Annex VI</p> <p>1.9.3 Describe the requirement for SOX emission control area (SECA)</p> <p>1.9.4 Describe the requirement for fuel oil quality in Regulation 18 of Annex VI</p>	2
<p>II. Oil Pollution Preparedness, Response & Cooperation Convention (OPRC) as amended (OPRCHNS Protocol) & OPA – 90</p>	8
<p>2.1 Oil Pollution Preparedness, Response & Cooperation Convention (OPRC) as amended (OPRCHNS Protocol)</p> <p>2.1.1 State that the Protocol on Preparedness, Response and Cooperation to Pollution Incidents by Hazardous and Noxious Substances (HNS), 2000 or the OPRC-HNS Protocol, aims to provide a global framework for international co-operation establishing systems for preparedness and response in combating incidents or threats of marine pollution involving HNS at the national, regional and global levels; in improving scientific and technological understanding and knowledge in this field; in promoting technical cooperation in response techniques; and in developing specialized training programmes.</p>	4
<p>2.2 OPA – 90</p> <p>2.2.1 Explain the contents and purpose of OPA – 90</p>	4
<p>III. Oil Record Book (Part I - Machinery Space Operations and Part II – Cargo/Ballast Operations)</p>	6
<p>Specific Learning Objectives:</p> <p>3.1 Oil Record Book (Part I - Machinery Space Operations and Part II – Cargo/Ballast Operations)</p>	

<p>(IMO 7.04,2014: F4/4.1.2/2.2)</p> <p>3.1.1 Describe the requirements for the provision of Oil Record Books, which is, Oil tankers of 150 tons GT and every ship of 400 tons of GT and above other than an oil tanker to carry an Oil Record Book Part I (Machinery Space Operations)</p> <p>3.1.2 Describe the various operation when the Oil Record Book has to be completed.</p> <p>3.1.3 List the various entries that needs to be made in the Oil Record Book with respect to above for following operations for machinery space operations (all ships)</p>	6
<p>IV. Shipboard Oil Pollution Emergency Plan (SOPEP) including Shipboard Marine Pollution Emergency Plans (SMPEP) for Oil and/or Noxious Liquid Substances and Vessel Response Plan (VRP) (IMO 7.04,2014: F4/4.1.2/2.3)</p>	6
<p>Specific Learning Objectives:</p> <p>4.1 Explain that the Shipboard Oil Pollution Emergency Plan ("SOPEP") is to be seen as an information from the owners to the Master of a particular ship.</p> <p>4.2 Explain it is advice to the Master how to react in case of an oil spill to prevent or at least mitigate negative effects on the environment.</p> <p>4.3 Explain that the Plan contains operational aspects for various oil spill scenarios and lists communication information to be used in case of such incidents.</p>	6
<p>V. Volatile Organic Compound (VOC) Management Plan, Anti-fouling systems & Ballast Water Management and their discharge criteria</p>	10
<p>5.1 Volatile Organic Compound (VOC) Management Plan (IMO 7.04,2014: F4/4.1.2/2.5)</p> <p>5.1.1 Describe that Volatile Organic Compounds (VOC) are organic chemicals that easily vaporize at normal conditions and enter into the atmosphere</p> <p>5.1.2 Explain that the amount of VOC emissions depends on many factors including the properties of the cargo oil, the degree of mixing and temperature variations during the sea voyage</p> <p>5.1.3 Describe that Regulation 15.6 of MARPOL requires a tanker carrying crude oil shall have onboard and implement a VOC Management Plan (Management Plan) approved by the Administration in accordance with IMO Resolution MEPC.185(59) "Guidelines for the Development of a VOC Management Plan"</p> <p>5.1.4 Explain that the aim of the VOC Management Plan is to identify the arrangements and equipment required to enable compliance with Regulation 15.6 of the Revised Annex VI and to identify for the ship's officers the operational procedures for VOC emission control.</p>	4
<p>5.2 Anti-fouling systems</p> <p>5.2.1 State that IMO adopted a new International Convention on the Control of Harmful Anti-Fouling Systems on Ships, on 5 October 2001 which will prohibit the use of harmful organism in antifouling paints used on ships and will establish a mechanism to prevent the potential future use of other harmful substances in anti-fouling system</p> <p>5.2.2 State that the convention entered into force on 17 September 2008.</p>	3
<p>5.3 Ballast Water Management and their discharge criteria (IMO 7.04,2014: F4/4.1.2/2.5)</p> <p>5.3.1 State that The International Convention for the Control and Management of Ships Ballast Water & Sediments (BWM convention)</p> <p>5.3.2 State that in order to show compliance with the requirements of the Convention each vessel shall have on board a valid Certificate, a Ballast Water Management Plan and a Ballast Water Record Book.</p> <p>5.3.3 Describe the conditions where the application of this convention may be exempted.</p> <p>5.3.4 Describe the management and control requirement based on Section B Regulation B1 to B6.</p> <p>5.3.5 Describe the various methods of ballast exchange.</p>	3

Subject Name/Code: Computer and Python Lab/UG11P5301

Instructional hours:

Practical	: 45 hours
Total contact hours	: 45 hours
Credits	: 1.5

Teaching Methods

The practical training will be hands-on with focus on safety and skills.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments)	: 50%
Final Exam	: 50%

Module-A

Simple C Programming

1. Data Types, Expression Evaluation,
2. Condition Statements, loop.
3. Arrays
4. String Handling
5. Structures and Unions
6. Functions

Module-B

Proposed List of Assignments for Python

1. Write a program in python to take two numbers and perform their addition, subtraction, multiplication and division.
2. Write a program in python to check a given number is even or odd.
3. Write a program in python to check a given number is prime or not.
4. Write a program in python to check a given number is Armstrong or not.
5. Write a program in python to find twin primes in a given range.
6. Write a program in python to calculate LCM of two given numbers
7. Write a program in python to calculate GCD of two given numbers
8. Write a program in python to display first N terms of the Fibonacci sequence.
9. Write a program in python to calculate factors of a given number
10. Write a program in python to calculate prime factors of a given number
11. Write a program in python to Multiply Two Matrix.
12. Write a program in python to create a list, insert data, sort them and display the list.
13. Write a program in python to create a list, insert data, and find minimum & maximum value from the list.
14. Write a program in python to create a list, insert data, and search for a given value from the list.
15. Write a program in python to create a list, insert data, and calculate frequency (occurrence) of a given value from the list.
16. Write a program in python to append new string with an existing string.

17. Write a program in python to Count all letters, digits, and special symbols from a given string.
18. Write a program in python to reverse a given string
19. Write a program in python to plot a function on X with given range of values for X.
20. Write a program in python to Plot Month wise average temperature for a particular year.
21. Image processing programs
22. Predictive modelling



Subject Name/Code: Fluid Mechanics and Hydraulics Lab/UG11P5302

Instructional hours:

Practical	: 45 hours
Total contact hours	: 45 hours
Credits	: 1.5

Teaching Methods

The practical training will be hands-on with focus on safety and skills.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments)	: 50%
Final Exam	: 50%

Text Book:

1. Fluid Mechanics and Hydraulics R K Bansal.
2. Hydraulics and Fluid Mechanics – P. N. Modi and S. M. Seth.

Reference:

1. Fluid Mechanics and Hydraulic Machines – R. K. Rajput.
2. Fluid Mechanics (Part 1 and Part 2) – J. F. Douglas.
3. Mechanics of Fluids – Bernard Massey and John Ward Smith.
4. Fundamentals of Fluid Mechanics – G. S. Sawhney

Table of Topics

Unit	Topics	Hour (P)
I	Fluid Properties Specific gravity Viscosity	4
II	Hydrostatics Hydraulic lifting machine	4
III	Fluid Flow Venturi meter Orifice meter Notches Losses in pipe	20
IV	Centrifugal Pumps Characteristics curve Design of centrifugal pump	8
V	Fluid Flow and Characteristics of Major Systems Reynolds Experiments	7
VI	Impact of Jet and Turbine Impact of jet apparatus	2
Total		45

Learning Objectives		P
General Learning Objective: To demonstrate knowledge and understanding of fluid mechanics concepts, hydraulic machines and systems.		
I. Fluid Properties General Learning Objective: To demonstrate a knowledge and understanding of fluid properties like density, specific gravity, viscosity etc.		
1.1 Specific Gravity Specific Learning Objective: To experimentally obtain specific gravity of a given liquid 1.1.1 Obtain specific gravity of given liquid/s experimentally 1.2 Viscosity Specific Learning Objective: To experimentally obtain viscosity a given liquid 1.2.1 Obtain viscosity of given liquid using experimental setup		4
II. Hydraulic Lifting Machine Specific Learning Objective: To demonstrate knowledge and working of hydraulic lifting machine. 2.1.1 Study design and working and demonstration of a hydraulic lifting/ power machine		4
III. Fluid Flow General Learning Objective: To demonstrate knowledge and understanding of loss of energy in fluid flow due to major and minor losses		
3.1 Venturi meter Specific Learning Objective: To experimentally determine coefficient of discharge of a Venturi meter 3.1.1. Determine coefficient of discharge of a given Venturi meter using experimental setup		5
3.2 Orifice meter Specific Learning Objective: To experimentally determine coefficient of discharge of a orifice meter 3.2.1. Determine coefficient of discharge of a given orifice meter using experimental setup		5
3.3 Notches Specific Learning Objectives: To experimentally determine coefficient of discharge of notches of different shapes 3.3.1. Determine coefficient of discharge of notches of different shapes (e.g., V notch, rectangular notch) using experimental setup		5
3.4 Losses in Pipe Specific Learning Objective: To experimentally determine losses occurring in flow through pipes		5

3.4.1. Determine coefficient of friction of given pipe using experimental setup	
IV. Centrifugal pumps (Ref: IMO 7.02 Competence 1.2 section 2.6 Page 47) General Learning Objective: To demonstrate knowledge and understanding of centrifugal pump	
4.1 Characteristics Curve Specific Learning Objective: To demonstrate knowledge and understanding of centrifugal pump characteristics 4.1.1. Determine operational characteristics of a given centrifugal pump using experimental Setup	4
4.2 Study of centrifugal pump Specific Learning Objective: To demonstrate knowledge and understanding of centrifugal pump design 4.2.1 Study of centrifugal pump considering important parts like impeller, vanes, casing etc.	4
V. Fluid Flow and Characteristics of Major Systems General Learning Objective: To demonstrate knowledge and working of different components of major systems.	
5.1 Reciprocating pumps (Ref: IMO 7.02 Competence 1.2 section 2.6 Page 47) General Learning Objective: To demonstrate knowledge and understanding of Reciprocating pump 5.2. Characteristics Curve Specific Learning Objective: To demonstrate knowledge and understanding of Reciprocating pump characteristics 5.2.1. Determine operational characteristics of a given Reciprocating pump using experimental Setup	7
VI. Impact of Jet Apparatus Specific Learning Objective: To demonstrate knowledge and working of a complete system	2

Subject Name/Code: Material Testing and Applied Mechanics Lab/ UG11P5303

Instructional Hours

Practical	: 45 hours
Total contact hours	: 45 hours
Credits	: 1.5

Teaching Methods

The practical training will be hands-on with focus on safety and skills.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments)	: 50%
Final Exam	: 50%

Text Book:

1. Strength of Materials, Rajput R.K, S. Chand Publishing, New Delhi.
2. A textbook of Engineering Mechanics by R.S Khurmi, S. Chand Publishing, New Delhi.

Reference:

1. Reed Volume 2: Applied Mechanics for Engineers; By William Embleton; Revised by J.T. Gunn; Publisher Sunderland
2. Tyne and Wear Thomas Reed: ISBN0900335874.
3. Applied Mechanics, J. Hannah and M.J. Hiller, Longman,1998, ISBN:9780582256323.
4. Strength of Materials, G. H. Ryder, Macmillan Pub, India.
5. Strength of Materials, Ramamrutham S, Dhanpat Rai Publishing, New Delhi.

Table of Topics

Unit	Topics	Hour (P)
I	<p>Materials under the load</p> <p>Practical 1: To conduct a tensile test of a given ductile material specimen on universal testing machine (UTM) and determine the following : (i) Limit of proportionality, (ii) Elastic limit, (iii) Yield strength, (iv) Ultimate strength, (v) Young's modulus of elasticity, (vi) Percentage elongation, (vii) Percentage reduction in area also draw stress strain curve for the same.</p> <p>Practical 2: To conduct the compression test and determine the ultimate compressive strength for a given specimen on universal testing machine (UTM).</p> <p>Practical 3: Conduct the Shear test of ductile material on Universal Testing Machine (UTM)</p> <p>Practical 4: To study the Brinell Hardness Machine and to determine the Brinell hardness of the given material.</p>	9
II	<p>Impact Testing</p> <p>Practical 5: To conduct Izod impact test on Impact testing machine and calculate value of energy absorbed.</p> <p>Practical 6: To conduct Charpy impact test on Impact testing machine and calculate value of energy absorbed.</p>	6
III	<p>Torsion</p> <p>Practical 7: To conduct torsion test on ductile circular bar and determine the modulus of rigidity. Also plot a curve of angle of twist vs torque.</p> <p>Practical 8: To determine the stiffness and modulus of rigidity of the material of given close coiled helical spring.</p>	6
IV	<p>Simple Harmonic motion</p> <p>Practical 9: To investigate simple harmonic motion using a simple pendulum and plot a graph between square of time period versus length of the pendulum.</p> <p>Practical 10: To investigate simple harmonic motion using a compound pendulum and plot a graph between square of time period versus length of the pendulum.</p>	3
V	To determine the characteristic curves of sleeve position against speed of rotation in case of: (i) Hartnell Governor (ii) Porter Governor and (iii) Proell Governor	6
VI	<p>To find out the Mechanical Advantage, Velocity Ratio, Theoretical Effort, Efficiency, Friction, the Equation giving the relation between Load and Actual Efforts, and draw graphs with load as base for</p> <p>(i) Efficiency, (ii) Actual Effort, (iii) Mechanical Advantage (iv) Friction for the following machines: (d) Compound Wheel and Axle; (e) Single Purchase Crab (f) Double Purchase Crab.</p>	15
	Total	45

Learning Objectives	P
<p>I. Materials under the load (IMO 7.04,2014: 3.1.3.1)</p> <p>General Learning Objective: Demonstrate a knowledge and understanding of mechanical behaviour of materials under the load.</p> <p>Materials under the load Sub-Topics:</p> <p>Practical 1: Conduct a tensile test of a given ductile material specimen on universal testing Machine (UTM) and determine the following :(i) Limit of proportionality, (ii) Elastic limit, (iii) Yield strength, (iv) Ultimate strength, (v) Young’s modulus of elasticity, (vi) Percentage elongation, (vii) Percentage reduction in area Also draw stress strain curve for the same</p> <p>Practical 2: Conduct the compression test and determine the ultimate compressive strength for a given specimen on universal testing machine (UTM)</p> <p>Practical 3: Conduct the Shear test of ductile material on Universal Testing Machine (UTM)</p> <p>Practical 4: Study the Brinell Hardness Machine and to determine the Brinell hardness of the given material</p>	10
<p>Specific Learning Objectives: (IMO 7.04,2014: 3.1.3.1) Demonstrate a knowledge and understanding of mechanical behaviour of materials under the tensile load.</p> <p>1.1 Practical 1: Conduct a tensile test of a given ductile material specimen on universal testing machine (UTM) and determine the following :(i) Limit of proportionality, (ii) Elastic limit, (iii) Yield strength, (iv) Ultimate strength, (v) Young’s modulus of elasticity, (vi) Percentage elongation, (vii) Percentage reduction in area Also draw stress strain curve for the same</p> <p>1.1.1 Define, for an elastic material subjected to a tensile load: elastic limit, yield point, ultimate strength, breaking strength, Percentage elongation, Percentage reduction in area</p> <p>1.1.2 State the significance in engineering practice of four physical properties in the above objective</p> <p>1.1.3 Explain and demonstrate the tensile test of a given ductile material specimen on universal testing machine (UTM)</p> <p>1.1.4 Show, on a sketched graph of load to a base of corresponding extension values, the behaviour of elastics materials under tensile loading and indicates the condition points listed above</p> <p>1.1.5 State that, within the elastic limit, Hook’s law will apply</p> <p>1.1.6 Define the constant contained in Hooks Law as the Modulus of Elasticity</p>	2
<p>Specific Learning Objectives: (IMO 7.04,2014: 3.1.3.1) Demonstrate a knowledge and understanding of mechanical behaviour of materials under the compressive load</p> <p>1.2 Practical 2: Conduct the compression test and determine the ultimate compressive strength for a given specimen on a universal testing machine (UTM).</p> <p>1.2.1 Explain and demonstrate the compression test of a given material specimen on universal testing machine (UTM)</p> <p>1.2.2 Show the behavior of given materials under compression loading.</p> <p>1.2.3 Determine the ultimate compressive strength for a given specimen on universal testing machine (UTM)</p>	2
<p>Specific Learning Objectives: (IMO 7.04,2014: 3.1.3.1) Demonstrate a knowledge and understanding of mechanical behaviour of materials under the shear load</p> <p>1.3 Practical 3: Conduct the Shear test of ductile material on Universal Testing Machine (UTM)</p> <p>1.3.1 Demonstrate a shear test attachment on universal testing machine (UTM)</p> <p>1.3.2 Explain and demonstrate the shear test of a given ductile material specimen on universal testing machine (UTM)</p> <p>1.3.3 Determine the shear strength for a given specimen on universal testing machine (UTM)</p> <p>1.3.4 Understand the behaviour of failure</p>	2

<p>Specific Learning Objectives: (IMO 7.04,2014: 3.1.3.1) Demonstrate a knowledge and understanding of hardness of materials by using Brinell Hardness Machine</p> <p>1.4 Practical 4: Study the Brinell Hardness Machine and to determine the Brinell hardness of the given material.</p> <p>1.4.1 Explain Brinell's Hardness Testing 1.4.2 Explain and demonstrate the procedure 1.4.3 Determine the Brinell hardness of the given material. 1.4.4 Complete write up with diagrams, observations, calculations and results and graphs</p>	2
<p>II. Impact testing. (IMO 7.02,2014: 1.2.3) General Learning Objective: Demonstrate a knowledge and understanding of fundamental concept related to impact load, stresses, strains and strain energy Topic 2: Impact Testing. Sub-Topics: Practical 5: Conduct Izod impact test on Impact testing machine and calculate value of energy absorbed</p> <p>Practical 6: Conduct Charpy impact test on Impact testing machine and calculate value of energy Absorbed</p>	6
<p>Specific Learning Objectives: (IMO 7.02,2014: 1.2.3) Demonstrate a knowledge and understanding of fundamental concept related to strain energy due to impact loading by using Izod impact test</p> <p>2.1 Practical 5: Conduct Izod impact test on Impact testing machine and calculate value of energy absorbed</p> <p>2.1.1 Explain impact testing and energy absorbed 2.1.2 Explain apparatus and demonstrate procedure 2.1.3 Perform experiment 2.1.4 Complete write up with diagrams, observations, calculations and results and graphs</p>	2
<p>Specific Learning Objectives: (IMO 7.02,2014: 1.2.3) Demonstrate a knowledge and understanding of fundamental concept related to strain energy due to impact loading by using Charpy impact test</p> <p>2.2 Practical 6: Conduct Charpy impact test on Impact testing machine and calculate value of energy absorbed.</p> <p>2.2.1 Explain impact testing and energy absorbed 2.2.2 Explain apparatus and demonstrate procedure 2.2.3 Perform experiment 2.2.4 Complete write up with diagrams, observations, calculations and results and graphs</p>	2
<p>III. Torsion (IMO 7.02,2014: 1.2.4) General Learning Objective: Demonstrate knowledge and understanding the concept of torsional moment in structural elements Topic 3: Torsion Sub-Topics: Practical 7: Conduct torsion test on ductile circular bar and determine the modulus of rigidity. Also plot a curve of angle of twist vs torque Practical 8: Determine the stiffness and modulus of rigidity of the material of given close coiled helical the spring</p>	4
<p>Specific Learning Objective: (IMO 7.02,2014: 1.2.4) Demonstrate knowledge and understanding the concept of torsional moment in ductile circular bar</p> <p>Sub-Topics: 3.1: Practical 7: Conduct torsion test on ductile circular bar and determine the modulus of rigidity. Also, plot a curve of angle of twist vs torque</p> <p>3.1.1 Explain torsion stress and modulus of rigidity 3.1.2 Explain apparatus and demonstrate procedure 3.1.3 Perform experiment 3.1.4 Complete write up with diagrams, observations, calculations and results and graphs</p>	2
<p>Specific Learning Objective: (IMO 7.02,2014: 1.2.4) Demonstrate knowledge and understanding the concept of torsional moment in close coiled helical spring</p>	

<p>Sub-Topics:</p> <p>3.2: Practical 8: Determine the stiffness and modulus of rigidity of the material of given close coiled helical spring</p> <p>3.2.1 Explain stiffness of spring for round section wire</p> <p>3.2.2 Explain apparatus and demonstrate procedure</p> <p>3.2.3 Perform experiment</p> <p>3.2.4 Complete write up with diagrams, observations, calculations and results and graphs</p>	2
<p>IV. Simple Harmonic motion (IMO 7.02,2014: 1.2.2)</p> <p>General Learning Objective: Demonstrate a knowledge and understanding of the concept and application of simple harmonic motion</p> <p>Topic 4: Simple Harmonic Motion</p> <p>Sub-Topics:</p> <p>Practical 9: Investigate simple harmonic motion using a simple pendulum and plot a graph between square of time period versus length of the pendulum</p> <p>Practical 10: Investigate simple harmonic motion using a compound pendulum and plot a graph between square of time period versus length of the pendulum</p>	8
<p>Specific Learning Objective: (IMO 7.02,2014: 1.2.2)</p> <p>Demonstrate a knowledge and understanding of the concept and application of simple harmonic motion by using simple pendulum</p> <p>Sub-Topics:</p> <p>4.1: Practical 9: Investigate simple harmonic motion using a simple pendulum and plot a graph between square of time period versus length of the pendulum</p> <p>4.1.1 Explain apparatus and demonstrate procedure</p> <p>4.1.2 Perform experiment</p> <p>4.1.3 Determine the time period in case of a simple pendulum and to plot the graph square of time period versus length of the pendulum</p> <p>4.1.4 Complete write up with diagrams, observations, calculations and results</p>	2
<p>Specific Learning Objective: (IMO 7.02,2014: 1.2.2)</p> <p>Demonstrate a knowledge and understanding of the concept and application of simple harmonic motion by using compound pendulum</p> <p>Sub-Topics:</p> <p>4.2: Practical 10: Investigate simple harmonic motion using a compound pendulum. Also find the radius of gyration and equivalent length of compound pendulum</p> <p>4.2.1 Explain apparatus and demonstrate procedure</p> <p>4.2.2 Perform experiment</p> <p>4.2.3 Determine the time period in case of a compound pendulum</p> <p>4.2.4 Find the radius of gyration and equivalent length of compound pendulum.</p> <p>4.2.5 Complete write up with diagrams, observations, calculations and results</p>	2

Subject Name/Code: Electrical Machines Lab/UG11P5304

Instructional hours:

Practical : 45 hours

Total contact hours : 45 hours

Credits : 1.5

Teaching Methods

The practical training will be hands-on with focus on safety and skills.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments) : 50%

Final Exam : 50%



Exp.No.	List of Experiments	Hour (P)
I	Open circuit and short circuit test of single-phase transformer.	4
II	Paralleling of single-phase transformers.	3
III	Open circuit characteristics of DC separately excited generator.	4
IV	Speed control of DC shunt motor.	4
V	Torque slip characteristics of slip ring induction motor.	4
VI	Speed control of three phase induction motor.	4
VII	Load test of three phase squirrel cage induction motor.	4
VIII	V and inverted V curves of synchronous motor.	4
IX	Synchronization of three phase alternators	4
X	Load test of three phase alternator.	4
XI	Study of single-phase induction motors.	3
XII	Study of DC motor starters.	3
Total		45

SEMESTER – IV

Subject Name/Code: Marine Diesel Engine - Components and Functions/UG11T5401

Instructional Hours:

Lecture	: 45 hours
Tutorial	: 15 hours
Total contact hours	: 60 hours
Credits	: 4

Teaching Methods

The course shall be conducted in a combination of classroom/online lectures and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments:	30%
Final Written Exam	: 70%

Text book:

1. Marine Diesel Engines, Pounder C.C: Newnes-Butterworths, London
2. Marine Diesel Engines - Deven Aranha, Shroff Publishers.
3. Marine Diesel Engines, D.K. Sanyal, Bhandarkar publications, latest edition

Reference:

1. Jackson L & Morton T.D: General Engineering Knowledge for Marine Engineers, Thomas Reed Publications
2. Cowley J.K., The Running and Maintenance of Marine Machinery, Institute of Marine Engineers
3. H D McGeorge: General Engineering Knowledge, Butterworth-Heinemann
4. Christensen, Stanley G: Lamb's Questions & Answers on The Marine Diesel Engine, Butterworth Heinemann
5. Christen Knak: Diesel Motor Ships Engines and Machinery, G. E. C.
6. Griffiths, Denis: Marine Low Speed Diesel Engines, IMarEST Publication
7. Griffiths, Denis: Marine Medium Speed Diesel Engines, MEP Series, Vol. 1, Part 3, IMarEST Publication

Table of Topics

Unit	Topics	Hour (L)
I	Valve Timing Diagrams and Classification of Engines	11
II	Diesel Engine Fuel Atomisation and Combustion	11
III	Basic Construction of Large Bore (Two-Stroke) Engine	25
IV	Turbocharger and Charge Air Systems	13
Total		60

Learning Objectives		L
I. Valve Timing Diagrams and Classification of Engines		11
General learning objective: Valve Timing Diagrams & Classification of Engines		
Specific learning objectives: Understand the basic diesel engine cycles and classification of engines based on different parameters.		
1.1 Two stroke Valve Timing Diagram 1.1.1 Explain the meaning of "single-and double-acting" as applied to reciprocating engines. 1.1.2 Describe the processes which take place in each stroke of the two-stroke engine. 1.1.3 List the usual maximum temperatures and pressures for the cycle listed in the above objective Sketch a diagram showing typical crank angles at which air and exhaust valves or ports open and close and the periods of air inlet, compression, combustion, expansion and exhaust in the above objective.	2	
1.2 Four Stroke Valve Timing Diagram 1.1.3 Describe the processes which take place in each stroke of the Four-stroke engine. 1.2.2 List the usual maximum temperatures and pressures for the cycle listed in the above objective. Sketch a diagram showing typical crank angles at which air and exhaust valves or ports open and close and the periods of air inlet, compression, combustion, expansion and exhaust in the above objective.	2	
1.3 Bore Size 1.3.1 State that marine diesel engines are normally described in broad categories by the bore of their cylinders and their rotational speed. 1.3.2 State that large-bore engines are normally fitted with piston rods and crossheads. 1.3.3 State that smaller diesel engines normally have trunk pistons and gudgeon pin in the place of piston rods and crossheads. 1.3.4 State that large-bore engines are normally directly connected to the propeller and therefore rotated at low speed.	3	
1.4 Speed 1.4.1 State that other diesel engines may run at medium speed or high speed, depending upon their duty. 1.4.2 State that medium-speed and high-speed engines are often used as direct drives for generation of electrical power. 1.4.3 State that medium-speed engines (and occasionally high-speed engines) are used, through some form of speed reduction, as main propulsion engines.	2	

1.4.4 State the approximate speed ranges related to the following engines: low-speed medium-speed high-speed	
1.5 Other Parameters 1.5.1 State the classification of engines based on the following parameters according to: ignition System. Operating Cycles. Strokes/Cycle. Piston Action. Piston Connection. Cylinder Arrangement. Method of Fuel Injection. Method of Charging. Fuel Used. Bore/Stroke Ratio.	2
II. Diesel Engine Fuel Atomisation and Combustion	11
General Learning Objective: Diesel Engine Fuel Atomization and Combustion Specific Learning Objectives: Understand the concept of atomization, fuel combustion and related Knowledge	
2.1 Combustion of Fuel 2.1.1 Describe the combustion process in and engine cylinder 2.1.2 Describe the chemical reaction in combustion as being between combustible material such as hydrocarbon in fuels and the oxygen contained in atmospheric air. 2.1.3 State that, as a result of combustion, heat energy become available, enabling thermodynamic operations to be carried out	4
2.2 Constituents of Fuel 2.2.1 State that sulphur is usually present in marine fuels 2.2.2 State that the salts of sodium and vanadium are usually present in marine fuels. 2.2.3 State that sulphur, although combustible is an undesirable element in a fuel. 2.2.4 State that sodium and vanadium are also undesirable elements in a fuel 2.2.5 State typical percentages of carbon, hydrogen and sulphur for fuel oil marine diesel fuel	3
2.3 Injector Nozzle & Its Function 2.3.1 Sketch a section through a typical injector nozzle assembly. 2.3.2 Describe the care necessary with injector nozzle holes. 2.3.3 Explain how atomization is produced by the injector nozzle. 2.3.4 Explain why swirl and penetration are important to the ignition and combustion of the fuel/air mixture. 2.3.5 Operation of Fuel Injector	4
III. Basic Construction of Large Bore (Two-Stroke) Engine	25
General objective: Basic Construction -Large-bore (two-stroke) engine details Specific learning objectives: Understand the construction and component arrangements of large 2 stroke marine diesel engines.	
3.1 Structure of the bedplate 3.1.1 Describe the structure of the bedplate. 3.1.2 Describe the basic construction of bedplate. 3.1.3 Explain where cracks in bedplates sometimes occur. 3.1.4 Explain the possible causes of cracking in a bedplate. 3.1.5 Name the materials of engine bedplate construction.	1
3.2 Bedplate connection to tank top 3.2.1 Explain that bedplate is connected to the tank top using holding down bolts. 3.2.2 Explain the types of chocks used in connection with bedplate. 3.2.3 Sketch and explain how the bedplate rests on the tank top with the aid of chocking & holding down bolts arrangement.	1
3.3 Arrangement of holding down arrangement 3.3.1 Explain the purpose of holding down bolts and side chocking. 3.3.2 Describe the attention necessary to holding down bolts and chocks. 3.3.3 Explain the source of transverse forces which cause lateral movement and tend to rock the engine. 3.3.4 Explain the inspection carried out on the holding bolts arrangement.	1

<p>3.3.5 Explain the consequences running engine with slack holding down bolts.</p> <p>3.3.6 Explain the consequences of over tightening for the holding down bolts.</p>	
<p>3.4 Structure of A-frame and column</p> <p>3.4.1 Describe the basic construction of the A-Frame.</p> <p>3.4.2 Explain the purpose of the A-frame.</p> <p>3.4.3 List the materials used for the A-frame construction.</p> <p>3.4.4 Identify the location of defects normally found on an engine A-frame.</p> <p>3.4.5 Identify with reasons the weak points in an A-frame.</p>	1
<p>3.5 Arrangement of tie- bolts</p> <p>3.5.1 Explain the purpose of tie-bolts installed in modern diesel engines.</p> <p>3.5.2 Describe the procedure of tightening the tie-bolts.</p> <p>3.5.3 Name the materials used for construction for the tie-bolts.</p> <p>3.5.4 Explain the causes of tie-bolts failure during in service.</p> <p>3.5.5 Describe the methods of fitting tie-bolts.</p>	1
<p>3.6 Cylinder block and entablature</p> <p>3.6.1 Explain the functional purpose of a cylinder block.</p> <p>3.6.2 Name the materials from which the cylinder is made.</p> <p>3.6.3 Describe the basic construction of the cylinder block and entablature.</p> <p>3.6.4 Explain the reasons for manufacturing the liner separately from the cylinder block.</p> <p>3.6.5 Sketch and describe the type of an engine cylinder block that may be used on the modern diesel engine.</p> <p>3.6.6 Identify the location of defects normally found on an engine cylinder block.</p>	1
<p>3.7 Cylinder Liner</p> <p>3.7.1 Construction & Materials</p> <p>3.7.2 Liner wear measurement</p>	1
<p>3.8 Piston</p> <p>3.8.1 Piston construction details</p> <p>3.8.2 Materials</p> <p>3.8.3 Trunk type piston</p> <p>3.8.4 Cross head piston</p> <p>3.8.5 Piston inspection</p> <p>3.8.6 Piston rod</p>	1
<p>3.9 Piston Rings</p> <p>3.9.1 Types of rings & Ring materials</p> <p>3.9.2 Ring clearance and measurement</p> <p>3.9.10 Piston ring inspection</p>	1
<p>3.10 Arrangement of main bearing caps</p> <p>3.10.1 Sketch and describe the arrangement of main bearing caps.</p> <p>3.10.2 Describe the methods of tightening the jack bolts for the main bearing caps.</p> <p>3.10.3 Identify the common defects normally found on the main bearing caps& jack bolts.</p> <p>3.10.4 Explain the maintenance carried out for the main bearing caps arrangement.</p>	1
<p>3.11 Arrangement of piston rod gland assembly</p> <p>3.11.1 Sketch and label the various parts of the piston rod gland assembly.</p> <p>3.11.2 Explain the functional purpose of the piston rod gland assembly.</p> <p>3.11.3 Name the materials used for construction for the piston rod gland assembly.</p> <p>3.11.4 Describe the stresses that act during operation.</p> <p>3.11.5 Describe the clearances to be taken.</p> <p>3.11.6 Identify the consequences in running of an engine with improper clearances in the piston rod assembly.</p> <p>3.11.7 Explain the causes of excessive wear of the piston rod gland assembly.</p> <p>3.11.8 Explain why replaceable lamellae are used in some of the modern diesel engines in the stuffing box glands.</p>	1
<p>3.12 Cylinder Cover</p> <p>3.12.1 Sketch and describe the cylinder cover of a typical 2-stroke propulsion engine.</p> <p>3.12.2 Name the materials used for construction.</p> <p>3.12.3 Define the stresses the cylinder cover is subjected to.</p>	1
<p>3.13 Exhaust Valve</p> <p>3.13.1 Sketch and explain the Exhaust valve fitted on a typical 2-stroke propulsion engine.</p> <p>3.13.2 Name the materials used for construction.</p>	1

<p>3.13.3 Define the method of cooling for the exhaust valve.</p> <p>3.13.4 State the importance of Spring air in the operation of the exhaust valve.</p>	
<p>3.14 Crankshaft</p> <p>3.14.1 Explain the functional purpose of the crankshaft.</p> <p>3.14.2 Name the materials used for construction for the manufacture of the crankshaft.</p> <p>3.14.3 Sketch and describe the type of crankshaft that may be used on modern marine diesel Engines.</p> <p>3.14.4 Define the stresses that act on the crankshaft during operation.</p> <p>3.14.5 Identify the location of defects normally found on a crankshaft.</p> <p>3.14.6 Describe the procedure in taking crankshaft deflection.</p> <p>3.14.7 Explain the factors affecting crankshaft deflection reading.</p> <p>3.14.8 Explain the reasons for crankshaft misalignment.</p> <p>3.14.9 Identify the critical areas for crankshaft inspection.</p>	1
<p>3.15 Main bearing</p> <p>3.15.1 Sketch a cross section through main bearing assembly and its structural support.</p> <p>3.15.2 Identify types of forces acting on the main bearing.</p> <p>3.15.3 Explain the procedure of renewal main bearing shell and bearing clearance.</p> <p>3.15.4 Explain what inspection is made to ensure adequate main bearing clearance.</p> <p>3.15.5 Describe the causes of main bearing failures as follows:</p> <p>3.15.6 Wiping</p> <p>3.15.7 Fatigue</p> <p>3.15.8 Tin Oxide Corrosion</p> <p>3.15.9 Cavitation Erosion</p> <p>3.15.10 Electrical Potential</p> <p>3.15.11 Fretting</p> <p>3.15.12 Thermal ratchetting in white metal</p> <p>3.15.13 Scratching</p> <p>3.15.14 Identify with reasons the points of weakness in main bearing.</p> <p>3.15.15 Name the materials used for construction and its properties for manufacture of main bearing.</p> <p>3.15.16 Explain why bearing keeps are sometimes secured by jack bolts rather that holding down bolts.</p>	2
<p>3.16 Thrust block and bearing</p> <p>3.16.1 Sketch a cross-section through thrust block and bearing assembly and its structural support.</p> <p>3.16.2 Explain the factors affecting the load carrying capacity of lubrication of thrust bearing.</p> <p>3.16.3 Name the materials used for construction for the manufacture of tilting pad thrust bearing.</p> <p>3.16.4 Explain the advantages of using tilting pad journal bearing for marine diesel engine.</p>	1
<p>3.17 Bottom end bearing</p> <p>3.17.1 Sketch a cross-section of bottom end bearing assembly showing the flow of lubricating oil.</p> <p>3.17.2 Name the materials used for construction for construction.</p> <p>3.17.3 Describe the procedures for checking alignment, and the bearing clearance.</p> <p>3.17.4 Identify with reasons the points of weakness in the bottom end bearing.</p> <p>3.17.5 Explain the causes of the bottom end bearing failures.</p> <p>3.17.6 Identify types of forces acting on the bottom end bearing.</p> <p>3.17.7 Identify the location of defects normally found on the bottom end bearing.</p>	1
<p>3.18 Connecting Rod</p> <p>3.18.1 Sketch a cross-section of a connecting rod and showing the flow of lubricating oil.</p> <p>3.18.2 Name the materials used for construction.1</p> <p>3.18.3 Describe the procedure of hydraulic method of tightening connecting rod bolts.</p> <p>3.18.4 Identify the location of defects normally found on the connecting rod.</p> <p>3.18.5 Identify the design consideration for the manufacture of connecting rod.</p>	1
<p>3.19 Crosshead and Bearings</p> <p>3.19.1 Sketch a cross-section of a crosshead bearing and label the various parts</p> <p>3.19.2 List the materials used for construction.</p> <p>3.19.3 Explain the common problems associated with crosshead and bearing.</p> <p>3.19.4 Explain why the lubrication of the crosshead bearing is difficult.</p> <p>3.19.5 Describe the design changes adopted in modern diesel engines to overcome the problems.</p>	2

<p>3.19.6 Explain types of forces acting on the crosshead bearings.</p> <p>3.19.7 Explain the causes of distortion of crosshead pin and con-rod flange.</p> <p>3.19.8 Describe with sketches one arrangement whereby lubricant is fed to top end bearings, slippers and guide.</p>	
<p>3.20 Guides and guides shoes</p> <p>3.20.1 Sketch a cross-section of a guide and guide shoe and label all the parts.</p> <p>3.20.2 Name the materials used for construction.</p> <p>3.20.3 Explain types of forces acting on the guides and guide shoes.</p> <p>3.20.4 Explain the causes of guide and guide shoes failure.</p> <p>3.20.5 Identify the common defects found at the guide and guides shoes.</p> <p>3.20.6 Describe how the alignment is checked for guides and guide shoes.</p>	1
<p>3.21 Camshaft drive arrangement</p> <p>3.21.1 Sketch and describe the camshaft drive arrangement for modern marine diesel engine.</p> <p>3.21.2 Explain the functional purpose of the camshaft drive arrangement</p> <p>3.21.3 Name the materials used for construction.</p> <p>3.21.4 Explain the common defects found in the camshaft drive arrangement.</p> <p>3.21.5 Explain inspection and maintenance carried out on Camshaft drive arrangement.</p>	1
<p>3.22 Gear wheel transmission</p> <p>3.22.1 Sketch and explain the gear wheel transmission and label all parts.</p> <p>3.22.2 Name the materials used for construction.</p> <p>3.22.3 Identify the common defects found on the gear wheel transmission.</p> <p>3.22.4 Explain the causes of defect gear wheel profile.</p> <p>3.22.5 Identify types of inspection on gear wheel transmission.</p>	1
<p>3.23 Chain wheel transmission</p> <p>3.23.1 Sketch and explain the Chain Wheel Transmission.</p> <p>3.23.2 Explain the functional purpose of the chain wheel transmission.</p> <p>3.23.3 Name the materials used for construction.</p> <p>3.23.4 Explain the procedure of tightening of the chain wheel.</p> <p>3.23.5 Explain the causes of having a slack chain wheel during engine running.</p> <p>3.23.6 Identify the common defects found on the chain wheel transmission.</p>	1
<p>IV. Turbocharger and Charge Air Systems</p>	13
<p>General Learning Objective: Scavenging, Turbo-Charging & Charge Air Systems</p> <p>Specific learning objective: Understand the functions and types of ancillary systems aiding in engine performance.</p>	
<p>4.1 Turbocharger</p> <p>4.1.1 Sketch and explain the components of radial and axial flow type of turbochargers of a Marine Engine.</p> <p>4.1.2 Explain Lubrication and cooling requirements of turbochargers</p> <p>4.1.3 Identify typical faults and identify appropriate actions to be undertaken with defective or damaged turbochargers</p> <p>4.1.4 Explain what is meant by turbocharger surging</p> <p>4.1.5 Identify the symptoms of turbocharger surging</p> <p>4.1.6 Explain the causes of turbocharger surging</p> <p>4.1.7 Explain the operation of propulsion engine with turbocharger out of operation</p> <p>4.1.8 Explain the methods of Turbocharger Washing when in operation</p>	3
<p>4.2 Scavenging</p> <p>4.2.1 Explain the purpose of scavenging, turbo-charging and exhaust in diesel engine</p> <p>4.2.2 Explain the stages in scavenging process</p> <p>4.2.3 Explain types of scavenging used in diesel engine</p>	2
<p>4.3 Constant Pressure Turbo-charging</p> <p>4.3.1 Explain the meaning of turbo-charging</p> <p>4.3.2 Explain the advantages of turbo-charging</p> <p>4.3.3 Identify the methods of turbo-charging</p> <p>4.3.4 Explain the types of equipment used for turbo-charging</p> <p>4.3.5 Sketch and explain the constant pressure turbo-charging system</p>	2
<p>4.4 Pulse Type Turbo-charging</p> <p>4.4.1 Sketch and explain the pulse system of turbo charging</p> <p>4.4.2 Explain the advantages and disadvantages for pulse and constant pressure exhaust Systems</p>	2

<p>4.5 Latest trends in turbo-charging</p> <p>4.5.1 Explain the latest developments in turbo-charging / turbochargers (e.g. hybrid, VGT etc.)</p> <p>4.5.2 Sketch and explain two stage turbocharging</p>	2
<p>4.6 Air Cooler</p> <p>4.6.1 Explain the function of charge air cooler in marine diesel engine.</p> <p>4.6.2 Explain the causes for fouling of air cooler on the water and air side.</p> <p>4.6.3 Explain the methods employed for cleaning of air cooler on the water and air side.</p>	1
<p>4.7 Auxiliary Blower</p> <p>4.7.1 State the importance of Auxiliary Blower in the operation of Main Engine.</p> <p>4.7.2 State the operation of auxiliary blower and how is it controlled.</p>	1



Subject Name/Code: Marine Auxiliary Systems/ UG11T5402

Instructional Hours:

Lecture	: 45 hours
Tutorial	: 15 hours
Total contact hours	: 60 hours
Credits	: 4

Teaching Methods

The course shall be conducted in a combination of classroom/online lectures, tutorials and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments):	30%
Final Written Exam	: 70%

Text Book:

1. Marine Auxiliary machinery - H.D. McGeorge
2. General Engineering Knowledge for Marine Engineers-Reeds Volume 8

Reference:

1. Marine Auxiliary Machinery - D.W. Smith
2. Marine Engineering Practice - IMEI Publication
3. Marine Machineries-Operation & Maintenance- T.B. Srinivasan, IMEI Publication
4. The Running &. Maintenance of Marine Machinery - J. Cowley by IMEI Publication
5. Basic Marine Engineering - J.K. Dhar

Table of Topics

Unit	Topic	Hour (L)
I	Engine Room Layout Sub-Topics: Layout of main and auxiliary machinery in engine rooms in different ships.	4
II	Engine Room Piping Layout Sub-Topics: Layout and arrangement of important Pipelines in Engine Room with fittings and its materials of construction. These include systems like - Steam, Bilge, Ballast, Sea water, Fire Fighting systems etc. Fresh water / Sea water Hydrophore systems, distilled water, Drinking water systems and their filling lines. Colour codes and other symbols used to identify pipelines.	12
III	Air Compressors Sub Topics: Operation & Constructional details of Compressors used on board ships. Use of Compressed Air. Air battles, construction, mountings, compressor safeties & associated systems.	12
IV	Evaporators Sub Topics: Construction & Operation of different types of Evaporators & maintenance. Fresh water Generator's distillers. Reverse Osmosis process, Conditioning arrangements of distilled water for drinking purpose.	10
V	Heat Exchangers Sub Topics: Types of heat exchangers Construction Materials Application of heat exchangers	12
VI	Other Shipboard Machineries Sub Topics: Different types of ship stabilizer. Bow Thrusters, Hull protection arrangements & Marine Growth Protection System.	10
	Total	60

Learning objectives	L
I. Engine Room Layout	4
General learning Objective: To introduce Layout of main and auxiliary machinery in engine room of different ships.	
General learning Objectives: The student should be able to understand/familiarize with machinery layout at various platforms in various kinds of ships engine room.	
1.1 Various types of Merchant ship & propulsion: 1.1.1 To describe the various types of merchant ships and explain various types of propulsion on merchant vessels	2
1.2 Layout of various machineries on different platforms: 1.2.1 Explain the layout of various machineries on different - platforms in engine room of a ship. 1.2.2 To assess knowledge of layout of different machineries/and components on merchant vessels with reasons for their locations. 1.2.3 To asses knowledge of purpose of fitting various components, their mountings and maintenance procedures. 1.2.4 purpose and location of emergency bilge suction, emergency fire pump, its suction valve, self, SW pumps, SW overboard, high sea suction chest and Low Sea suction chest, mountings and their purpose	2
II. Engine Room Piping Layout	12
General learning Objective: A student learns about layout & arrangement of important pipelines in Engine room with fittings & its materials	
Specific learning Objective To understand: Various components of piping system such as types of valves, elbow, expansion bellows, cocks etc. Lay out of important piping system such as Steam, Bilge, Ballast, Sea water, Fire Fighting systems etc. Fresh water / Sea water Hydrophore systems, distilled water, Drinking water systems and their filling lines. Color codes and other symbols used to identify pipelines	
2.1 Routine pumping operations: 2.1.1 State the need to understand the pipelines constructing pumping systems to be daily used in order to maintain the normal operation of the plant. Color code of Pipelines. 2.1.2 Examine that the status of valves concerned in both manual and automatic pumping system must be periodically checked.	4
2.2 Bilge & ballast pumping system: Describe the purpose of bilge pumping system. 2.2.1 Explain why non return valves are fitted to bilge pipes in watertight compartment which contain the open end of the pipe. 2.2.2 Sketch a diagrammatic arrangement of a bilge pumping system, including the connections to other pumps. 2.2.3 Formulate the requirement of the critical dimensions of the piping's of bilge system as per MARPOL, describe the purpose, siting and common principal connections of an emergency bilge suction. 2.2.4 Explain the purpose of a ballast pumping system. 2.2.5 Sketch a diagrammatic arrangement of ballast system.	4
2.3. Fresh water and sea water system: 2.3.1 Explain a schematic diagram of Main Engine Jacket cooling system and centralizing cooling water system. 2.3.2 Describe a domestic fresh water (Hydrophore) Supply system, explain how: - o The water pressure is maintained.	4

<ul style="list-style-type: none"> ○ The pump is started and stopped. ○ The water is heated. ○ Describe the treatment necessary for water produced by evaporators for human consumption <p>2.3.3 Sea water cooling system</p> <p>2.3. 4 Firefighting system (Sea Water)</p>	
III. Air Compressors	12
General Learning Objective: To understand constructional & operational details of Air compressors & air bottles used on board.	
Specific Learning Objective: To understand the operational & constructional details of compressors used on board, uses of compressed air on board. Air bottles construction & mountings. Compressor safeties & associated system.	
3.1. Introduction to operational and constructional details of compressors& uses of compressed air board the ship: 3.1.1 Explain operational and constructional details of compressors used on board ships. 3.1.2 Use of compressed air. On board ship.	7
3.2. Air bottle construction & mountings: 3.2.1 Air Bottles, Construction, mountings & associated system.	5
IV. Evaporators	10
General Learning Objective: Student learns about features, working principle, operation and maintenance of evaporators & Fresh water Generator	
Specific learning objective: To understand: <ul style="list-style-type: none"> ▪ Construction & Operation of different types of Evaporators & maintenance. ▪ Arrangement of distilled water for drinking purpose, 	
4.1. Introduction 4.1.1 Explain why 'fresh water' may have to be produced from seawater. 4.1.2 List the purposes for which the water might be used. 4.1.3 Explain the effect that distillation has on the dissolved solids in seawater. 4.1.4 Define the term distillation as used in marine engineering practice. 4.1.5 State that evaporators and distillers are pressure vessels and as such must conform to approved standards for materials, fittings and construction	2
4.2. Principles of vapor formation 4.2.1 State that there are two main methods of obtaining vapor from seawater: by direct boiling, using boiling water evaporators and by the evolution of vapor when the seawater is 'supersaturated', using flash evaporators 4.2.2 Describe in simple terms, using line sketches, the construction of a shell and coil evaporator, naming the materials of the principal parts	2

<p>4.3. Construction, mountings and working principle</p> <p>4.3.1 List the mountings fitted to a simple shell and coil evaporator</p> <p>4.3.2 State that the heat transfer can be obtained from: a supply of steam or other hot fluid passing through coils tubes which are immersed in the seawater or / and electrical element immersed in the seawater</p> <p>4.3.3 Explain why low-pressure evaporators are used</p> <p>4.3.4 Explain what is meant by single-effect and by double-effect evaporation</p> <p>4.3.5 Explain the principle of flash evaporation.</p> <p>4.3.6 State that flash evaporators can use a number of stages, with seawater feed passing through each stage in succession</p> <p>4.3.7 Describe, with the aid of a simple sketch, a two-stage flash evaporator</p> <p>4.3.8 Explain the principle of operation of the evaporator in the above objective (Multiple-effect Evaporation)</p> <p>4.3.9 State that shell and coil evaporators can be connected in series, with the vapour produced in the first unit being used as the heating fluid in the next unit, the seawater passing through-each unit in turn</p> <p>4.3.10 State that production of vapour in the second and successive units occurs partly by boiling and partly by flash evaporation</p> <p>4.3.11 State that such a system is termed 'multiple effect'</p> <p>4.3.12 State that multiple-effect evaporation produces an increased quantity of fresh water compared to a single evaporator using a similar input of heat</p> <p>4.3.13 Describe, with the aid of a single line sketch, the arrangement of a two-stage Flash-evaporation plant</p>	2
<p>4.4. Starting and stopping procedures:</p> <p>4.4.1 Describe the need for starting fresh water generator and the limitation of keeping its running.</p> <p>4.4.2 State the procedure of starting and stopping of vacuum distillation plant</p> <p>4.4.3 Explain how the formation of scale on the heating surfaces of coils, tubes and other heat-transfer elements is controlled</p>	2
<p>4.5. Reverse osmosis type FWG:</p> <p>4.5.1 Explain the theory of osmosis process that fluid flows due to change in energy level in two solutions</p> <p>4.5.2 Explain the theory of reverse osmosis</p> <p>4.5.3 Describe a reverse osmosis plant for generation of fresh water</p>	2
<p>V. Heat Exchangers</p>	12
<p>Specific Learning Objectives: Heat Exchangers – (IMO 704,2014: F1/1416/4)</p> <p>5.1 Explain the surface heat-transfer type of marine heat exchangers</p> <p>5.1.1 State the most common cooling medium used</p> <p>5.1.2 Describe surface heat transfer, referring to the relative direction of flow of fluid</p> <p>5.1.3 Define 'contact heat transfer' as the heat flow between fluids initially at different temperatures</p> <p>5.1.4 When they are mixed together</p> <p>5.2 Sketch the principle of construction of the shell and tube surface heat exchanger</p> <p>5.2.1 Explain the meaning of single-pass, two-pass, etc.</p> <p>5.3 State the materials used for the shell, tubes and tube plates of heat Exchangers</p> <p>5.3.1 Explain how:</p> <ul style="list-style-type: none"> - Differential expansion is allowed for - an effective seal is maintained between the fluids - leakage is detected <p>5.4 Explain how temperature control is achieved in coolers</p> <p>5.4.1 Describe the effect of partially closing the cooling-water inlet valve</p> <p>5.4.2 Explain the effect of entrained air in cooling water and how it is removed</p>	12

<p>5.5 Sketch the principle of construction of the flat plate type surface heat exchangers</p> <p>5.6 List the types of heat exchanger used for the following:</p> <ul style="list-style-type: none"> - lubricating-oil coolers - fuel-oil heaters - fresh-water coolers - compressed-air coolers - fresh-water heaters - steam condensers - seawater evaporating and distilling plant - seawater heaters - evaporators and condensers in refrigerators 	
VI. Other Shipboard Machineries	10
<p>General Learning Objective: Student learns about construction & operation of different types of ship stabilizer, Bow thruster, Hull protection arrangement & Marine Growth Protection system</p>	
<p>Specific learning objective:</p> <p>To understand:</p> <ul style="list-style-type: none"> ▪ Working principles of various types of ship stabilizers. ▪ Operation of Bow thruster ▪ Hull protection & Marine Growth Protection system. 	
<p>6.1. Different types of ship stabilizers</p> <p>6.1.1 Working principles of various types of ship stabilizer</p>	5
<p>6.2. Bow thruster & Hull protection system:</p> <p>6.2.1 Operation of Bow thruster</p> <p>6.2.2 Hull protection & Marine Growth Protection system.</p>	5

Subject Name/Code: Shipboard Power Generation and Distribution/UG11T5403

Instructional Hours:

Lecture : 45 hours

Tutorial : 15 hours

Total contact hours : 60 hours

Credits : 4

Teaching Methods

The course shall be conducted in a combination of classroom/online lectures and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments: 30%

Final Written Exam : 70%

Text book:

1. Marine Electrical Technology, Elstan A. Fernandez; Publisher: Shroff Publisher & Distributors Pvt.Ltd; Year: 2022; ISBN: 978-93-5542-151-7
2. Practical Marine Electrical Knowledge, Dennis T. Hall; Wither, Publishing Group Ltd; ISBN: 978-1-85609-857-1

Reference:

1. Shipboard Electrical Power System, Mukund R Patel, CRC Press.
2. Marine Electrical Practice, G.O.Watson, B.P.Publishing , Latest Edition.

Table of Topics

Unit	Topics	Hour (L)
I	<p><u>Specification of Electric Power for Shipboard Installations</u> Classification of symbols, notation, notations scheme designation, terminologies, abbreviations and acronyms. Distinguish between: block diagram, system diagram, circuit diagram, wiring diagram AC power supply: KVA, kW, list of connected equipment and line diagram DC power supply: kW, list of connected equipment and line diagram Power Generation: Diesel-electrical power generator configurations with rating, Diesel engine capacity, generator capacity, voltage, current, KVA and kW. Turbo electric power generation, block diagram, shaft power generator, emergency generator, batteries, block diagram of: Integration of Different Sources of Power Generation and Driven Loads for Hybrid power system Integration of Different Sources of Power Generation and Driven Loads for All-Electric systems Combination of Different Types of Power Generation, Energy Sources and Driven Loads for Hybrid power systems Compliance related to electric power for shipboard installations</p>	14
II	<p><u>Configurations of Electric Power Generation Plant for Electric Propulsion Ships</u> Line diagram including MV and HV and its description Various conditions of ships operation and power requirement covering Sea going ballast condition – normal sailing Sea going ballast condition with cargo / ballast operations Seagoing laden voyage Sea going laden voyage with cargo / ballast operations Manoeuvring in / out of power or restricted areas Port discharging Power loading</p>	10
III	<p><u>Power Distribution System on Shipboard</u> Main Generator, Emergency Generator, Shore Supply, Battery Charging, 440-Volt Supply, 220-Volt Supply Circuit Breakers Transformers Main Switchboard Cargo Switchboards Group Starter Panels Lighting Distribution systems and Panel Remote Starter Panels / Local Starter Panels Back-Up and Redundancy Arrangement – Emergency Power Emergency Power Generation and Distribution, Its Location Power Failure and Restoration Power management System (PMS) Energy Management System (EMS) Control, Monitoring, Alarm and Safety Systems</p>	10
IV	<p><u>Shipboard Power System Protection</u> Degree of Protection Risk Assessment Earthing Circuit Breaker (ACB, OCB, VCB and SF6)</p>	12

	Hazardous areas and safety systems Typical protective devices and cooling methods used for Generator, Motor, Transformer Oil cooling Water cooling Air cooling (natural and forced)	
V	Emergency Power Supply Emergency Power Requirements Power failure (blackout) Emergency sources of Power Power Supply System on Board Ships and its Back-up System Automatic Starting Arrangement for the Emergency Generator Emergency switchboard and Safety Interlock System Batteries and Battery Charging (lead-acid, alkaline batteries and Lithium ion)	14
Total		60

Specific Learning Objective	L
I. Specification of Electric Power for Shipboard Installations	14
General Learning Objective: To understand the specifications, classifications, and integration of electric power systems for shipboard installations, including the distinctions between different types of diagrams, power supply systems (AC and DC), and power generation configurations, with an emphasis on compliance requirements.	
1.1 Classification and Terminology: 1.1.1 Understand the classification of symbols, notation schemes, designations, terminologies, abbreviations, and acronyms used in shipboard electrical installations. 1.1.2 Symbols and Notations: 1.1.3 Classification: Learn the classification of symbols used in shipboard electrical diagrams. 1.1.4 Notation Schemes: Understand different notation schemes and their applications. 1.1.5 Terminologies: Define and understand common terminologies used in shipboard electrical systems. 1.1.6 Abbreviations and Acronyms: Memorize and understand the common abbreviations and acronyms used in shipboard electrical documentation.	2
1.2 Diagram Distinctions: 1.2.1 Distinguish between block diagrams, system diagrams, circuit diagrams, and wiring diagrams. 1.2.2 Types of Diagrams: 1.2.3 Block Diagram: Understand the purpose and components of a block diagram. Distinguish between block diagrams and other types of diagrams. 1.2.4 System Diagram: Understand the purpose and components of a system diagram. Distinguish between system diagrams and other types of diagrams. 1.2.5 Circuit Diagram: Understand the purpose and components of a circuit diagram. Distinguish between circuit diagrams and other types of diagrams. 1.2.6 Wiring Diagram: Understand the purpose and components of a wiring diagram. Distinguish between wiring diagrams and other types of diagrams.	2
1.3 AC Power Supply: 1.3.1 Understand the specifications and requirements for AC power supply systems on ships, including KVA, kW ratings, and the list of connected equipment. 1.3.2 Interpret line diagrams for AC power supply systems.	2

<p>1.3.3 AC Power Specifications: 1.3.4 KVA and kW: Define KVA and kW and explain their importance in shipboard AC power systems. 1.3.5 Connected Equipment: List typical equipment connected to AC power supplies on ships. 1.3.6 Line Diagram: Interpret and create line diagrams for AC power supply systems.</p>	
<p>1.4 DC Power Supply: 1.4.1 Understand the specifications and requirements for DC power supply systems on ships, including kW ratings and the list of connected equipment. 1.4.2 Interpret line diagrams for DC power supply systems. 1.4.3 DC Power Specifications: 1.4.4 kW Ratings: Define kW and explain its importance in shipboard DC power systems. 1.4.5 Connected Equipment: 1.4.6 List typical equipment connected to DC power supplies on ships. 1.4.7 Line Diagram: Interpret and create line diagrams for DC power supply systems.</p>	2
<p>1.5 Power Generation: 1.5.1 Understand the configurations and specifications of diesel-electrical power generators, including diesel engine capacity, generator capacity, voltage, current, KVA, and kW ratings. 1.5.2 Understand turbo electric power generation systems and their block diagrams. 1.5.3 Understand the role and specifications of shaft power generators, emergency generators, and batteries. 1.5.4 Diesel-Electrical Power Generation: 1.5.5 Configurations: Understand different diesel-electrical power generator configurations and their ratings. 1.5.6 Specifications: Learn about diesel engine capacity, generator capacity, voltage, current, KVA, and kW ratings. 1.5.7 Turbo Electric Power Generation: 1.5.8 Block Diagram: 1.5.9 Understand the block diagram of turbo electric power generation systems. 1.5.10 Shaft Power Generator and Emergency Generator: 1.5.11 Explain the roles and specifications of shaft power generators and emergency generators. 1.5.12 Batteries: 1.5.13 Understand the use and specifications of batteries in shipboard power systems.</p>	2
<p>1.6 Integration of Power Systems: 1.6.1 Understand the integration of different sources of power generation and driven loads for hybrid power systems. 1.6.2 Understand the integration of different sources of power generation and driven loads for all-electric systems. 1.6.3 Understand the combination of different types of power generation, energy sources, and driven loads for hybrid power systems. 1.6.4 Hybrid Power Systems: 1.6.5 Integration: 1.6.6 Understand how different sources of power generation and driven loads are integrated in hybrid power systems. 1.6.7 Block Diagrams: 1.6.8 Interpret block diagrams showing the integration of hybrid power systems. 1.6.9 All-Electric Systems: 1.6.10 Integration: 1.6.11 Understand how different sources of power generation and driven loads are integrated in all-electric systems. 1.6.12 Block Diagrams: 1.6.13 Interpret block diagrams showing the integration of all-electric systems. 1.6.14 Combination of Power Systems: 1.6.15 Integration: 1.6.16 Understand the combination of different types of power generation, energy sources,</p>	2

<p>and driven loads in hybrid power systems.</p> <p>1.6.17 Block Diagrams:</p> <p>1.6.18 Interpret block diagrams showing the combination of different power systems.</p>	
<p>1.7 Compliance:</p> <p>1.7.1 Understand the compliance requirements related to electric power for shipboard installations.</p> <p>1.7.2 Compliance Requirements:</p> <p>1.7.3 Regulations:</p> <p>1.7.4 Learn about the regulatory bodies and standards governing electric power systems for shipboard installations.</p> <p>1.7.5 Compliance:</p> <p>1.7.6 Understand the specific compliance requirements and procedures to ensure safety and efficiency in shipboard electrical installations.</p>	1
<p>1.8 Examples and Practical Applications:</p> <p>Examples:</p> <p>1.8.1 Solve practical problems related to the specifications, integration, and compliance of shipboard electrical systems.</p> <p>Practical Applications:</p> <p>1.8.2 Apply these concepts to real-world scenarios, such as designing and maintaining shipboard electrical power systems, ensuring compliance with regulations, and optimizing system performance.</p>	1
<p>II. Configurations of electric power generation plant for electric propulsion ships</p>	10
<p>General Learning Objective:</p> <p>To understand the configurations and operation of electric power generation plants for electric propulsion ships, including line diagrams for medium voltage (MV) and high voltage (HV) systems, and the power requirements under various ship operating conditions.</p>	
<p>2.1 Electric Power Generation Configurations:</p> <p>2.1.1 Understand different configurations of electric power generation plants used in electric propulsion ships.</p> <p>2.1.2 Analyze the advantages and limitations of each configuration.</p> <p>Configurations:</p> <p>2.1.3 Diesel-Electric Power Generation:</p> <p>2.1.4 Understand the configuration of diesel-electric power generation systems.</p> <p>2.1.5 Discuss the benefits of diesel-electric systems for electric propulsion.</p> <p>2.1.6 Gas Turbine-Electric Power Generation:</p> <p>2.1.7 Understand the configuration of gas turbine-electric power generation systems.</p> <p>2.1.8 Analyze the efficiency and operational characteristics of gas turbine systems.</p> <p>2.1.9 Hybrid Power Generation:</p> <p>2.1.10 Understand the configuration of hybrid power generation systems that combine diesel engines, gas turbines, and batteries.</p> <p>2.1.11 Discuss the advantages of hybrid systems in terms of efficiency and environmental impact.</p> <p>2.1.12 Turbo-Electric Power Generation:</p> <p>2.1.13 Understand the configuration and operation of turbo-electric power generation systems.</p> <p>2.1.14 Evaluate the benefits and challenges of using turbo-electric systems.</p>	2
<p>2.2 Line Diagrams for MV and HV Systems:</p> <p>2.2.1 Interpret and create line diagrams for medium voltage (MV) and high voltage (HV) systems.</p> <p>2.2.2 Describe the components and functions of MV and HV systems in shipboard power generation.</p> <p>2.2.3 Medium Voltage (MV) Systems:</p> <p>2.2.4 Line Diagram:</p> <p>2.2.5 Create and interpret line diagrams for MV power distribution systems.</p> <p>2.2.6 Components:</p> <p>2.2.7 Describe the components of MV systems, including generators, transformers, switchboards, and distribution panels.</p> <p>2.2.8 Functions:</p>	3

<p>2.2.9 Explain the functions of each component in the MV system and how they interconnect to provide reliable power distribution.</p> <p>2.2.10 High Voltage (HV) Systems:</p> <p>2.2.11 Line Diagram:</p> <p>2.2.12 Create and interpret line diagrams for HV power distribution systems.</p> <p>2.2.13 Components:</p> <p>2.2.14 Describe the components of HV systems, including HV generators, transformers, switchgear, and distribution networks.</p> <p>2.2.15 Functions:</p> <p>2.2.16 Explain the functions of each component in the HV system and how they interconnect to provide reliable power distribution</p>	
<p>2.3 Power Requirements for Different Operating Conditions:</p> <p>2.3.1 Understand the power requirements for different operating conditions of ships, including sea going ballast condition, laden voyage, maneuvering, port operations, and cargo/ballast operations.</p> <p>2.3.2 Sea Going Ballast Condition – Normal Sailing:</p> <p>2.3.3 Power Requirement: Understand the power requirements for normal sailing conditions without cargo or ballast operations.</p> <p>2.3.4 Description: Describe the typical power generation and distribution configuration for this condition.</p> <p>2.3.5 Sea Going Ballast Condition with Cargo/Ballast Operations:</p> <p>2.3.6 Power Requirement: Understand the power requirements for ballast conditions with simultaneous cargo or ballast operations.</p> <p>2.3.7 Description: Describe the typical power generation and distribution configuration for this condition.</p> <p>2.3.8 Sea Going Laden Voyage:</p> <p>2.3.9 Power Requirement: Understand the power requirements for a laden voyage with the ship fully loaded.</p> <p>2.3.10 Description: Describe the typical power generation and distribution configuration for this condition.</p> <p>2.3.11 Sea Going Laden Voyage with Cargo/Ballast Operations:</p> <p>2.3.12 Power Requirement: Understand the power requirements for a laden voyage with simultaneous cargo or ballast operations.</p> <p>2.3.10 Description: Describe the typical power generation and distribution configuration for this condition.</p> <p>2.3.11 Manoeuvring in/out of Port or Restricted Areas:</p> <p>2.3.12 Power Requirement: Understand the power requirements for maneuvering in and out of port or restricted areas.</p> <p>2.3.13 Description: Describe the typical power generation and distribution configuration for this condition.</p> <p>2.3.14 Port Discharging:</p> <p>2.3.15 Power Requirement: Understand the power requirements for port discharging operations.</p> <p>2.3.16 Description: Describe the typical power generation and distribution configuration for this condition.</p> <p>2.3.17 Port Loading:</p> <p>2.3.18 Power Requirement: Understand the power requirements for port loading operations.</p> <p>2.3.19 Description: Describe the typical power generation and distribution configuration for this condition.</p>	<p>3</p>

<p>2.4 Examples and Practical Applications:</p> <p>Examples:</p> <p>2.4.1 Solve practical problems related to the configuration and power requirements of electric propulsion ships under various operating conditions.</p> <p>Practical Applications:</p> <p>2.4.2 Apply these concepts to real-world scenarios, such as designing and optimizing power generation plants for electric propulsion ships, ensuring reliable power supply, and meeting operational power demands efficiently.</p>	2
<p>III. Power Distribution System on Shipboard</p>	10
<p>General Learning Objective: To understand the components and operation of power distribution systems on ships, including main and emergency power generation, distribution systems, safety mechanisms, and management systems.</p>	
<p>3.1 Power Generation Systems:</p> <p>3.1.1 Understand the function and operation of main and emergency generators on a ship.</p> <p>3.1.2 Explain the role of shore supply and battery charging in maintaining shipboard power.</p> <p>3.1.3 Main Generators:</p> <p>3.1.4 Function and Operation:</p> <p>3.1.5 Understand the role of main generators in providing primary power to the ship.</p> <p>3.1.6 Describe the operational principles and components of main generators.</p> <p>3.1.7 Maintenance and Safety: Discuss routine maintenance practices and safety procedures for main generators.</p> <p>3.1.8 Emergency Generators:</p> <p>3.1.9 Function and Operation:</p> <p>3.1.10 Understand the importance of emergency generators for critical power supply during main power failures.</p> <p>3.1.11 Describe the operational principles and components of emergency generators.</p> <p>3.1.12 Location and Safety: Explain the typical locations of emergency generators and the safety measures associated with their operation.</p> <p>3.1.13 Shore Supply:</p> <p>3.1.14 Function and Connection:</p> <p>3.1.15 Describe how shore supply is used to power the ship when docked.</p> <p>3.1.16 Explain the connection procedures and safety considerations for shore supply.</p> <p>3.1.17 Battery Charging:</p> <p>3.1.28 Systems and Operation:</p> <p>3.1.19 Understand the battery charging systems used on ships.</p> <p>3.1.20 Explain the importance of maintaining battery charge for emergency and auxiliary power.</p>	3
<p>3.2 Power Distribution Systems:</p> <p>3.2.1 Describe the power distribution network, including 440-volt and 220-volt supplies.</p> <p>3.2.2 Identify the components involved in power distribution, such as circuit breakers, transformers, switchboards, and panels.</p> <p>3.2.3 440-Volt and 220-Volt Supply:</p> <p>3.2.4 Distribution Network:</p> <p>3.2.5 Describe the distribution of 440-volt and 220-volt power on a ship.</p> <p>3.2.6 Explain the components involved in each voltage level's distribution network.</p> <p>3.2.7 Safety Measures: Discuss the safety measures and regulations associated with handling different voltage levels.</p> <p>3.2.8 Circuit Breakers and Transformers:</p> <p>3.2.9 Function and Types:</p> <p>3.2.10 Understand the role of circuit breakers in protecting electrical circuits.</p> <p>3.2.11 Describe different types of circuit breakers and their applications.</p> <p>3.2.12 Transformers: Explain the function of transformers in voltage conversion and distribution.</p> <p>3.2.13 Describe the types and operation of transformers used on ships.</p> <p>3.2.14 Main Switch board and Cargo Switch boards:</p> <p>3.2.15 Components and Functions:</p> <p>3.2.16 Understand the layout and function of the main switchboard in distributing power.</p> <p>3.2.17 Describe the cargo switchboards and their role in managing power for cargo</p>	3

<p>operations.</p> <p>3.2.18 Group Starter Panels and Lighting Distribution Systems:</p> <p>3.2.19 Function and Operation:</p> <p>3.2.20 Describe the purpose of group starter panels and their components.</p> <p>3.2.21 Explain the lighting distribution system and its importance for shipboard operations.</p> <p>3.2.22 Remote and Local Starter Panels:</p> <p>3.2.23 Operation and Usage:</p> <p>3.2.24 Understand the differences between remote and local starter panels.</p> <p>3.2.25 Explain how these panels are used to control and monitor electrical systems.</p>	
<p>3.3 Emergency Power Systems:</p> <p>3.3.1 Explain the arrangement and importance of back-up and redundancy systems for emergency power.</p> <p>3.3.2 Understand the procedures for emergency power generation, distribution, and restoration after a power failure.</p> <p>3.3.3 Back-Up and Redundancy Arrangement:</p> <p>3.3.4 Emergency Power: Explain the necessity of backup and redundancy arrangements for emergency power. Describe the systems and components involved in providing emergency power.</p> <p>3.3.5 Emergency Power Generation and Distribution:</p> <p>3.3.6 Location and Safety: Understand the typical locations and safety measures for emergency power generation and distribution systems.</p> <p>3.3.7 Restoration Procedures: Describe the procedures for restoring power after a failure, including the role of emergency power systems.</p>	2
<p>3.4 Power Management and Control Systems:</p> <p>3.4.1 Understand the operation of Power Management Systems (PMS) and Energy Management Systems (EMS).</p> <p>3.4.2 Explain the control, monitoring, alarm, and safety systems related to shipboard power distribution</p> <p>3.4.3 Power Management System (PMS):</p> <p>3.4.4 Operation and Components:</p> <p>3.4.5 Explain the role of the Power Management System in optimizing power usage.</p> <p>3.4.6 Describe the components and functionalities of PMS on a ship.</p> <p>3.4.7 Energy Management System (EMS):</p> <p>3.4.8 Efficiency and Monitoring:</p> <p>3.4.9 Understand the purpose of the Energy Management System in enhancing energy efficiency.</p> <p>3.4.10 Explain how EMS monitors and manages energy consumption on a ship.</p> <p>3.4.11 Control, Monitoring, Alarm, and Safety Systems:</p> <p>3.4.12 Systems and Integration:</p> <p>3.4.13 Describe the control and monitoring systems used in shipboard power distribution.</p> <p>3.4.14 Explain the alarm and safety systems in place to protect against electrical hazards.</p>	1
<p>3.5 Examples and Case Studies:</p> <p>3.5.1 Practical Problems: Solve practical problems related to the design and operation of shipboard power distribution systems.</p> <p>3.5.2 Case Studies: Analyze case studies of power failures and restorations on ships to understand real-world applications of theoretical concepts.</p>	1
<p>IV. Shipboard Power System Protection</p>	12
<p>General Learning Objective: To understand the protection mechanisms, safety protocols, and cooling methods used in shipboard power systems, including the degree of protection, risk assessment, earthing, circuit breakers, hazardous areas, and protective devices for generators, motors, and transformers.</p>	
<p>4.1 Degree of Protection:</p> <p>4.1.1. Understand the classification of protection degrees for electrical equipment on ships.</p> <p>4.1.2 Explain the importance of different protection levels in ensuring the safety and reliability of shipboard power systems.</p> <p>4.1.3 Classification of Protection Degrees:</p>	2

<p>4.1.4 IP Codes: Understand the International Protection (IP) codes used to classify the degree of protection provided by electrical enclosures.</p> <p>4.1.5 Marine Standards:</p> <p>4.1.6 Learn about marine-specific standards and regulations for electrical equipment protection.</p> <p>4.1.7 Application:</p> <p>4.1.8 Explain how different degrees of protection are applied to various shipboard environments.</p>	
<p>4.2 Risk Assessment:</p> <p>4.2.1 Perform risk assessments for shipboard electrical systems.</p> <p>4.2.2 Identify and mitigate potential hazards associated with electrical equipment and operations.</p> <p>4.2.3 Risk Assessment for Electrical Systems:</p> <p>4.2.4 Identification of Hazards:</p> <p>4.2.5 Identify common hazards associated with shipboard electrical systems, such as electrical shock, short circuits, and equipment failure.</p> <p>4.2.6 Mitigation Strategies:</p> <p>4.2.7 Develop strategies to mitigate identified risks, including the use of protective devices, safety protocols, and regular maintenance.</p> <p>4.2.8 Documentation:</p> <p>4.2.9 Understand the importance of documenting risk assessments and safety measures.</p>	2
<p>4.3 Earthing:</p> <p>4.3.1 Understand the principles and practices of earthing in shipboard power systems.</p> <p>4.3.2 Explain the types and functions of earthing systems used on ships.</p> <p>4.3.3 Earthing Systems:</p> <p>4.3.4 Principles of Earthing:</p> <p>4.3.5 Explain the basic principles of earthing and its importance in preventing electrical hazards.</p> <p>4.3.6 Types of Earthing Systems:</p> <p>4.3.7 Describe the different types of earthing systems used on ships, such as TN, TT, and IT systems.</p> <p>4.3.8 Earthing Components: Identify the components of earthing systems, including earth electrodes, conductors, and bonding systems.</p>	2
<p>4.4 Circuit Breakers:</p> <p>4.4.1 Describe the types and functions of different circuit breakers, including Air Circuit Breakers (ACB), Oil Circuit Breakers (OCB), Vacuum Circuit Breakers (VCB), and SF6 Circuit Breakers.</p> <p>4.4.2 Explain the selection criteria and applications of each type of circuit breaker in shipboard power systems.</p> <p>4.4.3 Types and Functions of Circuit Breakers:</p> <p>4.4.4 Air Circuit Breakers (ACB):</p> <p>4.4.5 Understand the construction, operation, and applications of ACBs in shipboard power systems.</p> <p>4.4.6 Oil Circuit Breakers (OCB):</p> <p>4.4.7 Explain the function and maintenance requirements of OCBs.</p> <p>4.4.8 Vacuum Circuit Breakers (VCB):</p> <p>4.4.9 Describe the advantages of VCBs in terms of performance and reliability.</p> <p>4.4.10 SF6 Circuit Breakers:</p> <p>4.4.11 Discuss the use of SF6 circuit breakers and their environmental impact.</p>	1
<p>4.5 Hazardous Areas and Safety Systems:</p> <p>4.5.1 Identify hazardous areas on ships and understand the safety systems in place to manage risks.</p> <p>4.5.2 Explain the classification of hazardous areas and the safety measures required to operate electrical equipment in these areas.</p> <p>4.5.3 Hazardous Areas:</p> <p>4.5.4 Classification and Identification: Learn about the classification of hazardous areas based on the presence of flammable gases, vapors, and dust.</p> <p>4.5.5 Safety Systems:</p>	2

<p>Understand the safety systems and protocols required to operate electrical equipment in hazardous areas.</p> <p>4.5.6 Equipment Protection:</p> <p>4.5.7 Explain the types of protection used for electrical equipment in hazardous areas, such as explosion-proof enclosures and intrinsically safe designs.</p>	
<p>4.6 Protective Devices and Cooling Methods:</p> <p>4.6.1 Describe the typical protective devices used for generators, motors, and transformers on ships.</p> <p>4.6.2 Explain the various cooling methods used for electrical equipment, including oil cooling, water cooling, and air cooling (natural and forced).</p> <p>4.6.3 Protective Devices for Generators, Motors, and Transformers:</p> <p>4.6.4 Generator Protection:</p> <p>4.6.5 Describe the protective devices used for generators, including overcurrent relays, differential protection, and voltage regulators.</p> <p>4.6.6 Motor Protection:</p> <p>4.6.7 Explain the protection mechanisms for motors, such as thermal overload relays, short circuit protection, and phase failure relays.</p> <p>4.6.8 Transformer Protection:</p> <p>4.6.9 Discuss the protective devices used for transformers, including Buchholz relays, temperature monitors, and differential protection.</p> <p>4.6.10 Cooling Methods:</p> <p>Oil Cooling: Understand the principles and applications of oil cooling for electrical equipment.</p> <p>Water Cooling: Describe the water cooling systems used for shipboard electrical equipment, including closed-loop and open-loop systems.</p> <p>Air Cooling:</p> <p>4.6.11 Explain the differences between natural and forced air cooling methods and their applications in shipboard power systems.</p>	2
<p>4.7 Examples and Case Studies:</p> <p>4.7.1 Practical Problems: Solve practical problems related to the protection and cooling of shipboard electrical systems.</p> <p>4.7.2 Case Studies: Analyze case studies of electrical faults and failures on ships to understand the application of protection and cooling systems.</p>	1
<p>V. Emergency Power Supply</p>	
<p>General Learning Objective: To understand the requirements, systems, and protocols for emergency power supply on ships, including emergency power requirements, blackout scenarios, emergency sources of power, backup systems, automatic starting arrangements, emergency switchboards, safety interlocks, and battery systems.</p>	
<p>5.1 Emergency Power Requirements:</p> <p>5.1.1 Understand the regulatory requirements and standards for emergency power on ships.</p> <p>5.1.2 Explain the essential systems and equipment that must be powered during an emergency.</p> <p>5.1.3 Regulatory Requirements and Standards:</p> <p>5.1.4 SOLAS Requirements:</p> <p>5.1.5 Understand the International Convention for the Safety of Life at Sea (SOLAS) requirements for emergency power systems.</p> <p>5.1.6 Classification Society Standards:</p> <p>5.1.7 Learn the standards set by classification societies such as Lloyd’s Register, DNV GL, and</p> <p>5.1.8 ABS for emergency power systems on ships.</p> <p>5.1.9 Essential Systems and Equipment:</p> <p>5.1.10 Critical Systems:</p> <p>5.1.11 Identify the systems and equipment that must remain operational during an emergency, such as navigation lights, communication systems, fire pumps, and emergency lighting.</p> <p>5.1.12 Duration of Emergency Power:</p> <p>5.1.13 Understand the required duration for emergency power supply as per regulatory standards.</p>	2

<p>5.2 Power Failure (Blackout):</p> <p>5.2.1 Understand the causes and consequences of power failure (blackout) on ships.</p> <p>5.2.2 Learn the procedures and protocols for managing and recovering from a blackout.</p> <p>5.2.3 Causes and Consequences of Blackout:</p> <p>5.2.4 Common Causes: Identify the common causes of power failure on ships, such as equipment failure, human error, and external factors.</p> <p>5.2.5 Impact of Blackout: Understand the consequences of a blackout, including loss of propulsion, navigation, and safety systems.</p> <p>5.2.6 Management and Recovery:</p> <p>5.2.7 Procedures:</p> <p>5.2.8 Learn the standard procedures for managing a blackout, including initial response, system checks, and communication protocols.</p> <p>5.2.9 Recovery Protocols:</p> <p>5.2.10 Understand the steps to restore power and ensure the safety and stability of the ship.</p>	2
<p>5.3 Emergency Sources of Power:</p> <p>5.3.1 Identify different types of emergency power sources used on ships, such as emergency generators and batteries.</p> <p>5.3.2 Understand the criteria for selecting and maintaining emergency power sources.</p> <p>5.3.3 Types of Emergency Power Sources:</p> <p>5.3.4 Emergency Generators:</p> <p>5.3.5 Describe the function, types, and requirements of emergency generators on ships.</p> <p>5.3.6 Battery Systems: Understand the role of batteries in providing emergency power and their integration with emergency systems.</p> <p>5.3.7 Selection and Maintenance:</p> <p>5.3.8 Criteria for Selection:</p> <p>5.3.9 Explain the criteria for selecting emergency power sources based on capacity, reliability, and regulatory compliance.</p> <p>5.3.10 Maintenance Practices:</p> <p>5.3.11 Learn the maintenance practices and checks required to ensure the readiness of emergency power sources.</p>	2
<p>5.4 Power Supply System and Backup Systems:</p> <p>5.4.1 Describe the configuration of the power supply system on ships, including main and backup systems.</p> <p>5.4.2 Explain the integration and coordination of backup power systems with the main power supply.</p> <p>5.4.3 Configuration of Power Supply Systems:</p> <p>5.4.4 Main Power System:</p> <p>5.4.5 Describe the main power generation and distribution system on ships.</p> <p>5.4.6 Backup Systems:</p> <p>5.4.7 Explain the integration of backup power systems with the main power supply, including redundancy and reliability measures.</p> <p>5.4.8 Coordination of Backup Systems:</p> <p>5.4.9 System Integration:</p> <p>5.4.10 Understand the coordination between main and backup power systems to ensure seamless power transfer during emergencies.</p>	1
<p>5.5 Automatic Starting Arrangement for the Emergency Generator:</p> <p>5.5.1 Understand the mechanisms and protocols for automatic starting of emergency generators.</p> <p>5.5.2 Learn the requirements for automatic starting systems to ensure reliable operation during emergencies.</p> <p>5.5.3 Mechanisms of Automatic Starting:</p> <p>5.5.4 Automatic Transfer Switch (ATS):</p> <p>5.5.5 Explain the function and operation of Automatic Transfer Switches in emergency power systems.</p> <p>5.5.6 Starting Mechanisms: Understand the different starting mechanisms for emergency generators, including battery start, air start, and hydraulic start.</p> <p>5.5.7 Requirements for Automatic Systems:</p>	2

<p>5.5.8 Reliability and Testing: 5.5.9 Learn the requirements for ensuring the reliability of automatic starting systems and the importance of regular testing and maintenance.</p>	
<p>5.6 Emergency Switchboard and Safety Interlock System: 5.6.1 Describe the function and configuration of emergency switchboards. 5.6.2 Understand the safety interlock systems that prevent hazardous conditions during emergency power transfer. 5.6.3 Function and Configuration of Emergency Switchboards: 5.6.4 Emergency Switchboard Layout: 5.6.5 Describe the layout and components of an emergency switchboard. 5.6.6 Power Distribution: 5.6.7 Understand how emergency power is distributed through the switchboard to essential systems. 5.6.8 Safety Interlock Systems: 5.6.9 Interlock Mechanisms: 5.6.10 Explain the safety interlock mechanisms that prevent hazardous conditions during the transfer of power. 5.6.11 Protection and Monitoring: 5.6.12 Learn the protection and monitoring features integrated into emergency switchboards to ensure safe operation.</p>	2
<p>5.6.13 Batteries and Battery Charging: 5.6.14 Understand the types, characteristics, and maintenance of different batteries used for emergency power (lead-acid, alkaline, and lithium-ion). 5.6.15 Learn the principles and methods of battery charging and monitoring. 5.6.16. Types of Batteries: Lead-Acid Batteries: Understand the characteristics, advantages, and limitations of lead-acid batteries. Alkaline Batteries: Explain the properties and applications of alkaline batteries in emergency power systems. Lithium-Ion Batteries: Describe the benefits and considerations of using lithium-ion batteries for emergency power on ships. 5.6.17 Battery Charging and Monitoring: 5.6.18 Charging Methods: 5.6.19 Learn the principles and methods of charging different types of batteries used in emergency power systems. 5.6.20 Battery Monitoring: Understand the importance of battery monitoring systems to ensure the health and readiness of battery banks.</p>	2
<p>5.7 Examples and Case Studies: 5.7.1 Practical Problems: Solve practical problems related to emergency power supply, blackout recovery, and system integration. 5.7.2 Case Studies: Analyze case studies of real-world incidents involving emergency power systems on ships to understand best practices and lessons learned.</p>	1

Subject Name/Code: Ship Structure and Construction/UG11T5404

Instructional Hours:

Lecture	: 45 hours
Tutorial	: 15 hours
Total contact hours	: 60 hours
Credits	: 4

Teaching Methods

The course shall be conducted in a combination of classroom/online lectures, tutorial and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments)	: 30%
Final Written Exam:	: 70%

Text Book:

1. Ship Construction - Reeds Volume:5
2. Merchant Ship Construction - D.A. Taylor

Reference:

1. Marine Engineering, group of authorities, Editor: Roy L Harrington, ISBN: 0-939773-10-4, SNAME (USA)
2. Modern Marine Engineer's Manual, Hunt, E. C. United State: Cornell Maritime Press.
3. Young, P., Kemp, J. F. Ship Construction Sketch and Notes. (n.p.): Taylor & Francis.
4. Eyres, D. J., Bruce, G. J. Ship Construction. Germany: Elsevier Science.
5. Merchant Ship Construction - H.J. Pursey
6. Surveyor's Glossary Hull Terms & Hull_Survey Terms Recommendation 82 July 2003 / Rev.1 Oct 2018.
7. Loading of the Hull Girder, J. Moe– Translated, F C Michelsen, Report No.118 The Dept. of Name, The University of Michigan College of Engineering.

Table of Topics

Unit	Topics	Hour (L)
I	Types of Ships Subtopics: Classification of ships based on purpose, General Arrangement of Main Cargo ships	10
	Structural terms used in ships Subtopics: Ship structural components	
	Load Line and Tonnage Sub Topics: Load line markings and tonnage	
II	Ship Structural Materials Subtopics: Ship structural materials	14
	Loads and stresses acting on the ship Subtopics: Loads and stresses acting on the ship structure and resisting structural components, Ship-board loads and stresses management	
	Stiffening of plates – Framing systems Subtopics: Framing systems	
	Bottom and side structures Subtopics: Bottom structure, Side structure	
III	Shell and deck Structures Subtopics: Hatches and closing, Deck structure, Shell and associated structure	10
IV	Midship section Subtopic: Midship section of important cargo ships	14
	Bulkheads & Deep Tanks: Subtopics: Types of bulkheads, Arrangement of plating and stiffeners on WT bulkheads. Openings in watertight bulkheads, Deep tanks	
	Fore-End Arrangements Sub Topics: Fore end arrangements	
	Aft End Arrangement Sub Topics: Aft end arrangements	
V	Propeller shafting and components Sub Topics: Shafting installation – description, Shafting ancillaries – design features	12
	Ship surveys Sub Topics: Annual Surveys and harmonized system	
	Total	60

Learning Objectives	
IMO Model Course Competence References 7.02 – 4.1.1, 4.1.2, 4.1.3, 1.1.5 7.04 – 4.2.2.2, 4.2.2.3, 4.2.2.4, 4.2.2.7, 1.4.1.5	L
I. Types of Ships	
General Learning Objective Distinguish between ships and classifies the ships based on their purpose Sub-topic: Classification of ships based on purpose Sub-subtopics & SLOs 1.1 Classification of ships- purpose- category- based on purpose- 1.2. Discusses the distinguishing features of the following ship types: 1.2.1 General cargo ships 1.2.2 Oil Tankers 1.2.3 Bulk carriers 1.2.4 Container carriers 1.2.5 RO-RO ships 1.2.6 Passenger ships 1.2.7 Liquefied gas carriers 1.2.8 Chemical Tankers 1.3. Special purpose vessels: 1.3.1. Dredgers, Tugs, Cattle carrier, offshore vessels-OSP, MSP, DSB, PSV, GTV, TIV, cable laying, pipe laying ships,	4
1.2 Structural terms used in ships Subtopics: Ship structural components General Learning Objective: Uses appropriate terms to identify and illustrate ship’s structural features and components. Sub-topic: Ship structural components Sub-sub topics & SLOs 1.2 illustrate the ship’s structural parts 1.2.1 shell plating, decks, tank top Keel, bottom side girders, bottom longitudinal, stringers, deck girders 1.2.2 Keel, bottom side girders, bottom longitudinal, stringers, deck girders 1.2.3 Frame spacing and Frame stations 1.2.4 Solid floors, bracket or open floors, web frames, hold frames, deck beams, beam knees, brackets, tank-side brackets 1.2.5 bulkheads and stiffeners, pillars 1.2.6 hatch side girders, hatch end beams, half beams, coamings, stays, bulwarks 1.2.7 bow and stern framing, can’t beams, breast-hooks 1.2.8 Bulbous bow, Stern frame, transom floor 1.2.9 Describe the various sections used and their general purpose. Flat Plate, Offset bulb plate, Equal angle, Unequal angle, Channel, Tee, Round, Half Round, scantlings’	4
1.3 Load Line and Tonnage General Learning Objective: Definition of freeboard, conditions for assignment, Load line Surveys. Details of markings permanently carved. Definition of GT and NT as per Tonnage regulations. L1 Sub Topic: Load Line and Tonnage Sub-Sub Topics & SLOS: 1.3.1 Define deck line and freeboard 1.3.2 State the conditions of assignment of freeboard 1.3.3 Sketches with details the permanent load line markings 1.3.4 Define GT and NT with relevant definitions from tonnage regulations.	
II. Ship structural materials	
Sub-sub topics & SLOs Describe the desirable properties for material used in ship building as follows: IACS grades of steel, Aluminium, FRP- advantages and disadvantages, Describe the use of Steel Castings and Forgings in ship building	3

<p>2.1 Loads and stresses acting on the ship Describe the stresses due to various loads acting on the ship structure and state the Structural components resisting them</p> <p>General Learning Objective: Describe the stresses due to various loads acting on the ship structure and state the structural components resisting them</p> <p>Loads and stresses acting on the ship structure and the resisting structural components</p> <p>Specific Learning Objectives:</p> <ul style="list-style-type: none"> 2.1.1 Describe the loading conditions and stresses caused on ship's structure and the structural components resisting the loads 2.1.2 Distinguish between global and local loads and lists them 2.1.3 Describe Longitudinal bending and shear in still water and in seaway <ul style="list-style-type: none"> • Describe in qualitative terms shear force and bending moments • Sagging, hogging-comparison, loading, stresses and its effects. 2.1.4 Racking stress, torsional stresses, stresses due to dry docking loads, and its causes 2.1.5. panting, pounding, or slamming- causes and effects. 2.1.6 Stress Concentrations- around openings, slashing in partially filled tanks 	3
<p>2.2 Stiffening of plates – Framing systems</p> <p>General Learning Objective: Demonstrate the requirement for stiffening of the hull plating and illustrates how it is accomplished by use of frames in transverse and longitudinal direction</p> <p>Framing systems</p> <p>Specific Learning Objectives:</p> <ul style="list-style-type: none"> 2.2. 1. Framing Systems, stiffeners- functions 2.2.2 Describe with aid of sketches the longitudinal, transverse and combination framing systems- Advantages and disadvantages. 	4
<p>2.3 Bottom and side structures</p> <p>General Learning objective: Demonstrate the understanding of bottom structure, side structure and the brackets connecting them</p> <p>Sub Topic: Bottom structure</p> <p>Specific Learning Objectives:</p> <ul style="list-style-type: none"> 2.3.1 Types of bottom structures- advantages& disadvantages, Transverse framing, longitudinal framing- description of double bottom structure for longitudinal and transverse framing 2.2.2. Lists the advantages of double bottom over single bottom ships 2.2.3. Water tight floors, solid and bracket floors, CVK, Intercostal Side girders, bottom longitudinal 2.3.4. Keels- types- structure- safety features 2.3.5 Side framing, tank side brackets-functions- 2.3.6. Margin plates- general cargo and refer ships, 2.3.7. Beam knee- functions, 	4
III. Shell and Deck structure	
<p>General Learning Objective: Describe Shell & Deck structures emphasizing on: Deck plating & deck girders. Discontinuities, such as hatches and other openings. Supporting & closing arrangements, Plating systems for shell plating including keel, bilge strake, sheer strake, Bulwark, bilge keel</p> <p>Sub Topic: Hatches and closing</p> <p>Sub-Sub Topic & SLOs</p> <ul style="list-style-type: none"> 3.1.1 strakes- types, deck plating, Seams and Butts, Keel strake- types, arrangement, stringer plate, stealer plates 3.1.2 Hatch end beams, tripping brackets, deck girders, hatch covers- types, Arrangements, stresses, loss of strength, coaming, closing and opening arrangements of hatch covers. 3.1.3 bulwark and guard rail stanchions-description and arrangement 3.1.4 Midship section-general cargo, bulk carrier, tanker & container 	10

<p>3.2 Bulkheads & Deep Tanks General Learning Objective: Understand Principle Dimensions of the ship & various terms related to ship construction so that different dimension they will have to use for the various calculation.</p>	
<p>IV. Midship section</p>	
<p>General Learning Objective: Understand the construction of midship sections of General Cargo, Tanker, bulk carrier and container ships with the help of neat labelled Sketch</p> <p>Sub Topic: Midship section of important cargo ships Sub-Sub Topics & SLOs 4.1.1 Draw neat Sketch of typical midships sections of following ships showing both primary and secondary frames and labels parts</p> <ul style="list-style-type: none"> • General Cargo • Double hull Tanker • Bulk carrier • Container carrier <p>Sub Topic: Types of Bulkheads Sub-Sub Topics & SLOS:</p> <ul style="list-style-type: none"> • bulkheads: Classification, functions, structure, requirements- description • watertight doors-requirements, construction and operation • Deep tanks- structure, Access and opening - for dry and liquid cargo, ballast operation 	14
<p>4.2 Fore- & Aft-end Arrangements General Learning Objective: Describe Stem construction. Arrangements to resist panting. Forepeak – Collision bulk head, Bulbous bows. Anchor and cable arrangements, Chain locker</p> <p>Sub Topic: Fore-end Arrangements Sub-Sub Topics & SLOS: 4.2.1 stem construction- centerline profile- structural arrangements -collision bulkheads, Chain locker, anchor- arrangements, features, purpose Bulbous bow- structure & description, 4.2.2 Stern frame- types, Rudder-types, rudder stock, bearings, Shaft tunnel- bearings, aft peak tank</p>	
<p>V. Propeller shafting installations</p>	
<p>5.1 Propeller shafting installations General Learning Objective: Describe the following installations/equipment constructing shafting and their design features and operative mechanism of propeller shaft and associated ancillaries</p> <p>Sub Topic: Shafting installation - description Sub-Sub Topics & SLOS: 5.1.1 shafting-different components-description, alignment, checking shaft alignment, checking stern tube- sealing arrangements. Propellers- types, fixing and mounting</p>	12
<p>5.2 Ship Surveys General Learning Objective: Definition of freeboard, conditions for assignment, Load line Surveys. Details of markings permanently carved. Definition of GT and NT as per Tonnage regulations.</p> <p>Sub Topic: Ship Surveys Sub-Sub Topics & SLOS: 5.2.1 Describe the functions of classification societies 5.2.2 Describe the periodical surveys carried out by the classification society 5.2.3 Harmonised systems of survey</p>	

Subject Name/Code: Control Engineering and Marine Automation/ UG11T5405

Instructional Hours:

Lecture : 45 hours

Tutorial : 15 hours

Total Contact hours : 60 hours

Credits : 4

Text Book:

1. Modern Control engineering, Roy Choudary, PHI
2. Applied Marine control and Automation, Majumdar, Fernades and Patil, SPD Publications, Latest edition

Reference:

1. Marine Control Practice, D.A.Taylor, B.P. publisher
2. Control Systems Engineering, I J Nagrath, M. Gopal, New Age International

Table of Topics

Unit	Topic	Hour (L)
I	Introduction to System Analysis	10
II	Transient Response Analysis	12
III	Frequency-domain Analysis of Linear Systems	14
IV	Controllers and Compensation Techniques	12
V	Application of Controls on Ships	12
Total		60

Learning Objectives		L
I. Introduction to System Analysis:		10
1.1 Introduction to Automatic Control Systems.		
1.1.1 Basic Components of a control system, Types of control system (open & closed loop) with example, Advantage and disadvantage of open & closed loop system, Classification of Systems, Effects of the feedback.		
1.2 Electrical Analogy of Physical System.		
1.2.1 Explain mechanical systems elements, free body diagram, procedure of writing the models of mechanical system. Electrical Analogous of Mechanical Translational & Rotational Systems (Force-Voltage, Force-Current, Torque-Voltage, Torque-Current Analogy)		
1.2.2. Electrical, Thermal and Liquid Level system by using of Laplace Transforms.		
1.3 Transfer Function, Block Diagram and Signal Flow Graph		
1.3.1. Define Transfer function, Properties of transfer function, Explain Block diagram, how to draw block diagram, find transfer function by block diagram reduction technique,		
1.3.2. Explain signal flow graph, find transfer function by signal flow graph using Mason's gain formula, - basic numerical		
II. Transient Response Analysis		12
2.1 Time-Domain Analysis of Control Systems		
2.1.1 Test input signals, Time domain analysis of 1 st and 2 nd order closed loop System with different input signals.		
2.1.2 Transient response specifications of 2 nd order system.		
2.1.3 Steady state errors in terms of closed loop transfer functions, Static error coefficients, Generalized or dynamic error coefficients. Possible questions and problems discussion.		
2.2 Stability of linear control systems		
2.2.1 Methods of Determining Stability, Stability of linear system by pole location.		
2.2.2 Routh-Hurwitz criteria, Relative Stability Analysis. - basic numerical		
2.3 The Root Locus Technique		
2.3.1. Root Locus, rules for construction of root locus. basic numerical		
2.3.2. Effect of adding poles and zeros in system.		
III. Frequency-domain Analysis of Linear Systems		14
3.1 Bode plots & Polar plots		
3.1.1 Advantage of frequency response, Concepts of frequency response, frequency domain specifications.		
3.1.2. The 2 nd order system the resonant peak, the resonant frequency and the bandwidth. - basic numerical		
3.1.3. Procedure of Bode plots, polar plots. - basic numerical		
3.1.4. Calculation of gain and phase margins- basic numerical		

3.2 Nyquist Criteria	
3.2.1. Nyquist Stability criterion, Stability analysis. - basic numerical	
3.2.2. Relative stability closed loop frequency response	
IV. Controllers and Compensation Techniques	12
4.1 Basic Control Actions and Controller Characteristics	
4.1.1. The Characteristics of P, I and D controllers.	
4.1.2. Response with P, PI & PID Controllers.	
4.1.3. Tuning of PID controller: Ziegler Nichol's	
4.1.4. Two step (On-Off) control, Modulating Control, Ratio and Cascade Control.	
4.2 Compensation Techniques	
4.2.1. Improvement of the system performance through compensation.	
V. Application of Controls on Ships	12
5.1 Function, Performance Test, Configuration of Monitoring Systems and Configuration of Protective Devices	
5.1.1 State what a monitoring system or data logger is. Explain how a monitoring system is constructed showing its system configuration. Explain functions of the following system components for a monitoring system: CPU unit, I/O interface, monitoring display, log printer, alarm printer, lamp driver, extension alarm system.	6
5.1.2 State what is meant by protective/safety devices and how they work in simple terms. Explain how protective/safety Alarms, trips and safety interlock in the following operation systems can be tested: main engine, power generation and distribution, boiler, auxiliary machinery.	
5.2 Safety Devices for The Main Engine	
5.2.1 Boiler Automatic starting and stopping sequence	
5.2.2 Boiler automatic cross loop combustion control	
5.2.3 Boiler Feed water control – 2 & 3 Element control	
5.2.4 Main engine central cooling water system	
5.2.5 Steering gear control with Auto pilot	
5.2.6 Direct Reversing cam less engine control system	
5.2.7 Purifier Automatic Desludging System	
5.2.8 Instrument for UMS classification	
5.2.9 Dual Fuel boiler combustion system	6

Subject Name/Code: Mechanics of Machines/ UG11T5406

Instructional Hours:

Lecture	: 45 hours
Tutorial	: 15 hours

Total Contact Hours : 60 hours

Credits : 4

Teaching Methods

The Course shall be conducted in a combination of Classroom/online lectures, tutorials and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments) : 30%

Final Exam : 70%

Text Book:

1. Theory of Machines, S.S. Rattan, Tata McGraw Hill Publishing Company, New Delhi.
2. The Theory Machines, Thomas Bevan, CBS Publishers and Distributors, New Delhi

Reference:

1. The Theory of Machines, J.S. Rao, New Age International Publishers.
2. Advanced Mechanics Machines, J. Hannah and R.C. Stephens, Viva Publications, New Delhi.
3. Kenneth J. Waldron/Gary Kinzel, Kinematics Dynamics and Design of machinery, John Wiley and Sons.
4. Theory of Machines, Kinematics and Dynamics, Sadhu Singh, Pearson Publications.

Table of Topics

Unit	Topics	Hour (L)
I	Kinematics of Machines and Mechanisms Subtopics: Introduction to basic mechanisms, kinematic pairs, links and chain Inversions and variants of kinematic chains. Degrees of freedom	5
II	Marine Engine Dynamics Sub topics: Determination velocities and accelerations of Piston, Connecting Rod inertia forces of piston, connecting rod, crank by analytical method Dynamically equivalent system of connecting rod.	9
III	Gears and Gear Trains Sub topics: Types and classification of all gears used in the field of marine engineering, Force analysis of Spur Gear, Bevel gear, worm gear Type of Classification of Gear Trains Force analysis of Simple Gear Train, Compound Gear Train, Epicyclic Gear Train	12
IV	Cam and Follower Mechanisms Sub topics: Types and Classification Cam and Follower mechanisms used in different machineries on board, Force analysis of Cam and Follower mechanisms and determination of cam profile for specified follower motions like uniform velocity, SHM, uniform acceleration and retardation.	10
V	Balancing Subtopics: Introduction to Concept of Balancing, Static balance and Dynamic Balance Single plane and multiplane balancing; Balancing of reciprocating machinery on board Partial balancing Primary and Secondary balancing of Inline engines.	12
VI	Single degrees of freedom vibration systems Sub topics: Introduction to resonance, amplitude, frequency and time period analysis of simple harmonic motions with application to spring-mass system, shaft-rotor system; Single degree of freedom undamped and damped free system.	12
Total		60

Learning Objectives		L
I. Kinematics of Machines and Mechanisms (IMO7.02,2014,1.1)		5
General Learning Objective Understand the development of machines from simple ideas to complicated levels. Understand the evolution and the historical development of various machines and mechanisms		
Specific Learning Objectives: 1.1 State how each one of the machines was brought into existence for the first and foremost. 1.2 Classify The Types of Basic kinematic chains, mechanisms, machines and explain their applications in field of engineering 1.3 Explain The Concept of Kinematics Pairs(joints)and to determine the number of degrees of freedom for a given mechanism 1.4 Identify The Different Type of Four-bar mechanisms and her classifications. 1.5 Describe the method of obtaining various inversions of basic kinematic chains to suit different applications 1.6 Explain how all modern machines are developed from basic chains		
II. Marine Engine Dynamics (IMO7.02,2014,1.1)		9
General Learning Objective: Understand the engine dynamics and methods of carrying out inertia force analysis of engine mechanisms		
Specific Learning Objectives: 2.1 Perform kinematic analysis of an engine mechanism to determine position, velocity and acceleration fall members 2.2 Perform a kinetic analysis of an engine mechanism to determine the forces on all joints and torque required to drive the mechanism 2.3 Determine Velocities and accelerations of various links of given IC engine mechanism by analytical method 2.4 Evaluate the efficiency of a mechanism using the velocities and acceleration of various links 2.5 Evaluate Inertia Forces Piston, connecting rod, crank by analytical method 2.6 Determine load on engine foundation and frame corresponding to the fluctuation of inertia forces		
III. Gears and Gear Trains		12
General Learning Objective: Understand various types of gears and gear trains and their kinematics Sedin the field of marine Engineering.		
Specific Learning Objectives:(IMO7.02,2014,1.1) 3.1 State the Advantages of Gear Drives Over Belt Drive 3.2 Explain the Importance positive down rate field application 3.3 Classify All the gore.r.the position of shaft axes 3.4 Analyze the kinematics of spur gear. 3.5 Describe the involute Gear tooth profile 3.6 Analyze the Gears for interference and undercutting 3.7 Classify the Different Types of Gear Trains 3.8 Evaluate Mechanical Advantage of a Given Gear Train 3.9 Analyze the kinematics of Simple Gear Train, Compound Gear Train, Reverted Gear Train and Epicyclic Gear Train		
IV. Cam and Follower Mechanisms (IMO7.02,2014,1.1)		10
General Learning Objective: Understand Types of cams and follower sand their applications in the field of marine engineering.		
Specific Learning Objectives: 4.1 Describe the function of cam and follower 4.2 Describe the kinematic analysis of a cam follower mechanism 4.3 Construct Displacement, velocity, acceleration, jerk diagrams of a follower mechanism 4.4 Determine cam profile graphically for specified follower motions like uniform velocity, SHM, uniform acceleration and retardation, cycloidal motion 4.5 Analyse the cam follower mechanisms required for specific applications on board like valve operation fuel injections, air starting, reversing marine engines		

V. Balancing (IMO7.02,2014,1.21.2.2,7.04,3.2,3.1.3)	12
<p>General Learning Objective: Understand and apply concept to feed and actual method of balancing as applied to compressors and multi cylinder in-line engines & V-engines, radial engines, pumps etc., and to determine whether a system is balanced or not.</p>	
<p>Specific Learning Objectives:</p> <ul style="list-style-type: none"> 5.1 Describe The Need and Method of Balancing 5.2 Differentiate Static and Dynamic Balancing 5.3 Describe Types of Machinery Unbalance 5.4 Enumerate Important Balancing Conditions 5.5 Describe principles of balancing like single plane balancing, two plane balancing 5.6 Evaluate and determine the primary and secondary balance of multi cylinder in-line engines and compressors, pumps 5.7. Describe the Working of Balancing Machines 5.8 Determine the Conditions for Secondary Balancing 5.9 Deduce and determine the conditions for primary and secondary balancing for high-speed engines, compressors, pumps etc. 5.10 Describe the concept of partial balance and complete balance 5.11. Determine and design static, dynamic balancing of rotating, reciprocating, combined rotary and reciprocating, unbalance masses, reciprocating unbalance masses 5.12 Explain Complete Balancing of Reciprocating Machinery 	
VI. Single degrees of freedom vibration systems (IMO 7.04, Appendix IV,2014)	12
<p>General Learning Objective: Understand the meaning of resonance, amplitude, frequency and time period and analysis of simple harmonic motion in spring mass system and shaft rotor system. Analysis of damped and undamped single degree of freedom of free vibration system.</p>	
<p>Specific Learning Objectives:</p> <ul style="list-style-type: none"> 6.1 Basic Parameters of Resonance, amplitude, time period, frequency of simple harmonic system. 6.2 Governing equation of Spring Mass System. 6.3 Governing equation of Shaft Rotor System. 6.4 Damped free vibrations system analysis. 6.5 Undamped free vibration system analysis. 6.6 Equation of motion of damped and undamped free vibration system. 6.7 Logarithmic decrement. 	

Subject Name/Code: Marine Refrigeration and Air Conditioning/ UG11T5407

Instructional Hours:

Lecture	: 45 hours
Tutorial	: 15 hours
Total Contact Hours	: 60 hours
Credits	: 4

Teaching Methods

The Course shall be conducted in a combination of Classroom/online lectures, tutorials and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments)	: 30%
Final Exam	: 70%

Text Book:

1. Marine Refrigeration and Air conditioning, Harbatch, J.A.Cornell Maritime Press.
2. Marine Auxiliary Machinery, H D MCGEORGE, Mc George

Reference:

1. Refrigeration at Sea, R. Muntun and J R Stott, IMAREST, U.K.
2. Running and Maintenance of Marine Machinery, Cowley J.K., IME

Table of Topics

Unit	Topic	Hour (L)
I	Introduction to Marine Refrigeration and AC System	8
II	Marine Refrigeration Systems	10
III	Components of Marine Refrigeration and AC System	12
IV	Marine Refrigerants and Refrigerant Oil	8
V	Marine Refrigerant Charging and Retrofitting	10
VI	Marine Air Conditioning System	12
Total		60

Learning Objectives		L
I. Introduction to Marine Refrigeration and AC System		8
Specific Learning Objective: 1.1 Explain the use of refrigeration on board ships 1.2 Introduction to marine refrigeration and air conditioning system (mainly difference) 1.3 Units for refrigeration (TR), KW, KJ/s, KJ/min etc 1.4 Comparison between different similar systems - Heat pump, heat engine, refrigerator and their performance measuring parameters 1.5 Explain basic concepts like refrigeration effect, compressor work, coefficient of performance (COP), Theoretical COP, Actual COP, Relative COP 1.6 Explain the concepts with respect to ships: cargo refrigeration, provisional refrigeration, reefer ships, Comfort ACs in accommodation, secondary cooling system, etc.		
II. Marine Refrigeration Systems		10
Specific Learning Objective: 2.1 Explain ideal vapour compression system (VCC) – Block diagram, P-h and T-s diagram 2.2 Explain vapour compression cycle (VCC) with different modifications – superheating, sub cooling, changes in pressures at condenser or evaporator 2.3 Explain the following concepts with P-h and T-s diagrams, Wet compression, Dry compression, its significance 2.4 Simple Numerical based on ideal, superheating, sub cooling conditions in VCC 2.5 Explain different faults and troubleshooting of the VCC 2.6 Explain vapour absorption system: Block diagram and working		
III. Components of Marine Refrigeration and AC System		12
Specific Learning Objective: 3.1 Explain Compressor - types of compressors, reciprocating, belt-driven, hermetic, semi-hermetic, rotary, scroll, discus valve design, liquid in the compressor cylinder, system maintenance and compressor efficiency 3.2 Explain Condenser – types of condensers and its evaluation, its maintenance 3.3 Explain Expansion valve- TEV, TXV components, the valve body, the diaphragm, needle and seat, the spring, the sensing bulb and transmission tube, types of bulb charge, the liquid charge bulb, the cross-liquid charge bulb, the vapour charge bulb, its maintenance, its		

<p>maintenance</p> <p>3.4 Explain Evaporator- Types of evaporators, evaporator evaluation, latent heat in the evaporator, the flooded evaporator, dry type evaporators performance, evaporator superheat, hot pull down, pressure drop in evaporators, liquid cooling evaporators (chillers), evaporators for low temperature applications, its maintenance</p> <p>3.5 Explain functions of following: reservoir, accumulator, HP cut out, LP cut in/out, Temperature controls, oil safety pressure control, suction line, discharge line, heat exchanger, Pressure regulating valve, Crankcase pressure regulator, relief valves, Receivers, filter driers, refrigerant check valves, refrigerant sight glasses, Liquid refrigerant distributors, Suction line accumulators, suction line filter driers, Discharge service valves, refrigeration line service valves, Oil separators, Ball valves</p> <p>3.6 Explain fan cycling and defrost cycles (Random or Off-Cycle defrost, planned defrost, Low-temperature evaporator defrosting, internal heat defrosting – hot gas / cool gas defrosting, external heat defrosting, defrost termination and fan delay control)</p>	
<p>IV. Marine Refrigerants and Refrigerant Oil</p>	8
<p>Specific Learning Objective:</p> <p>4.1 Marine Refrigerants: definition, classification and important properties of refrigerants (Mainly – R-134a, Ammonia, Sulphur-Di-Oxide (SO₂), Carbon-Di-Oxide (CO₂), Freon -12 (F-12), F-11).</p> <p>4.2 Qualities of good refrigerants, Secondary refrigerant.</p> <p>4.3 Explain refrigerant Oils (its important properties and classification for marine systems)</p>	
<p>V. Marine Refrigerant Charging and Retrofitting</p>	10
<p>Specific Learning Objective:</p> <p>5.1 Explain refrigerant recovery</p> <p>5.2 Refrigerant recycling,</p> <p>5.3 Refrigerant reclaiming,</p> <p>5.4 Refrigerant retrofitting and</p> <p>5.5 Refrigerant charging (liquid and vapour)</p> <p>5.6 Explain refrigerant leakage</p> <p>5.7 Explain types of refrigerant leaks</p> <p>5.8 Explain refrigerant leak detection methods,</p> <p>5.9 Explain system evacuation, multiple evacuation, triple evacuation</p>	
<p>VI. Marine Air Conditioning System</p>	12
<p>Specific Learning Objective:</p> <p>6.1 Explain different marine air conditioning system layouts</p> <p>6.2 Explain concepts of air cleaning, air ventilation, Psychometric and related terms: Definition, Composition of air, Daltons law of partial pressure, Gas and Vapour mixture, Dry and Wet bulb temperature, Wet bulb depression, Dew point, Dew point depression, Saturated air, Specific humidity, Degree of saturation, Relative humidity, Absolute humidity, Humid specific volume and humid specific heat, Enthalpy of moist air.</p> <p>6.3 Use of psychometric charts and tables, Sensible heating and cooling, Humidification and dehumidification and their methods, 6.4 Simple numerical problems using steam table and psychometric chart.</p> <p>6.4 Explain human comfort chart</p> <p>6.5 Explain maintenance involved in marine air conditioning system</p>	

Subject Name /Code: Marine Diesel Engines Lab/UG11P5401

Instructional hours

Practical : 45 hours

Total contact hours : 45 hours

Credits: : 1.5

Exp.No.	Topics	P
I	<p>Study of the following Marine Equipment: Cylinder liner of Marine Diesel Engine and its calibration for 2 Stroke and 4 Stroke Engine: Cylinder liner function Cylinder liner material Stress in Liners Cooling of Liners Cylinder Liner Failures Cylinder Liner Location on Engine Points to be observed while inspecting the cylinder liner Cylinder Liner Wear Tools required for calibration the wear Cylinder Liner Calibration and tabulation Interpretation of Liner Wear</p>	9
II	<p>Piston / Piston ring of 2 Stroke and 4 Stroke Marine Diesel engine and its calibration: The purpose of Piston and Rings Piston Parts identification and Location inside Engine Material of construction Stresses on Piston and Rings Points to be observed while inspecting the Piston and Rings Measurements / Calibration of Piston and Rings & Ring Grooves What is Compression Pressure? Interpretation of Low Compression Pressure</p>	9
III	<p>Cylinder head and mountings for 2 Stroke and 4 Stroke Engine: The purpose of Cylinder Head Cylinder Head mountings identification and Location inside Engine. Function of each mounting Material of construction Points to be observed while inspecting the Heads Measurements / Calibration of Suction and Exhaust Valves & Seats Importance of Tappet Clearances Tappet Clearances Measurement Main bearing and bottom end bearing clearance measurement and checking Measurement of crankshaft deflection</p>	9
IV	<p>Air starting valves: Purpose of Air Starting Valve Location of Air Starting Valve Operation of Air Starting Valve Parts of Air Starting Valve Dismantling and Maintenance of Air Starting Valve</p>	6

V	Fuel injectors: Purpose of Fuel injectors Location of Fuel injectors Operation of Fuel injectors Parts of Fuel injectors Dismantling and Maintenance of Fuel injectors, Pressure Testing	6
VI	Cylinder relief valves: Purpose of Cylinder relief valves Location of Cylinder relief valves Operation of Cylinder relief valves Parts of Cylinder relief valves Dismantling and Maintenance of Cylinder relief valves, Pressure Testing	6
	Total	45

Subject Name/Code: Control Engineering and Automation Lab / UG11P5402

Instructional hours:

Practical : 45 hours

Total contact hours : 45 hours

Credits : 1.5

Teaching Methods

The practical training will be hands-on with focus on safety and skills.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments) : 50%

Final Exam : 50%

Exp.No.	List of Experiment	Hour (P)
I	Temperature, flow, pressure and level control system using PID controller.	8
II	Study the working of Synchro, PLC and ladder programming.	7
III	Study of MATLAB and Simulink simulation of systems.	8
IV	Generate transfer function for first and second order system and corresponding root locus, bode plot, Nyquist plot in MATLAB.	8
V	Study of flapper nozzle characteristics.	4
VI	Demonstrate working of strain gauge.	2
VII	Demonstrate working of RTD.	2
VIII	The differential pressure transmitter operation and adjustment	2
IX	Fuel viscosity control system operation and management	2
X	Crankcase oil mist concentration monitoring device operation	2
	Total	45

SEMESTER – V

Subject Name: Marine Diesel Engines Operation and Manoeuvring / UG11T5501

Instructional Hours:

Lecture	: 45 hours
Tutorial	: 15 hours
Total contact hours	: 60 hours
Credits	: 4

Teaching Methods

The course shall be conducted in a combination of classroom/online lectures, practical in workshops and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments):	30%
Final Written Exam	: 70%

Text book:

1. Marine Diesel Engines, Pounder C.C: Newnes-Butterworths, London
2. Marine Diesel Engines, Deven Aranha
3. Marine Diesel Engines, D.K.Sanyal, Bhandarkar publications , Latest Edition

Reference:

1. Jackson L & Morton T.D: General Engineering Knowledge for Marine Engineers, Thomas Reed Publications
2. Cowley J.K, The Running and Maintenance of Marine Machinery, Institute of Marine Engineers
3. H D McGeorge: General Engineering Knowledge, Butterworth-Heinemann
4. Christensen, Stanley G: Lamb's Questions & Answers on The Marine Diesel Engine, Butterworth Heinemann
5. Christen Knak: Diesel Motor Ships Engines and Machinery, G. E. C.
6. Marine Low Speed Diesel Engines, Griffiths, Denis: IMarEST Publication
7. Griffiths, Denis: Marine Medium Speed Diesel Engines, MEP Series, Vol. 1, Part 3, IMarEST Publication

Table of Topics

Unit	Topics	Hour (L)
I	Medium Speed Engines and Propulsion Configuration	15
II	Indicator Diagrams and Power Calculations Fuel Pumps and Metering Devices	10
III	Lubrication Systems and Cooling Systems	8
IV	Forces and Stresses, Manoeuvring Systems	10
V	Propeller and Load Diagrams	7
VI	Propulsion Characteristics of Diesel	10
Total		60

Learning objectives		L
I. Medium Speed Engines and Propulsion Configuration		15
<p>1.1 Medium Speed Engines General Learning Objective: Understand the types of marine medium speed diesel engines and their features. Specific learning objectives:</p> <ul style="list-style-type: none"> 1.1.1 Different types of medium speed marine diesel engines (Inline and V-type engines) 1.1.2 Describe in simple terms the principal features of a typical "V"-type medium speed diesel engine. 1.1.3 Reversible Medium speed diesel engines having FPP. 1.1.4 Clutch and geared reversible unidirectional medium speed engines with fixed pitch propeller. [Clutch with reverse Reduction Gear] 1.1.5 Mechanical Hydraulic Governors (UG8) Parts of Generator fitted with temperature alarms, pressure alarms & over speed trip		7
<p>1.2 Propulsion configuration General Learning Objective: Understand the connections of various prime movers to the propelling drives and other line shafting arrangements. Specific Learning Objectives: Explain the following:</p> <ul style="list-style-type: none"> 1.2.1 Brief description of various types of propulsion arrangements covering: 1.2.2 Slow Speed Diesel Engine direct drive to propeller 1.2.3 Medium and high speed with reduction gearing 1.2.4 Electric Propulsion arrangement using diesel-electric, turbo-electric plants 1.2.5 Engine propeller matching - Choice of propeller 		8

II. Indicator Diagrams and Power Calculations in Diesel Engines, Fuel Pumps and Metering Devices	
<p>General learning objective: Understand power calculations and analysis, which help in maintenance and operation.</p> <p>2.1 Indicator diagrams and Power Calculations in Diesel Engines</p> <p>2.1.1 Power diagrams - types, significance, power calculations, fault detection- Overloading, High exhaust gas temperature, Misfiring.</p> <p>2.1.2 Discuss engine condition monitoring and evaluation systems with regard to: Supplemented by cylinder pressure measurement online</p> <p>2.1.3 Draw cards-significance, out of phase diagrams, power balancing</p> <p>General learning objective: Understand the fuel system components on the engine</p> <p>2.2 Fuel pumps and Metering Devices</p> <p>Fuel injection</p> <p>2.2.1 Explain how and why fuel pumps, camshafts and injectors are altered for varying fuel types</p> <p>2.2.2 Compare the injection requirement for Slow, medium and high-speed diesel engines, including pilot injection</p> <p>2.2.3 Describe the Unit injection, CRDI systems</p> <p>2.2.4 Describe the helical groove and spill valve type fuel pumps</p> <p>2.2.5 Describe VIT fuel system</p> <p>2.2.6 Uni-fuel and dual - fuel systems (for high/ medium viscosity fuels)</p> <p>2.2.7 Electronic injection system [FIVA / ICU]</p> <p>2.2.8 Incorporation of FQS along with Variable injection timing</p> <p>2.2.9 Identify the common service faults, pump timing and metering adjustments</p>	10
III. Lubrication Systems and Cooling Systems	
<p>3.1 Lubrication Systems</p> <p>General learning objective: Understand the lubrication system of large and medium size diesel engines</p> <p>3.1.1 Engine lubrication: Principle, distribution of lubricant oil in diesel engines with neat sketch.</p> <p>3.1.2 Cylinder lubrication: Types, mechanism, description</p> <p>3.1.3 Lubrication in main bearings, bottom end bearings, cross head bearings,</p> <p>3.1.4 Lubrication system for turbo chargers.</p> <p>General learning objective: Understand the cooling system of large diesel engines</p> <p>3.2 Cooling systems: Piston cooling, cylinder jacket, cylinder heads, bore cooling, exhaust valve cooling, maintenance of cooling system.</p>	8
IV. Forces and stresses:	
<p>General Learning Objective: Understand the stresses in diesel engine components and effects on the performance.</p> <p>Specific Learning Objectives: Explain the following:</p> <p>4.1.1 Schematic layout of forces & stresses acting on the engine.</p> <p>4.1.2 Engine vibrations- Types, effects & damping [Axial, Torsional & Transverse]</p> <p>General Learning Objective: Understand the operational aspects of starting, running and stopping the engine.</p> <p>Specific Learning Objectives:</p> <p>4.2 Manoeuvring Systems:</p> <p>4.2.1 Checks to be carried out prior starting up and after shutting down.</p> <p>4.2.2 Various types of starting methods for marine diesel engines</p> <p>4.2.3 Describe main components of a Large 2 stroke engine starting air system</p> <p>4.2.4 Large 2 stroke diesel engine Starting air system layout and operation with interlocks</p> <p>4.2.5 Reversing systems in 4 stroke diesel engines.</p> <p>4.2.6 Reversing system of large 2 stroke diesel engines.</p>	10

V. Propeller and Load diagrams	
<p>General Learning Objective: Understand the use of Engine Layout and Load diagrams and the various parameters.</p> <p>Specific Learning Objective: Explain the following:</p> <ul style="list-style-type: none"> 5.1 Propeller curve 5.2 Propeller design point 5.3 Fouled hull, sea margin and heavy propeller 5.4 Constant ship speed lines 5.5 Sea Trial related to engine speed and power measurement. 	7
VI. Propulsion Characteristics of Diesel Engine	
<p>General Learning Objective: Understand Engine Load diagrams and factors limiting engine power and measures for effective operations.</p> <p>Specific Learning Objective: Explain the following:</p> <ul style="list-style-type: none"> 6.1. Diesel Engine Operating Region and Load Diagram 6.2 Continuous Service Rating 6.3 Engine Margin 6.4 Limits of Continuous Operation 6.5 Limits for overload operation 6.6 Turbocharger Diesel Engine Matching, Compressor Maps 6.7 Specific Fuel Oil Consumption (SFOC) 6.8 SFOC based on reference ambient conditions stated in ISO 3046/1-1986 6.9 Adjustments to SFOC for lower calorific value of fuels and ambient conditions different from ISO reference conditions 	10

Subject Name/Code: Marine Turbo Machinery/ UG11T5502

Instructional Hours:

Lecture	: 45 hours
Tutorial	: 15 hours
Total contact hours	: 60 hours
Credits	: 4

Teaching Methods

The course shall be conducted in a combination of classroom/online lectures, practical in workshops and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments:	30%
Final Written Exam	: 70%

Text Book:

1. Gas Turbines, V. Ganeshan
2. Theory and Practice of Steam Turbines, Kearton

Reference:

1. Turbines, Compressors and Fans, S. M. Yahya.
2. Practice on Turbomachines – G. Gopalakrishnan & D. Prithviraj, SCI Tech Publishers, Chennai.
3. McBurnie, S. C. Marine, Steam Engines, and Turbines. United Kingdom: Elsevier Science.
4. Marine Gas Turbines, John B Woodward, Wiley-inter science publication, a volume in Ocean Engineering, ISBN 0-471-95962-6, John Wiley & Sons.
5. Marine Engineering, Group of Authorities, Editor: Roy L Harrington, ISBN: 0-939773-10-4, SNAME (USA).
6. Gas Turbines – Theory and practice – Zucrow
7. Operations of Machinery in Ships: Steam Turbines, Boilers and Auxiliary Plant (Part 15-IME) (Part 18 - IME) Institute of Marine Engineers, IME.

Table of Topics

Unit	Topics	Hour (L)
I	Fundamentals of Turbo Machines	8
II	Marine Steam Turbines	20
III	Dimensional Analysis: Similitude for Turbo Machinery	10
IV	Turbo-Compressor	12
V	Gas Turbines	10
Total		60

Learning objectives	L
<p>I. Fundamentals of Turbo machines General Learning Objective: Understand the fundamental theory of turbo machines. Specific learning objectives:</p> <ul style="list-style-type: none"> 1.1 Definition and need of turbo machines in marine 1.2 Parts of turbo machines 1.3 Comparison with positive displacement machines 1.4 Classification 1.5 Basic equation of energy transfer in Turbo machine: Euler turbo machinery equation 1.6 Component of Energy transfer in Turbo machine 1.7 Energy transfer in axial and radial flow machines 1.8 Degree of Reaction and Utilization factor 	8
<p>II. Marine Steam Turbines General Learning Objective: Understand design, construction and operation of steam turbines Specific Learning Objectives:</p> <ul style="list-style-type: none"> 2.1 Introduction and Classification of Steam Turbines: Construction and description of the individual parts (Rotor, diaphragm, casing, blades, labyrinth gland) 2.2 The guiding devices: Nozzle s with enlarged cross-section, Guide vanes, Nozzle efficiency 2.3 Steam turbine for marine industries 2.4 Axial Impulse Turbines: Description – De Laval Turbine, condition for maximum blade efficiency, stage efficiency, blade speed ratio, velocity triangles, axial thrust, Energy output and performance, efficiency, efficiency – blade speed ratio plot. 2.5 Axial Reaction Turbines: Description, velocity triangles, axial thrust, enthalpy - entropy diagram, Energy output and performance, efficiency, condition for maximum blade efficiency efficiency – blade speed ratio plot. 2.6 Compounding in Turbines: Need and methods of compounding, Multistage impulse turbine, Reaction turbine – Parsons turbine, reaction staging 2.7 Velocity compounding with axial turbines: Curti’s stage and Curtis Turbine, schematic and velocity triangles, Efficiency – blade speed ratio plots for single row, two row and three row of blades 2.8 Pressure compounding with axial turbines – Rateau Turbine, schematic for pressure – velocity variation across the turbine, h-s plot 2.9 Pressure velocity compounding with axial turbines – Curtis stages, illustration of schematic, pressure – velocity variation 2.10 Pressure compounding with Parson’s reaction turbine, schematic with pressure – velocity variation and relative velocity variation across the turbine, degree of reaction. 	20

<p>2.11 The losses in the steam turbines and the efficiencies: Nozzle losses, blade losses, exit losses, the wheel friction, loss by exhaust, Gland steam losses, pressure loss across labyrinth seals – pressure gradient, the mechanical losses, energy losses due to heat transfer, effect of wetness and elimination.</p>	
<p>III: Dimensional Analysis: Similitude for Turbo Machinery General learning objective: Analyse issues in matching compressor and turbine or compressor and diesel engine. Specific Learning Objectives:</p> <p>3.1-Dimensional analysis and performance laws 3.2 Buckingham’s π Theorem (Numerical) 3.3 Performance characteristics 3.4 Flow coefficient and stage loading 3.5 Specific speed 3.6 Contours of specific speed showing characteristics of various pump types 3.7 Range of specific speeds for various types of turbo-machines (plot only)</p>	10
<p>IV. Turbo-Compressor General learning objective: Understand design, construction and operation of Turbo-compressors Specific Learning Objectives:</p> <p>4.1 Centrifugal Compressor: General Equations; Velocity triangles and efficiencies; slip factor; Stanitz formulae; Effect of inlet Mach number; Losses in centrifugal compressor; Compressor characteristics, Surging and choking. 4.2 Stage loading and flow coefficients, stage pressure ratio, blade Mach number, stage efficiency 4.3 Axial flow compressor analysis – stage parameters – adiabatic efficiency, Geometry and velocity triangles, work done factor, enthalpy entropy diagram, exit swirl angle, stage loading and flow coefficients, degree of reaction, zero reaction, 50% reaction, Comparison of axial and centrifugal compressors.</p>	12
<p>V. Gas Turbines: General Learning Objective: Understand design, construction and operation of Gas Turbines. Specific Learning Objectives:</p> <p>5.1 Gas turbine working cycle and airflow, with plots of Temperature, Velocity, Mass flow rate along the length of the machine for various configuration, Classification of cycles and illustration of engines, structural arrangement, intercoolers and recuperators. Basic description of gas turbine and important components (Compressor, combustion chamber, turbine, nozzle, blade etc) 5.2 Combustion chambers, apportioning the airflow, flame tube cooling methods, types of combustion chambers 5.3 Turbines – triple stage single shaft, twin turbine, free power turbine, nozzle guide vanes, turbine blades - various, methods of attaching blades to turbine discs. 5.4 Blade materials & Blade cooling 5.5 Starting and ignition, methods of starting – electric, air, hydraulic, air starter motor 5.6 Noise suppression arrangement 5.7 Gas turbines for ship propulsion overview describing complete layout – general arrangement, air intake, exhaust uptake, environment ambient conditions and duct losses on performance, load requirements, service requirements, considerations. Gas turbine lubrication system layout. 5.8 Reduction gearing, starting and reversing, accessories – pumps and drives, fuel system, intake filters, inlet and exhaust silencers.</p>	10

Subject Name/Code: Marine Steam Engineering / UG11T5503

Instructional Hours:

Lecture : 45 hours
Tutorial : 15 hours

Total Contact hours : 60 hours

Credits : 4

Teaching Methods

The course shall be conducted in a combination of classroom lectures, case study analysis, writing assignments and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments) : 30 %

Final Exam : 70 %

Text Book:

1. Marine Steam Engineering for Marine Engineers, Reeds Volume 9. Thomas D Morton

Reference:

1. Resources from Spirax and Sarco on the relevant concepts
2. Marine Engineering – Editor: Roy L Harrington.
3. SNAME, T & R Bulletin, Marine Steam Power Plant Heat Balance Practices, United States.

Table of Topics

Unit	Topic	Hour (L)
I	Marine Steam systems and steam utilization, Steam Propulsion Plants	9
II	Steam system piping components ratings and specifications	13
III	Thermal oil systems, Condensate and Feed Systems	13
IV	Steam traps and steam trapping, Tracing steam lines and Insulation, De-superheating	11
V	Waste Heat Recovery Systems	14
Total		60

Learning Objectives	L
I. Marine Steam Systems and Steam Utilization: 1.1 Discuss various steam systems on board ships 1.2 Explain Heating systems 1.3 Explain Propulsion plant	3
II. Steam system piping components ratings and specifications 2.1 Explain with Examples of rating and sizing calculations for – 2.1.1 A steam heater 2.1.2 Steam demand for tank cleaning 2.1.3 Steam demand for Turbine 2.1.4 Steam flow for Waste Heat Extraction 2.2 Discuss Pipes and pipe sizing – standard sizes, pipeline standards for pressure service, pipeline sizing, allowances for fittings, allowances for thermal losses. 2.3 Explain Steam mains and drainage for - 2.3.1 Piping layout 2.3.2 Drain points 2.3.3 Water hammer and its effects 2.3.4 Branch lines and connections 2.4 Explain Stalling in heat exchangers and its effects 2.5 Explain Methods of preventing stall 2.6 Explain strainers	13
III. Thermal oil systems 3.1 Introduction to thermal oil systems 3.2 Explain Thermal oil properties, requirements, selection 3.3 Explain Controls and pipeline components of thermal oil systems 3.4 Explain Operation of thermal oil heater, 3.5 Explain Safety and environmental aspects of thermal oil use 3.6 Explain Process consumption – tank cleaning	8
IV. Condensate and Feed Systems: Specific Learning Objective: (IMO Model course 7.04 – 1.4.4) (IMO Model Course – 7.02 –1.1.4.1) 4.1 Describe Condensate and Drains System 4.2 Describe Layout of condensate return lines 4.3 Explain Drain lines to steam traps 4.4 Explain Common return lines – issues with temperature-controlled plant with steam traps	5

draining into flooded lines 4.5 Explain Sizing condensate return lines	
V. Steam traps and steam trapping: Specific Learning Objective: (IMO Model course 7.04 – 1.4.4) (IMO Model Course – 7.02 – 1.2.4, 1.3.3) 5.1 Explain Use of steam traps 5.2 Explain Types of steam traps – thermostatic steam traps, thermodynamic steam traps 5.3 Explain Considerations for selecting steam traps 5.4 Explain Testing and maintenance of steam traps	4
VI. Tracing steam lines and Insulation: Specific Learning Objective: (IMO Model Course – 7.02 – 1.2.4, 1.3.3) Explain the following: 6.1 Insulation of steam lines – materials, installation 6.2 Maintenance of insulation and minimizing losses 6.3 Tracing steam lines – layout 6.4 Tracing steam condensate return	3
VII. De-superheating: Specific Learning Objective: (IMO Model Course – 7.04 – 1.2.3, 1.2.4) Explain the following: 7.1 Basic de-superheating theory 7.2 Basic de superheater types	4
VIII. Waste Heat Recovery Systems: 8.1 Description of WHRS 8.2 Power concept and arrangement 8.3 Explain Waste Heat Recovery Systems 8.4 Steam Turbine Generator – WHRS 8.5 Other configurations 8.6 Single / Dual pressure steam systems 8.7 Thermodynamic concepts and steam generation from Main Engine Waste Heat – calculation 8.8 Acid formation – a limiting factor in WHRS?	14
IX. Steam Propulsion Plants: 9.1 Fundamentals of the steam propulsion plant (steam turbine), overview 9.2 The typical plant layout 9.3 Sample heat balance diagrams 9.4 Sample arrangement plans 9.5 Boiler performance curves	6

Subject Name/Code: Naval Architecture – Hydrostatics & Ship Stability/UG11T5504

Instructional hours:

Lecture	: 45 hours
Tutorial	: 15 hours

Total contact hours : 60 hours

Credits : 4

Teaching Methods

The course shall be conducted in a combination of classroom/online lectures and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments) : 30%

Final Exam : 70%

Text Book:

1. Naval Architecture, Reeds Volume 4, E. A. Stokoe, Bloomsbury.

Reference:

1. Gillmer, T. C., Johnson, B. Introduction to Naval Architecture. Netherlands: Island Press.
2. Barrass, B., Derrett, C. D. R. Ship Stability for Masters and Mates. United Kingdom: Elsevier Science
3. Safety practices related to small fishing vessel stability - <http://www.fao.org/3/i0625e/i0625e.pdf>.
4. Stability guide for smaller vessels – www.dma.dk.
5. Hull form and Geometry notes - <https://www.usna.edu>.
6. Dictionary of Ship Hydrodynamics - <https://ittc.info/media/1531/alphabetdictionary.pdf>.
7. Lewis, E. V. Principles of Naval Architecture: Stability and strength. United State: Society of Naval Architects and Marine Engineers.
8. Biran, A., Pulido, R. L. Ship Hydrostatics and Stability. Netherlands: Elsevier Science.
9. International Code on Intact Stability, United Kingdom: International Maritime Organization.

Table of Topics

Unit	Topics	Hour (L)
I	Geometry of Ship and Definitions Subtopics: Ship geometry, Definition of hull surface – coordinate systems, graphic description – Lines plan of ships, coefficients of form, Offsets and Offset table, Bonjean Curves.	6
II	Basic Ship Hydrostatics Subtopics: Density, relative density. Archimedes principle, Displacements, deadweight, meaning of buoyancy, reserve buoyancy. Ton per centimeter immersion (TPCI). Effect of change in density of water. FWA, DWA and Load line.	8
III	Numerical Integration in Naval Architecture Subtopics: Simpson's 1 st and 2 nd Rules for areas and volumes, 1 st moments and centroids, 2 nd moments of area (Area moment of Inertia), 5-8-1 & 3-10-1 rule for area, Use of half-spaced ordinates, Application to ship geometrical calculations	8
IV	Transverse Stability of the Ship Subtopics: Centre of Gravity & angle of List, Stability at small angles of heel, Stability at large angles of Heel, GZ Curve. The inclining experiment, Free Surface Affect. Angle of Loll	20
V	Longitudinal Stability and Trim Subtopics: Centre of Flotation, Longitudinal metacentre. Moment to change Trim (MCTC), change in trim due to small and large added masses. Change in draughts and trim due to change in density of water. True mean draught	8
VI	Flooding and Damage Stability, Stability during Dry-docking and during grounding, Stability requirements for vessels Subtopics: Assessment of ship conditions after flooding – Permeability, Lost Buoyancy or Added mass, change in mean draught due to bilging of amidships, side and endcompartments. Stability during Dry-docking and grounding Stability requirements for vessels Subtopic: IMO code of intact stability	10
	Total	60

Learning Objectives	L
I. Geometry of Ship and Definitions	
<p>General Learning Objective 1.1 Demonstrate understanding and application of concepts related to geometry of ship, coefficient of forms and lines plan drawing.</p> <p>Sub-topic: Lines plan drawing, Coefficient of Forms, Offset and offset table</p> <p>Sub-subtopics & SLOs</p> <ul style="list-style-type: none"> 1.1.1 Define and explain Lines plan drawing. 1.1.2 Define and explain Buttocks, waterlines, transverse section, Body plan, half breadth plan, profile view of ship. 1.1.3 Define and explain Offset and offset table. 1.1.4 Define, explain and utilize following form coefficients of ship in obtaining various principal parameters of ship 1.1.5 Block Coefficient, Prismatic coefficients, Midship coefficient, Water plane area coefficient 	6
II. Basic Ship Hydrostatics	
<p>General Learning Objective: 2.1 Demonstrate understanding and application of various hydrostatic parameters in Different density of water.</p> <p>Sub-topic: water Density, relative density. Archimedes principle, Displacements, deadweight, meaning of buoyancy, reserve buoyancy. Tonne per centimetre immersion (TPCI). Effect of change in density of water. FWA, DWA and Load line.</p> <p>Sub-sub topics & SLOs</p> <ul style="list-style-type: none"> 2.1.1 Define, explain and utilize Archimedes principle, Load Displacement, Lightship, deadweight, buoyancy, reserve buoyancy, 2.1.2 Effect of change of mass on draught - Tonnes per centimetre immersion, 2.1.3 FWA and DWA and Load line markings 2.1.4 Effect of change of density on draught 	8
III. Numerical Integration in Naval Architecture	
<p>General Learning Objective: 3.1 Demonstrate understanding and application of concepts related to Simpson's 1st and 2nd Rules for calculating various areas and underwater volume of ship.</p> <p>Sub topic: Simpson's 1st and 2nd Rules for areas and volumes. Application of Simpson's rules to calculate areas and volumes. Common areas such as water planes, sections and bulkheads, wetted surface area. Immersed volume of hull by sections and waterplanes. Bonjean curves and their use.</p> <p>Sub-sub topics & SLOs</p> <ul style="list-style-type: none"> 3.1.1 Define, explain and utilize Simpson's 1st and 2nd Rules to calculate areas such as water planes, sections and bulkheads, wetted surface area. 3.1.2 Define, explain and utilize Simpson's 1st and 2nd Rules to calculate immersed volume of hull by sections and waterplanes 3.1.3 Define, explain and utilize Bonjean curves to calculate geometric parameters of ship. 3.1.4 Utilize Simpson's 1st and 2nd Rules to calculate centroids of areas such as waterplanes, sections and bulkheads. 3.1.5 Utilize Simpson's 1st and 2nd Rules to calculate centroids of underwater volume such LCB and VCB. 3.1.6 Utilize Simpson's 1st and 2nd Rules to calculate 2nd moments of water plane area- Transverse moment of inertia, IT; Longitudinal moment of inertia, IL 	8

<p>IV. Transverse Stability of the Ship</p>	
<p>General Learning Objective: 4.1 Centre of Gravity & angle of List. Sub Topic: Longitudinal centre of gravity, Vertical centre of gravity, shift in centre of gravity due to the addition, removal or transfer of masses. Effect of suspended mass. Angle of List. Sub-sub topics & SLOs 4.1.1 Define and explain LCG, VCG and TCG, angle of list. 4.1.2 Determine the location of LCG, VCG, TCG and angle of list due to addition, removal and transfer of masses 4.1.3 Effect on these due to suspended masses.</p>	
<p>General Learning Objective: Understand, utilize and determine concepts related GM, BM, FSE and inclining experiment. Sub Topic: Conditions of equilibrium of floating bodies. Definition of stability, initial stability, meta-centric height, Righting arm at small angles of heel, calculation of BM, GM, Metacentric diagram, free surface effect. Inclining experiment. Sub-sub topics & SLOs 4.2.1 Define and explain the concepts of metacentre, metacentric height, metacentric radius and righting arm at small angles of heel. 4.2.2 Define and explain stable, unstable and neutral equilibrium condition for both floating and submerged bodies. 4.2.3 Deduce and utilize the expression for metacentric height, metacentric radius for the small angles of heel. 4.2.4 Explain Stiff ships and tender ships 4.2.5 Define and explain the metacentric diagram. 4.2.6 Define and explain the free surface effect. 4.2.7 Explain in detail and utilize the inclining experiment to find KG and GM of the lightship.</p>	20
<p>General Learning Objective: Demonstrate understanding and application of concepts related to stability at large angles of heel, angle of loll, KN curves and dynamical stability. Sub Topic: Definition of large angles of heel, Curve of Statical stability, Angle of loll, Cross curves of stability, KN Tables, Dynamical stability. Sub-sub topics & SLOs 4.3.1 Derive and explain the wall sided formula 4.3.2 Define and explain angle of loll and possible corrective actions 4.3.3 Explain complete stability using Attwood's formula 4.3.4 Explain the curve of statical stability (GZ curve) 4.3.5 Explain Cross curves of stability, KN curves, 4.3.6 Explain the effect of vertical shift of CG on GZ Curve 4.3.7 Explain the effect of transverse shift of CG on GZ Curve 4.3.8 Explain concept of dynamical stability</p>	
<p>V. Longitudinal Stability and Trim</p>	
<p>General Learning Objective: Demonstrate understanding and application of concepts related to longitudinal stability and trim. Sub Topic: Centre of Flotation, Longitudinal metacentre. moment to change Trim (MCTC), change in draughts due to small added masses Change in draught due to addition of small masses and large masses. Change in draughts and trim due to change in density of water. Sub-sub topics & SLOs 5.1.1 Define, explain and utilize centre of flotation, moment to change trim, MCTC and longitudinal metacentre for the calculation of trim, drafts at AP and FP due to addition, removal and shifting of weights 5.1.2 Effect of change in density on trim. 5.1.3 True mean draught 5.1.4 Effect of addition / removal of large masses on draught and trim- LCG method</p>	8

VI. Flooding and Damage Stability, Stability during Dry-docking and during grounding, Stability requirements for vessels	
<p>General Learning objective: Demonstrate understanding and application of concepts related to bilging of compartments.</p> <p>Sub Topic: Assessment of ship conditions after flooding – Permeability, Lost Buoyancy or Added mass, change in mean draught due to bilging of amidships, side and end compartments.</p> <p>Sub-Sub Topic & SLOs 6.1 Define, explain and utilize permeability, lost buoyancy method and added weight method for calculating drafts at AP and FP due to bilging of compartments located amidships and at the end for the rectangular barge.</p>	7
<p>General Learning objective: Demonstrate understanding and application of concepts related to stability during docking and grounding.</p> <p>Sub Topic: Stability during Dry-docking and stability during grounding: Stability when docking, Stability on grounding.</p> <p>Sub-Sub Topic & SLOs 6.2 Demonstrate understanding and application of concepts related to stability during docking and grounding.</p>	
<p>General Learning Objective: Understand stability requirements for vessels.</p> <p>6.3 Explain concepts related to IMO code of intact stability.</p> <p>Sub Topic: IMO code of intact stability.</p> <p>Sub-Sub Topic & SLOs 6.3.1 Explain concepts related to IMO code of intact stability- requirements for righting lever curve, wind heeling criteria, criteria for passenger ships, ship carrying cargo in bulk</p>	3

Subject Name/Code: Fuels and Lubricants / UG11T5505

Instructional Hours:

Lecture	: 45 hours
Tutorial	: 15 hours
Total Contact hours	: 60 hours
Credits	: 4

Teaching Methods

The course shall be conducted in a combination of classroom lectures, case study analysis, writing assignments and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments)	: 30 %
Final Exam	: 70 %

Text Book:

- 1) Fuels and Fuel Technology, Francis, W, Volume I & II
- 2) Fuels and Lubricants, M. Popovich and Haring, John Wiley & Sons.Inc

Reference:

- 1) A Practical Guide to Marine Fuel Oil Handling, Chris Jones, IMAREST Publication, IME
- 2) Alternate Fuels, Dr.S.S.Thipse, Jaico Publications
- 3) Elements of Fuels and Combustion, O.P. Gupta, Khanna Book Publishing Co.
- 4) Modern Petroleum Technology, Hobson, G.D. & Pohl. W
- 4) Lubrication-A Practical Guide to Lubricant Selection, A.R. Lansdown. Pergamon Press.
- 5) Lubrication. Raymond G. Gunther, Chipton Book C

Table of Topics

Unit	Topic	Hour (L)
I	<p>Properties and Testing of Fuels: Thermo-chemistry of fuels, properties and testing of fuels, relative density, calorific value, fire point, distillation, vapor pressure, flash point, spontaneous ignition, temperature, viscosity, pour point, flammability, ignitability, diesel index. API gravity, aniline point, Viscosity index etc. Additive – mechanism, requirements of an additive, diesel fuel additives specifications of fuels, diesel knock, Cetane rating, CCAI.</p>	15
II	<p>Low sulphur Diesel Fuel: Use of low sulphur fuel, current version of ISO 8217 -2017 fuel standards for marine distillates, Fuel stability, Low fuel viscosity, cooler in the fuel oil system, Lubricity-improvement additive for low sulphur diesel oil, Ultra-Low Sulphur Diesel (Ulsd) & Change Over Preparedness, Procedures of Change-Over HSFO to LSFO For Main Engine, Impacts on Piston-Cylinder of Main Engine Using LSFO, Impact of low sulphur content on engine operation, Impact of emission control area (ECA) on the ship operation, Impact of low sulphur fuel oil on diesel engine, Use of low BN cylinder oil for low Sulphur fuel Change over procedures, Bunker management and bunker requirements, The importance of correct labelling of bunker, The importance of an efficient fuel oil treatment system.</p>	10
III	<p>Alternate Fuels: Need for alternate fuels, availability & their properties, general use of alcohols, Use of alternate fuel in engines- vegetable oils, biodiesel & biogas. Merits & demerits of alternate fuels. Introduction to gaseous fuels such as LPG, CNG, LNG, hydrogen, ammonia and Methanol- LNG as a marine fuel, Advantages, LNG storage tanks, Likelihood of LNG releases, Storage and handling requirements -LNG & Hydrogen. Safety norms. Introduction to PEM fuel cell- construction and its working.</p>	15
IV	<p>Properties and Testing of Lubricants: Types of lubricants, Classification of lubricating oils, properties of lubricating oils, Specific requirements for Marine lubricants, grades of lubricating oils and their designation, viscosity, factors affecting viscosity and viscosity index, Oxidation, deterioration and degradation of lubricants, additives in lubricant, tests on lubricants. Synthetic lubricants- merits & demerits Grease, types of greases, lubrication of bearings and latest developments- Ultra Sound Assisted Lubrication, Introduction to air lubrication.</p>	10
V	<p>Theory of Lubricants: Engine friction – introduction, effect of engine variables on friction. Friction-speed characteristics in regard to lubrication, Hydrodynamic lubrication of lip seal etc. Fuel Dilution in Lubricating Oils and their avoidance, methods available etc. Recent developments in tribology</p>	10
Total		60

Learning Objectives	L
I. Properties & Testing of Fuels	15
<p>General Learning Objective: To understand the thermo-chemistry, properties, testing methods, and additives of various fuels, including parameters such as relative density, calorific value, fire point, and more. Additionally, to comprehend the mechanisms, requirements, and specifications of fuel additives, and concepts like diesel knock, Cetane rating, and CCAI.</p>	
<p>1.1 Thermo-Chemistry of Fuels: 1.1.1 Understand the basic principles of the thermo-chemistry of fuels. 1.1.2 Explain the chemical composition and reactions involved in fuel combustion. 1.1.3 Chemical Composition and Reactions: 1.1.4 Combustion Reactions: Understand the basic combustion reactions of hydrocarbons in fuels. 1.1.5 Energy Release: Explain the processes of energy release during fuel combustion.</p>	
<p>1.2 Properties and Testing of Fuels: 1.2.1 Relative Density: Define and measure the relative density of different fuels. 1.2.2 Calorific Value: Explain the significance of calorific value and methods to determine it. 1.2.3 Fire Point and Flash Point: Understand the concepts of fire point and flash point and their testing methods. 1.2.4 Distillation and Vapor Pressure: Describe distillation processes and vapor pressure measurements. 1.2.5 Spontaneous Ignition Temperature: Define and determine the spontaneous ignition temperature of fuels. 1.2.6 Viscosity and Viscosity Index: Explain the importance of viscosity and methods for measuring viscosity and viscosity index. 1.2.7 Pour Point: Understand the concept of pour point and its significance in fuel handling. 1.2.8 Flammability and Ignitability: Define and test the flammability and ignitability of fuels. 1.2.9 Diesel Index and Cetane Rating: Explain the diesel index and Cetane rating, and their importance in diesel fuel performance. 1.2.10 API Gravity and Aniline Point: Describe the significance of API gravity and aniline point in fuel testing. 1.2.11 Relative Density: 1.2.12 Measurement Techniques: Learn the methods to measure the relative density of fuels and their significance. 1.2.13 Calorific Value: 1.2.14 High and Low Calorific Values: Differentiate between high calorific value (HCV) and low calorific value (LCV). 1.2.15 Bomb Calorimeter: Understand the use of a bomb calorimeter to determine the calorific value of fuels. 1.2.16 Fire Point and Flash Point: 1.2.17 Definitions and Importance: Define fire point and flash point and their importance in fuel safety. 1.2.18 Testing Methods: Learn the standard methods for testing fire point and flash point (e.g., Pensky-Marten's apparatus). 1.2.19 Distillation and Vapor Pressure: 1.2.20 Distillation Process: Describe the distillation process and its role in separating fuel components. 1.2.21 Vapor Pressure Measurement: Understand the methods to measure vapor pressure and its significance in fuel volatility.</p>	

<p>1.2.22 Spontaneous Ignition Temperature:</p> <p>1.2.23 Concept and Measurement: Define spontaneous ignition temperature and learn how it is measured.</p> <p>1.2.24 Viscosity and Viscosity Index:</p> <p>1.2.25 Measurement Techniques: Understand how to measure the viscosity of fuels using viscometers.</p> <p>1.2.26 Viscosity Index: Explain the concept of viscosity index and its importance in assessing fuel behavior at different temperatures.</p> <p>1.2.27 Pour Point:</p> <p>1.2.28 Definition and Importance: Define pour point and explain its significance in cold weather fuel performance.</p> <p>1.2.29 Testing Methods: Learn the standard testing methods for determining the pour point.</p> <p>1.2.30 Flammability and Ignitability:</p> <p>1.2.31 Testing Methods: Understand the methods used to test the flammability and ignitability of fuels.</p> <p>1.2.32 Diesel Index and Cetane Rating:</p> <p>1.2.33 Definitions and Measurements: Define diesel index and Cetane rating, and understand how they are measured.</p> <p>1.2.34 Importance in Diesel Performance: Explain the importance of diesel index and Cetane rating in evaluating diesel fuel performance.</p> <p>1.2.35 API Gravity and Aniline Point:</p> <p>1.2.36 Significance in Fuel Testing: Describe the significance of API gravity and aniline point in determining fuel characteristics.</p> <p>1.2.37 Measurement Techniques: Learn the techniques used to measure API gravity and aniline point.</p>	
<p>1.3 Additives in Fuels:</p> <p>1.3.1 Mechanism and Requirements: Understand the mechanism of action and requirements for effective fuel additives.</p> <p>1.3.2 Diesel Fuel Additives: Identify various diesel fuel additives and their functions.</p> <p>1.3.3 Specifications of Fuels: Explain the specifications of fuels with additives and their impact on fuel performance.</p> <p>1.3.4 Diesel Knock and CCAI: Describe the phenomenon of diesel knock and the calculation of CCAI (Calculated Carbon Aromaticity Index).</p> <p>1.3.5 Mechanism and Requirements:</p> <p>1.3.6 Functionality of Additives: Understand how additives improve fuel properties and performance.</p> <p>1.3.7 Requirements for Effective Additives: Identify the key requirements for fuel additives to be effective.</p> <p>1.3.8 Diesel Fuel Additives:</p> <p>1.3.9 Types and Functions: Identify different types of diesel fuel additives and their specific functions.</p> <p>1.3.10 Impact on Fuel Performance: Explain how additives enhance fuel performance and address issues like diesel knock.</p> <p>1.3.11 Specifications of Fuels: Standards and Regulations: Understand the specifications and regulatory standards for fuels with additives. Diesel Knock and CCAI:</p> <p>1.3.12 Diesel Knock: Describe the causes and effects of diesel knock.</p> <p>1.3.13 Calculated Carbon Aromaticity Index (CCAI): Learn how to calculate and interpret the CCAI and its relevance to diesel fuel quality.</p>	
<p>1.4 Examples and Case Studies:</p> <p>1.4.1 Practical Problems:</p> <p>1.4.2 Solve practical problems related to fuel properties, testing methods, and additive usage.</p> <p>Case Studies:</p> <p>1.4.3 Analyze case studies of fuel performance and issues to understand best practices and lessons learned.</p>	

II. Low Sulphur Diesel Fuel	10
<p>General Learning Objective: To understand the properties, standards, and implications of using low sulphur diesel fuels (LSDF) in marine engines. This includes the transition to low sulphur fuels, fuel stability, and the impact on engine operation and maintenance within emission control areas (ECAs).</p>	
<p>2.1 Low Sulphur Diesel Fuel (LSDF): 2.1.1 Understand the composition and benefits of low sulphur diesel fuel. 2.1.2 Discuss the environmental and operational advantages of using LSDF. 2.1.3 Composition and Benefits: Composition: Understand the chemical composition of LSDF. Environmental and Operational Benefits: Discuss the reduction in sulphur emissions and improved air quality due to LSDF use. Explain operational benefits such as reduced engine wear and maintenance.</p>	
<p>2.2 ISO 8217:2017 Fuel Standards for Marine Distillates: 2.2.1 Explain the current version of ISO 8217:2017 fuel standards. 2.2.2 Identify the specific requirements for marine distillates under these standards. 2.2.3 Requirements and Standards: 2.2.4 ISO 8217:2017 Overview: Learn the key specifications and requirements for marine distillates as per ISO 8217:2017. 2.2.5 Compliance: Discuss how to ensure compliance with these standards.</p>	
<p>2.3 Fuel Stability: 2.3.1 Define fuel stability and its importance in marine operations. 2.3.2 Discuss factors affecting fuel stability and methods to ensure stable fuel quality 2.3.3 Importance and Methods: 2.3.4 Definition and Factors: Define fuel stability and discuss factors affecting it such as oxidation and contamination. 2.3.5 Ensuring Stability: Learn methods to maintain fuel stability, including proper storage and treatment.</p>	
<p>2.4 Low Fuel Viscosity: 2.4.1 Understand the implications of low fuel viscosity in marine engines. 2.4.2 Discuss the necessity and functioning of coolers in the fuel oil system. 2.4.3 Implications and Solutions: 2.4.4 Impact on Engines: Discuss how low viscosity affects fuel injection and combustion. 2.4.5 Fuel Oil System Coolers: Explain the role of coolers in maintaining appropriate fuel viscosity.</p>	
<p>2.5 Lubricity-Improvement Additive for Low Sulphur Diesel Oil: 2.5.1 Explain the need for lubricity-improvement additives in LSDF. 2.5.2 Identify common additives and their impact on engine performance. 2.5.3 Additives and Engine Performance: 2.5.4 Need for Additives: Understand why LSDF may require lubricity-improvement additives. 2.5.5 Common Additives: Identify common additives used and their benefits.</p>	
<p>2.6 Ultra-Low Sulphur Diesel (ULSD) & Change Over Preparedness: 2.6.1 Understand the characteristics and benefits of ULSD. 2.6.2 Discuss the procedures and precautions for changing over from high sulphur fuel oil (HSFO) to LSDF or ULSD. 2.6.3 Characteristics and Change Over: 2.6.4 Characteristics of ULSD: 2.6.5 Discuss the properties and advantages of ULSD. 2.6.6 Change Over Procedures: Learn the necessary steps for transitioning to ULSD, including tank cleaning and fuel system preparation.</p>	
<p>2.7 Procedures of Change-Over from HSFO to LSFO for Main Engine: 2.7.1 Explain the detailed steps and considerations for changing over from HSFO to LSFO. 2.7.2 Identify potential challenges and solutions during the change-over process. 2.7.3 Steps and Challenges:</p>	

<p>2.7.4 Change-Over from HSFO to LSFO: Understand the detailed procedures for changing from HSFO to LSFO.</p> <p>2.7.5 Potential Challenges: Identify and address challenges such as fuel compatibility and system flushing.</p>	
<p>2.8 Impacts on Piston-Cylinder of Main Engine Using LSFO: 2.8.1 Discuss the effects of using LSFO on the piston-cylinder assembly. 2.8.2 Identify measures to mitigate negative impacts.</p> <p>2.8.3 Effects and Mitigation:</p> <p>2.8.4 Impact on Engine Components: Discuss the specific effects of LSFO on the piston-cylinder assembly.</p> <p>2.8.5 Mitigation Strategies: Learn strategies to mitigate negative impacts, including proper lubrication and maintenance practices.</p>	
<p>2.9 Impact of Low Sulphur Content on Engine Operation: 2.9.1 Explain how low sulphur content affects engine performance and maintenance. 2.9.2 Discuss necessary adjustments in engine operation for optimal performance. 2.9.3 Adjustments and Best Practices:</p> <p>2.9.4 Operational Adjustments: Understand necessary adjustments in engine settings and operations when using LSDF.</p> <p>2.9.5 Maintenance Practices: Learn best practices for maintenance to ensure engine longevity and performance with LSDF.</p>	
<p>2.10 Impact of Emission Control Area (ECA) on Ship Operation: 2.10.1 Understand the regulations and requirements within ECAs. 2.10.2 Discuss the operational adjustments and compliance strategies for ships operating in ECAs.</p> <p>2.10.3 Regulations and Compliance:</p> <p>2.10.4 ECA Regulations: Understand the specific regulations within ECAs.</p> <p>2.10.5 Operational Strategies: Discuss strategies for compliance and optimal operation within ECAs.</p>	
<p>2.11 Impact of Low Sulphur Fuel Oil on Diesel Engine: 2.11.1 Analyze the overall impact of LSFO on diesel engine efficiency and longevity. 2.11.2 Discuss best practices for using LSFO in marine diesel engines. 2.11.3 Efficiency and Longevity:</p> <p>2.11.4 Performance Impact: Analyze how LSFO affects diesel engine performance.</p> <p>2.11.5 Best Practices: Learn best practices for using LSFO to ensure efficient and long-lasting engine operation.</p>	
<p>2.12 Use of Low BN Cylinder Oil for Low Sulphur Fuel: 2.12.1 Understand the importance of using low Base Number (BN) cylinder oil with LSFO. 2.12.2 Discuss the change-over procedures and benefits of using low BN cylinder oil. 2.12.3 Use and Benefits:</p> <p>2.12.4 Importance of Low BN Oil: Understand why low BN cylinder oil is necessary for LSFO.</p> <p>2.12.5 Change Over Procedures: Discuss the steps for changing to low BN cylinder oil.</p>	
<p>2.13 Bunker Management and Bunker Requirements: 2.13.1 Explain the importance of effective bunker management. 2.13.2 Discuss the requirements and best practices for bunkering operations. 2.13.3 Effective Management:</p> <p>2.13.4 Bunker Operations: Learn the requirements and best practices for effective bunker management.</p> <p>2.13.5 Documentation and Monitoring: Understand the importance of accurate documentation and continuous monitoring.</p>	
<p>2.14 Importance of Correct Labelling of Bunker: 2.14.1 Understand the significance of proper labelling of bunker fuel. 2.14.2 Discuss the potential risks of incorrect labelling and how to avoid them. 2.14.3 Risks and Prevention:</p> <p>2.14.4 Importance of Labelling: Explain why correct labelling is crucial for bunker fuel.</p> <p>2.14.5 Prevention of Risks:</p>	

Discuss methods to prevent risks associated with incorrect labelling.	
<p>2.15 Importance of an Efficient Fuel Oil Treatment System:</p> <p>2.15.1 Explain the role and importance of a fuel oil treatment system.</p> <p>2.15.2 Discuss the components and operation of an efficient fuel oil treatment system</p> <p>2.15.3 System Components and Operation:</p> <p>2.15.4 Components: Identify the key components of a fuel oil treatment system.</p> <p>2.15.5 Efficient Operation: Discuss how to operate and maintain an efficient fuel oil treatment system.</p>	
<p>2.16 Practical Problems:</p> <p>2.16.1 Solve practical problems related to fuel properties, change-over procedures, and engine performance.</p> <p>Case Studies:</p> <p>2.16.2 Analyze case studies on the impact of LSDF and management practices to understand real-world applications and solutions.</p>	
III. Alternate Fuels	15
<p>General Learning Objective: To understand the necessity, properties, applications, and safety considerations of alternate fuels for marine engines, including alcohols, vegetable oils, biodiesel, biogas, and various gaseous fuels such as LPG, CNG, LNG, hydrogen, ammonia, and methanol. Additionally, to learn about the use of PEM fuel cells in marine applications.</p>	
<p>3.1 Need for Alternate Fuels:</p> <p>3.1.1 Explain the environmental and economic reasons driving the need for alternate fuels in marine applications.</p> <p>3.1.2 Discuss the regulatory pressures and sustainability goals influencing the shift towards alternate fuels.</p> <p>3.1.3 Environmental and Economic Drivers:</p> <p>3.1.4 Environmental Impact: Understand the environmental benefits of alternate fuels in reducing greenhouse gas emissions and pollution.</p> <p>3.1.5 Economic Factors: Discuss the economic incentives and long-term cost benefits of transitioning to alternate fuels.</p> <p>3.1.6 Regulatory Pressures and Sustainability Goals:</p> <p>3.1.7 International Regulations: Identify key international regulations, such as IMO's MARPOL Annex VI, that mandate the use of cleaner fuels.</p> <p>3.1.8 Sustainability Goals: Understand the role of alternate fuels in achieving global sustainability targets.</p>	
<p>3.2 Availability and Properties of Alternate Fuels:</p> <p>3.2.1 Identify the sources and availability of various alternate fuels.</p> <p>3.2.2 Describe the physical and chemical properties of these fuels and how they compare to conventional fuels.</p> <p>3.2.3 Sources and Properties:</p> <p>3.2.4 Sources of Alternative Fuels: Identify various sources of alternative fuels, including biomass, natural gas, and renewable resources.</p> <p>3.2.5 Properties Comparison: Compare the calorific value, density, viscosity, and emission characteristics of alternate fuels with conventional fuels.</p>	
<p>3.2.6 General Use of Alcohols as Fuels: Understand the general characteristics and combustion properties of alcohols such as methanol and ethanol.</p> <p>3.2.7 Discuss the advantages and challenges of using alcohols as marine fuels.</p> <p>3.2.8 Characteristics and Combustion Properties:</p> <p>3.2.9 Methanol and Ethanol: Describe the characteristics and combustion properties of methanol and ethanol.</p> <p>3.2.10 Advantages and Challenges: Discuss the benefits, such as lower emissions, and challenges, such as corrosion and lower energy density, associated with alcohol fuels.</p>	

<p>3.3 Use of Vegetable Oils and Biodiesel in Engines:</p> <p>3.3.1 Explain the process of producing biodiesel from vegetable oils.</p> <p>3.3.2 Discuss the performance, emission characteristics, and engine compatibility of vegetable oils and biodiesel.</p> <p>3.3.3 Production and Performance:</p> <p>3.3.4 Biodiesel Production: Explain the process of transesterification to produce biodiesel from vegetable oils.</p> <p>3.3.5 Engine Compatibility: Discuss the modifications required for marine engines to use biodiesel and the impact on engine performance and emissions.</p>	
<p>3.4 Biogas as an Alternate Fuel:</p> <p>3.4.1 Describe the production and properties of biogas.</p> <p>3.4.2 Discuss the use of biogas in marine engines, including benefits and limitations.</p> <p>3.4.3 Production and Use:</p> <p>3.4.4 Biogas Production: Describe the anaerobic digestion process for producing biogas.</p> <p>3.4.5 Marine Engine Use: Discuss the feasibility and benefits of using biogas in marine engines.</p>	
<p>3.5 Merits and Demerits of Alternate Fuels:</p> <p>3.5.1 Evaluate the advantages and disadvantages of various alternative fuels in terms of environmental impact, engine performance, cost, and availability.</p> <p>3.5.2 Evaluation:</p> <p>3.5.3 Advantages:</p> <p>3.5.4 List the environmental and operational benefits of alternate fuels.</p> <p>3.5.5 Disadvantages:</p> <p>3.5.6 Discuss the limitations and challenges, such as storage requirements and energy density, associated with alternate fuels.</p>	
<p>3.6 LPG, CNG, LNG, Hydrogen, Ammonia, Methanol:</p> <p>3.6.1 Describe the properties, storage requirements, and safety considerations for LPG, CNG, LNG, hydrogen, ammonia, and methanol.</p> <p>3.6.2 LNG as a Marine Fuel:</p> <p>3.6.3 Discuss the advantages of LNG over other marine fuels.</p> <p>3.6.4 Explain the storage and handling requirements for LNG, including the design and safety features of LNG storage tanks.</p> <p>3.6.5 Describe the potential hazards and mitigation strategies for LNG releases.</p> <p>3.6.6 Storage and Handling of LNG and Hydrogen:</p> <p>3.6.7 Discuss the specific storage and handling requirements for LNG and hydrogen.</p> <p>3.6.8 Understand the safety protocols and equipment necessary to manage these fuels on board ships.</p> <p>3.6.9 Properties and Safety:</p> <p>3.6.10 LPG, CNG, LNG, Hydrogen, Ammonia, Methanol:</p> <p>3.6.11 Describe the properties, benefits, and challenges of each gaseous fuel.</p> <p>3.6.12 LNG as a Marine Fuel: Discuss the advantages of LNG, such as lower emissions and cost-effectiveness. Explain the design and safety features of LNG storage tanks and the procedures for handling LNG safely.</p> <p>3.6.13 Storage and Handling:</p> <p>3.6.14 LNG and Hydrogen: Understand the specific storage and handling requirements for LNG and hydrogen, including cryogenic storage and pressure management.</p>	
<p>3.7 Safety Norms for Alternate Fuels:</p> <p>3.7.1 Identify the international safety standards and regulations for the use of alternate fuels on ships.</p> <p>3.7.2 Discuss the safety measures required during the storage, handling, and usage of alternate fuels to prevent accidents and ensure crew safety.</p> <p>3.7.3 Safety Protocols:</p> <p>3.7.4 Discuss the safety measures necessary for storing and handling these fuels on board ships.</p> <p>3.7.5 Safety Norms</p> <p>3.7.6 International Safety Standards:</p> <p>3.7.7 Safety Regulations:</p> <p>3.7.8 Identify international safety regulations governing the use of alternate fuels.</p>	

<p>3.7.9 Preventive Measures: 3.7.10 Discuss preventive measures to ensure safe storage, handling, and usage of alternate fuels.</p>	
<p>3.8 Introduction to PEM Fuel Cell: 3.8.1 Explain the construction and working principle of Proton Exchange Membrane (PEM) fuel cells. 3.8.2 Discuss the application of PEM fuel cells in marine environments, including their benefits and limitations. 3.8.3 Construction and Working: 3.8.4 PEM Fuel Cell: 3.8.5 Explain the construction and operating principle of PEM fuel cells. 3.8.6 Marine Applications: 3.8.7 Discuss the potential applications, benefits, and limitations of using PEM fuel cells in marine environments. 3.8.8 Case Studies and Examples:</p>	
<p>IV. Properties and Testing of Lubricants</p>	10
<p>General Learning Objective: To understand the types, properties, and testing methods of lubricants, with a focus on marine lubricants, including the use of additives, synthetic lubricants, greases, and advanced lubrication techniques.</p>	
<p>4.1 Types of Lubricants: 4.1.1 Differentiate between various types of lubricants, including mineral oils, synthetic oils, and greases. 4.1.2 Understand the applications and characteristics of each type of lubricant. 4.1.3 Differentiation and Applications: 4.1.4 Mineral Oils: 4.1.5 Describe the sources and properties of mineral oils. 4.1.6 Explain their common applications in marine engines. 4.1.7 Synthetic Oils: 4.1.8 Discuss the types and properties of synthetic oils. 4.1.9 Compare synthetic oils to mineral oils in terms of performance and cost. 4.1.10 Greases: Understand the composition and types of greases. 4.1.11 Explain their specific applications in marine machinery.</p>	
<p>4.2 Classification of Lubricating Oils: 4.2.1 Classify lubricating oils based on their source, composition, and application. 4.2.2 Explain the specific requirements for marine lubricants and the standards they must meet. 4.2.3 Classification Criteria: 4.2.4 Source and Composition: 4.2.5 Classify lubricating oils based on their origin (mineral, synthetic, bio-based). 4.2.6 Application: 4.2.7 Explain the classification based on applications (engine oils, hydraulic oils, gear oils). 4.2.8 Marine Lubricants: Discuss the specific requirements for marine lubricants, including resistance to water washout and high load carrying capacity.</p>	
<p>4.3 Properties of Lubricating Oils: Describe key properties of lubricating oils such as viscosity, viscosity index, pour point, flash point, and thermal stability. 4.3.1 Understand how these properties affect lubricant performance in marine environments. 4.3.2 Key Properties: 4.3.3 Viscosity: 4.3.4 Define viscosity and its significance in lubrication. 4.3.5 Viscosity Index: 4.3.6 Explain the viscosity index and its role in assessing oil stability over temperature changes. 4.3.7 Pour Point and Flash Point: 4.3.8 Understand the importance of pour point and flash point in evaluating lubricants for low and high-temperature performance. 4.3.9 Thermal Stability: 4.3.10 Discuss the significance of thermal stability in preventing oil breakdown at high temperature</p>	
<p>4.4 Grades of Lubricating Oils and Their Designation: 4.4.1 Identify the different grades of lubricating oils and their designation according to international standards. 4.4.2 Understand how to select the appropriate grade of oil for specific marine applications.</p>	

<p>4.4.3 International Standards:</p> <p>4.4.4 Designation Systems: Identify the different grading systems (e.g., SAE, ISO) and their significance.</p> <p>4.4.5 Selecting Grades: Explain how to select the appropriate grade of oil for different marine applications based on these designations.</p>	
<p>4.5 Viscosity and Viscosity Index:</p> <p>4.5.1 Explain the concept of viscosity and its importance in lubrication.</p> <p>4.5.2 Understand the factors affecting viscosity and the significance of the viscosity index in evaluating lubricant performance.</p> <p>4.5.3 Concept and Factors:</p> <p>4.5.4 Viscosity Measurement:</p> <p>4.5.5 Describe how viscosity is measured and the units used.</p> <p>4.5.6 Factors Affecting Viscosity:</p> <p>4.5.7 Discuss factors such as temperature, pressure, and contamination that can affect oil viscosity.</p> <p>4.5.8 Viscosity Index Importance: Explain how the viscosity index helps predict the oil's performance over varying temperatures.</p>	
<p>4.6 Oxidation, Deterioration, and Degradation of Lubricants:</p> <p>4.6.1 Discuss the chemical processes that lead to the oxidation, deterioration, and degradation of lubricants.</p> <p>4.6.2 Understand the impact of these processes on lubricant effectiveness and machinery protection.</p> <p>4.6.3 Chemical Processes and Impact:</p> <p>4.6.4 Oxidation:</p> <p>4.6.5 Discuss the oxidation process and how it affects lubricant performance.</p> <p>4.6.6 Deterioration and Degradation:</p> <p>4.6.7 Explain the causes and consequences of lubricant deterioration and degradation.</p>	
<p>4.7 Additives in Lubricants:</p> <p>4.7.1 Identify common additives used in lubricants, such as anti-wear agents, antioxidants, and detergents.</p> <p>4.7.2 Explain the purpose of each type of additive and how they enhance lubricant performance.</p> <p>4.7.3 Types and Functions:</p> <p>4.7.4 Anti-Wear Agents:</p> <p>4.7.5 Explain the role of anti-wear agents in protecting engine parts.</p> <p>4.7.6 Antioxidants:</p> <p>4.7.7 Discuss how antioxidants prevent oil oxidation.</p> <p>4.7.8 Detergents and Dispersants:</p> <p>4.7.9 Describe how detergents and dispersants keep engine parts clean by preventing deposit formation.</p>	
<p>4.8 Testing of Lubricants:</p> <p>4.8.1 Describe the various tests conducted on lubricants to evaluate their properties and performance, including viscosity measurement, oxidation stability, and wear tests.</p> <p>4.8.2 Understand the importance of these tests in ensuring lubricant quality and suitability for marine applications.</p> <p>4.8.3 Evaluation Tests:</p> <p>4.8.4 Viscosity Tests:</p> <p>4.8.5 Describe tests used to measure oil viscosity.</p> <p>4.8.6 Oxidation Stability Tests:</p> <p>4.8.7 Explain methods to test oxidation stability of lubricants.</p> <p>4.8.8 Wear Tests:</p> <p>4.8.9 Discuss tests used to evaluate the anti-wear properties of lubricants.</p>	
<p>4.9 Synthetic Lubricants:</p> <p>4.9.1 Discuss the merits and demerits of synthetic lubricants compared to mineral oils.</p> <p>4.9.2 Understand the applications and benefits of synthetic lubricants in marine engines and machinery.</p> <p>4.9.3 Merits and Demerits:</p> <p>4.9.4 Advantages:</p> <p>4.9.5 List the benefits of synthetic lubricants, such as higher thermal stability and longer life.</p> <p>4.9.6 Disadvantages:</p> <p>4.9.7 Discuss the drawbacks, including higher cost and potential compatibility issues.</p>	

<p>4.10 Grease and Types of Greases:</p> <p>4.10.1 Differentiate between various types of greases based on their thickening agents and applications.</p> <p>4.10.2 Explain the importance of grease in the lubrication of bearings and other components.</p> <p>4.10.3 Composition and Applications:</p> <p>4.10.4 Thickening Agents: Describe different thickening agents used in greases (e.g., lithium, calcium).</p> <p>4.10.5 Applications: Explain the specific uses of different types of greases in marine applications.</p>	
<p>4.11 Lubrication of Bearings:</p> <p>4.11.1 Understand the principles and methods of bearing lubrication.</p> <p>4.11.2 Discuss the latest developments in bearing lubrication, including Ultra Sound Assisted Lubrication and air lubrication.</p> <p>4.11.3 Principles and Methods:</p> <p>4.11.4 Bearing Lubrication:</p> <p>4.11.5 Discuss the importance of proper bearing lubrication and methods used.</p>	
<p>4.12 Advanced Lubrication Techniques:</p> <p>4.12.1 Ultra Sound Assisted Lubrication:</p> <p>4.12.2 Explain the concept and benefits of Ultra Sound Assisted Lubrication.</p> <p>4.12.3 Air Lubrication: Introduce the principles and applications of air lubrication in marine environments.</p> <p>4.12.4 Advanced Techniques:</p> <p>4.12.5 Ultra Sound Assisted Lubrication:</p> <p>4.12.6 Explain how Ultra Sound Assisted Lubrication works and its benefits.</p> <p>4.12.7 Air Lubrication:</p> <p>4.12.8 Describe the principles and applications of air lubrication in marine environments.</p>	
<p>V. Theory of Lubricants</p>	10
<p>General Learning Objective: To understand the theory of lubricants, focusing on engine friction, lubrication methods, fuel dilution issues, and recent developments in tribology.</p>	
<p>5.1 Engine Friction:</p> <p>5.1.1 Understand the basic principles of engine friction.</p> <p>5.1.2 Explore the effect of engine variables on friction and lubrication.</p> <p>5.1.3 Introduction to Engine Friction:</p> <p>5.1.4 Basic Principles:</p> <p>5.1.5 Define friction and its significance in engine operation.</p> <p>5.1.6 Explain how friction affects engine performance and efficiency.</p> <p>5.1.7 Sources of Friction:</p> <p>5.1.8 Identify the major sources of friction within an engine (e.g., pistons, bearings, seals).</p>	
<p>5.2 Friction-Speed Characteristics:</p> <p>5.2.1 Analyze the relationship between friction and speed in lubrication.</p> <p>5.2.2 Understand hydrodynamic lubrication and its applications, including lip seals.</p> <p>5.2.3 Effect of Engine Variables on Friction:</p> <p>5.2.4 Temperature: Understand how temperature variations impact friction and lubrication.</p> <p>5.2.5 Load: Discuss the effect of different loads on friction levels within the engine.</p> <p>5.2.6 Speed: Explain how engine speed influences friction and lubrication effectiveness.</p> <p>5.2.7 Hydrodynamic Lubrication: Principles of Hydrodynamic Lubrication: Define hydrodynamic lubrication and explain its mechanism. Understand the conditions required for hydrodynamic lubrication to occur.</p> <p>5.2.8 Applications: Explore the use of hydrodynamic lubrication in engine components, particularly in lip seals.</p> <p>5.2.9 Friction-Speed Relationship: Analyze the relationship between friction and speed in hydrodynamic lubrication. Understand the impact of speed variations on lubrication film thickness and friction levels.</p>	

<p>5.3 Fuel Dilution in Lubricating Oils:</p> <p>5.3.1 Identify causes and consequences of fuel dilution in lubricating oils.</p> <p>5.3.2 Learn methods to avoid fuel dilution and maintain oil integrity.</p> <p>5.3.3 Causes and Consequences of Fuel Dilution:</p> <p>5.3.4 Sources of Fuel Dilution: Identify the primary sources of fuel dilution in lubricating oils.</p> <p>5.3.5 Impact on Lubrication: Discuss the adverse effects of fuel dilution on lubricating oil properties and engine performance.</p> <p>5.3.6 Detection Methods: Explore methods to detect fuel dilution in lubricating oils.</p> <p>5.3.7 Methods to Avoid Fuel Dilution:</p> <p>5.3.8 Preventative Measures: Discuss strategies to prevent fuel dilution in lubricating systems.</p> <p>5.3.9 Oil Formulation: Explain how specific oil formulations can minimize the risk of fuel dilution.</p> <p>5.3.10 Maintenance Practices: Outline maintenance practices that help avoid fuel dilution in engines.</p>	
<p>5.4 Recent Developments in Tribology:</p> <p>5.4.1 Explore recent advancements and innovations in the field of tribology.</p> <p>5.4.2 Understand their implications for lubrication and engine performance.</p> <p>5.4.3 Advancements in Tribology:</p> <p>5.4.4 New Lubricant Formulations:</p> <p>5.4.5 Explore recent developments in lubricant formulations designed to enhance performance and reduce friction.</p> <p>5.4.6 Surface Engineering:</p> <p>5.4.7 Understand how surface treatments and coatings contribute to improved tribological performance.</p> <p>5.4.8 Nano-lubricants: Discuss the role of nano-lubricants and their impact on reducing friction and wear.</p> <p>5.4.9 Advanced Testing Methods: Explore new methods and technologies for testing and evaluating tribological properties of materials and lubricants.</p>	
<p>5.5 Practical Applications and Problem-Solving</p> <p>5.5.1 Case Studies and Examples:</p> <p>5.5.2 Real-World Scenarios:</p> <p>5.5.3 Analyze case studies on the impact of engine friction and lubrication in various applications.</p> <p>5.5.4 Problem-Solving: Solve practical problems related to friction, lubrication, and fuel dilution in engines.</p>	

Subject Name/Code: Digital Electronics and PLC / UG11T5506

Instructional Hours:

Lecture	: 45 hours
Tutorial	: 15 hours
Total Contact hours	: 60 hours
Credits	: 4

Teaching Methods

The course shall be conducted in a combination of classroom lectures, case study analysis, writing assignments and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments)	: 30 %
Final Exam	: 70 %

Text Book:

1. Digital Principles and Applications, Leach (Mc Graw hill), Latest edition
2. Programmable Logic Controller, Jadhav (Khanna Publication), Latest edition

Reference:

1. Modern Digital Electronics, RP Jain (MC Graw hill), Latest edition
2. Digital Electronics, G.K. Kharate (Oxform), Latest edition

Table of Topics

Unit	Topic	Hour (L)
I	<p>Digital Circuits Overview of Number System, Boolean Algebra and Gates, Simplifications K Map, Quine- McCluskey Method, Combination Logic circuits- Full adder half adder, BCD Adder, Binary to Excess-3 convertor, Binary to Gray and Gray to Binary code convertor, comparator, BCD to seven segment convertors, Multiplexer, De Multiplexer 2x4 decoder, priority encoder Logic Family- Characteristics of Digital ICs, TTL NAND Gate & CMOS INVERTOR, NAND GATE, NOR GATE.</p>	13
II	<p>Sequential Logic Circuits Sequential logic circuits- Flip-flops (RS flip flop, JK flip-flop, Master slave JK flip flop, D Flip flop, T flip flop) inter conversion of flip-flop. Counters- Explain synchronous and asynchronous counter, Johnson counter, ring counter, up counter, down counter, Registers-Type of registers (SISO, SIPO, PIPO, PISO)</p>	12
III	<p>Converters (A-D and D-A) Parameters of ADC and DAC, Analog to Digital-Flash type ADC, Counter Type ADC and Digital to Analog Convertors- Weighted resistor DAC, R-2R DAC</p>	5
IV	<p>Introduction to Microprocessor 8085 and 8051 Microcontroller Pin diagram, Architecture, Memory, Instruction set, type of interrupt, Assembly Language programming- simple program of Arithmetic and logical operation, Data transfer and branching, Features of 8051 microcontroller, Block diagram of 8051- program status word (PSW), accumulator, program counter. Memory organization – RAM & ROM, register banks and stack, pin out diagram- description of pins, special function registers (SFRs), I/O port organization, Interrupts, Classification of instruction set - Data transfer group, arithmetic group, logical group, single bit, branching group, CALL and RET instructions and their usage, addressing modes - Immediate, register, direct, register indirect and indexed addressing modes</p>	15
V	<p>Programmable Logic Controller Concept of a generalized PLC configuration CPU, Power Supply, Rack, I/O Modules- DI, DO, AI, AO, specialty modules, PLC Rack Power Supply, Addressing, Remote Input Output Terminals (RTU), PLC Programming, Programmable Logic Controller (PLC) Overview, PLC Programming with ladder diagram Creating Relay Logic Diagrams, Programming Logic Gate Functions in PLCs, PLC Timer Functions, PLC Counter Functions, Introduction to SCADA SCADA-Overview, Architecture and functions</p>	15
	Total	60

Specific Learning Objective	L
I. Digital Circuits	
<p>General Learning Objective: To understand overview of Number System, Boolean Algebra and Gates, Simplifications K Map, Quine-McCluskey Method, Combination Logic circuits- Full adder half adder, BCD Adder, Binary to Excess-3 convertor, Binary to Gray and Gray to Binary code convertor, comparator, BCD to seven segment convertor, Multiplexer, De Multiplexer 2x4 decoder, priority encoder Logic Family- Characteristics of Digital ICs, TTL NAND Gate & CMOS INVERTOR, NAND GATE, NOR GATE.</p>	
<p>1.1 Overview of number system: 1.1.1 Explain and convert between different number systems, including binary, decimal, octal, and hexadecimal. 1.1.2 Perform arithmetic operations in different number systems. 1.1.3 Understand and apply Boolean algebra principles to simplify logic expressions. 1.1.4 Identify and use basic logic gates (AND, OR, NOT, NAND, NOR, XOR, XNOR) in digital circuits 1.1.5 Simplifications Using Karnaugh Maps (K-Map): 1.1.6 To construct and use Karnaugh Maps for simplifying Boolean expressions. 1.1.7 Minimize logic functions using K-Map techniques.</p> <p>1.2 Quine-McCluskey Method: 1.2.1 Explain the Quine-McCluskey method for logic simplification. 1.2.2 Students will be able to apply the Quine-McCluskey method to minimize logic functions systematically.</p> <p>1.3 Combination Logic Circuits Full Adder and Half Adder 1.3.1 Design and analyze full adder and half adder circuits. 1.3.2 Differences and applications of full adders and half adders. BCD Adder 1.3.3 Design and implement a BCD adder.</p> <p>1.4 Binary to Excess-3 Converter 1.4.1 Design a circuit to convert binary numbers to Excess-3 code. Binary to Gray and Gray to Binary Code Converter 1.4.2 Design and implement circuits for binary to gray code and Gray code to binary conversions.</p> <p>Comparator 1.4.3 Design and analyze a digital comparator circuit.</p> <p>BCD to Seven Segment Converter 1.4.4 Design a BCD to seven-segment display converter.</p> <p>1.5 Multiplexer 1.5.1 Explain the working principle of a multiplexer and design a 4-to-1 multiplexer circuit.</p> <p>Demultiplexer 1.5.2 Explain the working principle of a demultiplexer and design a 1-to-4 demultiplexer circuit.</p> <p>2x4 Decoder 1.5.3 Design and implement a 2x4 decoder.</p> <p>Priority Encoder 1.5.4 Explain and design a priority encoder circuit.</p> <p>Characteristics of Digital ICs: 1.5.5 Explain the key characteristics of digital ICs, including power consumption, speed, noise margin, fan-out, and propagation delay. 1.5.6 Differentiate between various logic families (e.g., TTL, CMOS) and their respective characteristics and applications.</p> <p>1.6 TTL NAND Gate: 1.6.1 Describe the internal structure and operation of a TTL NAND gate.</p> <p>CMOS INVERTER: 1.6.2 Explain the working principle of a CMOS inverter, including the role of p-channel and n-channel MOSFETs.</p> <p>CMOS NAND Gate: 1.6.3 Describe the internal structure and operation of a CMOS NAND gate.</p> <p>CMOS NOR Gate: 1.6.4 Explain the internal structure and operation of a CMOS NOR gate. 1.6.5 Compare CMOS NOR gates with TTL NOR gates and highlight their use in specific applications.</p>	<p style="text-align: right;">2</p> <p style="text-align: right;">2</p> <p style="text-align: right;">1</p> <p style="text-align: right;">1</p> <p style="text-align: right;">2</p> <p style="text-align: right;">2</p> <p style="text-align: right;">3</p>

II. Sequential Logic Circuits		
General Learning Objective: To understand sequential logic circuits- Flip-flops (RS flip flop, JK flip-flop, Master slave JK flip flop, D Flip flop, T flip flop) inter conversion of flip-flop. Counters- Explain synchronous and asynchronous counter, Johnson counter, ring counter, up counter, down counter, Registers-Type of registers (SISO, SIPO, PIPO, PISO)		
<p>2.1 Flip-flops:</p> <p>RS Flip-Flop:</p> <p>2.1.1 Explain the working principle of the RS flip-flop.</p> <p>2.1.2 Construct and analyze the truth table and characteristic equations of the RS flip-flop.</p> <p>2.1.3 Identify the applications and limitations of RS flip-flops in digital circuits.</p> <p>JK Flip-Flop:</p> <p>2.1.4 Describe the operation of the JK flip-flop and differentiate it from the RS flip-flop.</p> <p>2.1.5 Construct and analyse the truth table and characteristic equations of the JK flip-flop.</p> <p>2.1.6 Discuss the applications and advantages of using JK flip-flops.</p> <p>Master-Slave JK Flip-Flop:</p> <p>2.1.7 Explain the need for and the functioning of a master-slave JK flip-flop.</p> <p>2.1.8 Analyse the timing diagram and behavior of the master-slave configuration.</p> <p>2.1.9 Identify practical applications where master-slave JK flip-flops are advantageous.</p> <p>D Flip-Flop:</p> <p>2.1.10 Describe the working principle of the D flip-flop.</p> <p>2.1.11 Construct and analyse the truth table and characteristic equations of the D flip-flop.</p> <p>2.1.12 Discuss the common uses of D flip-flops in digital systems.</p> <p>T Flip-Flop:</p> <p>2.1.13 Explain the operation of the T flip-flop.</p> <p>2.1.14 Construct and analyse the truth table and characteristic equations of the T flip-flop.</p> <p>2.1.15 Identify application where T flip-flops are particularly useful.</p> <p>2.2 Counters:</p> <p>2.2.1 Synchronous and Asynchronous Counters:</p> <p>2.2.2 Explain the difference between synchronous and asynchronous counters.</p> <p>2.2.3 Design and analyse the operation of simple synchronous and asynchronous counters.</p> <p>2.2.4 Understand the timing issues and propagation delays associated with asynchronous counters.</p> <p>Johnson Counter:</p> <p>2.2.5 Describe the functioning of a Johnson counter.</p> <p>2.2.6 Construct the state diagram and analyse the sequence of a Johnson counter.</p> <p>2.2.7 Identify the applications and advantages of Johnson counters.</p> <p>Ring Counter:</p> <p>2.2.8 Explain the operation of a ring counter.</p> <p>2.2.9 Construct the state diagram and analyse the behaviour of a ring counter.</p> <p>2.2.10 Discuss the practical uses and benefits of ring counters.</p> <p>2.2.11 Up Counter and Down Counter:</p> <p>2.3 Types of Registers:</p> <p>Serial in Serial Out (SISO):</p> <p>2.3.1 Explain the operation and applications of SISO registers.</p> <p>Serial in Parallel Out (SIPO):</p> <p>2.3.2 Describe the working and uses of SIPO registers.</p> <p>Parallel in Serial Out (PISO):</p> <p>2.3.3 Explain the functioning and applications of PISO registers.</p> <p>Parallel in Parallel Out (PIPO):</p> <p>2.3.4 Describe the operation and benefits of PIPO registers.</p>	2 2 2 1 1 2 2	
III. Converters (A-D and D-A)		
General Learning Objective: To understand converters (A-D and D-A): Parameters of ADC and DAC, Analog to Digital-Flash type ADC, Counter Type ADC and Digital to Analog Convertors- Weighted resistor DAC, R-2R DAC.		
<p>3.1 Parameters of ADC and DAC</p> <p>3.1.1 Define and explain key parameters of ADCs and DACs, such as resolution, sampling rate, accuracy, linearity, and signal-to-noise ratio.</p> <p>3.1.2 Evaluate the performance of different ADCs and DACs based on these parameters.</p>	1	

<p>3.2 Analog to Digital Converters (ADCs) Flash Type ADC 3.2.1 Describe the working principle of flash type ADCs. 3.2.2 Analyse the advantages and disadvantages of flash type ADCs in terms of speed, complexity, and power consumption.</p> <p>3.3 Counter Type ADC 3.3.1 Explain the working principle of counter type ADCs. 3.3.2 Design a basic counter type ADC circuit and understand its operation. 3.3.3 Compare the counter type ADC with other types of ADCs in terms of speed, accuracy, and complexity.</p> <p>3.4 Digital to Analog Converters (DACs) 3.4.1 Weighted Resistor DAC 3.4.2 Explain the working principle of weighted resistor DACs. 3.4.3 Design a weighted resistor DAC circuit and analyse its performance.</p> <p>3.5 R-2R Ladder DAC 3.5.1 Describe the working principle of R-2R ladder DACs. 3.5.2 Explain its advantages over other types of DACs. 3.5.3 Compare the R-2R ladder DAC with the weighted resistor DAC in terms of design complexity, accuracy, and practicality.</p>	<p>1</p> <p>1</p> <p>1</p>
IV. Introduction to Microprocessor 8085 and 8051 Microcontroller	
<p>General Learning Objective: To understand pin diagram, Architecture, Memory, Instruction set, type of interrupt, Assembly Language programming- simple program of Arithmetic and logical operation, Data transfer and branching. Features of 8051 microcontroller, Block diagram of 8051- program status word (PSW), accumulator, program counter. Memory organization – RAM & ROM, register banks and stack, pin out diagram- description of pins, special function registers (SFRs), I/O port organization, Interrupts, Classification of instruction set - Data transfer group, arithmetic group, logical group, single bit, branching group, CALL and RET instructions and their usage, addressing modes - Immediate, register, direct, register indirect and indexed addressing modes.</p>	
<p>4.1 8085 Pin Diagram 4.1.1 Identify and explain the function of each pin in the 8085 microprocessor. 4.1.2 Describe the significance of various control and status signals in 8085 microprocessor.</p> <p>4.2 8085 Architecture 4.2.1 Explain the internal architecture of the 8085 Microprocessor, including the ALU, registers, control unit, and data bus. 4.2.2 Describe how data flows through the microprocessor and how different components interact.</p> <p>4.3 Memory Organization 4.3.1 Describe the memory organization and addressing modes of the 8085 microprocessor. 4.3.2 Explain the concepts of memory mapping, I/O mapping, and the difference between them.</p> <p>4.4 8085 Instruction Set 4.4.1 Categorize and explain the different types of instructions in the 8085-instruction set (data transfer, arithmetic, logical, control, branching). 4.4.2 Understand and write instructions using the 8085-instruction set for various operations.</p> <p>4.5 Types of Interrupts 4.5.1 Explain the different types of interrupts in the 8085 microprocessor (hardware and software interrupts). 4.5.2 Describe the priority and handling mechanism of each interrupt.</p> <p>Assembly Language Programming</p> <p>4.6 Arithmetic and Logical Operations 4.6.1 Write and execute assembly language programs for basic arithmetic operations (addition, subtraction, multiplication, division). 4.6.2 Write and execute assembly language programs for basic logical operations (AND, OR, XOR, NOT).</p> <p>Data Transfer 4.7.1 Write and execute assembly language programs for data transfer operations (moving data between registers, memory, and I/O ports).</p> <p>Branching 4.8.1 Write and execute assembly language programs for branching operations (conditional and unconditional jumps, loops).</p> <p>Features of 8051 Microcontroller</p>	<p>8</p> <p>7</p>

4.9.1 List and explain the key features of the 8051 microcontroller, including its on-chip memory, I/O ports, timers, and serial communication capabilities.

Block Diagram of 8051

Program Status Word (PSW)

4.10.1 Describe the function and structure of the Program Status Word (PSW) and how it is used to reflect the current state of the processor.

Accumulator

4.11.1 Explain the role of the accumulator in the 8051 microcontroller for arithmetic and logical operations.

Program Counter

4.12.1 Understand the function of the program counter and how it controls the flow of execution in the 8051 microcontroller.

Memory Organization

RAM and ROM

4.13.1 Describe the memory organization of the 8051, including the differences between RAM and ROM, and their specific uses.

4.13.2 Register Banks and Stack

4.13.3 Explain the use of register banks and the stack in the 8051 microcontroller.

Pin Out Diagram

4.14.1 Identify and describe the function of each pin in the 8051-microcontroller pinout diagram.

4.14.2 Special Function Registers (SFRs)

4.14.3 List and explain the purpose of the special function registers (SFRs) in the 8051 microcontroller.

I/O Port Organization

4.15.1 Describe the organization and usage of I/O ports in the 8051 microcontroller for interfacing with external devices.

Interrupts

4.16.1 Explain the types of interrupts available in the 8051 microcontroller, their priorities, and how they are handled.

Classification of Instruction Set

Data Transfer Group

4.17.1 Understand and use instructions related to data transfer within the 8051 microcontroller.

Arithmetic Group

4.17.2 Understand and use arithmetic instructions to perform addition, subtraction, multiplication, and division.

Logical Group

4.17.3 Understand and use logical instructions for bitwise operations.

Single Bit Instructions

4.17.4 Manipulate single bits within registers and memory using single bit instructions.

Branching Group

4.17.5 Use branching instructions for decision making and altering the flow of execution.

CALL and RET Instructions

4.17.6 Understand the usage of CALL and RET instructions for subroutine handling.

Addressing Modes

4.18.1 Immediate Addressing Mode

4.18.2 Use immediate addressing mode to work with constants directly in instructions.

Register Addressing Mode

4.18.3 Use register addressing mode to manipulate data stored in registers.

Direct Addressing Mode

4.18.4 Use direct addressing mode to access specific memory locations directly.

Register Indirect Addressing Mode

4.18.5 Use register indirect addressing mode to access memory locations indirectly through registers.

Indexed Addressing Mode

4.18.6 Use indexed addressing mode to access data in memory using a base register and an offset.

V. Programmable Logic Controller

General Learning Objective:

To understand the fundamentals of generalized PLC configuration, PLC programming with ladder diagram and SCADA

<p>5.1 Concept of a generalized PLC configuration</p> <p>5.1.1 Explain the basic concept and purpose of a Programmable Logic Controller (PLC) in industrial automation.</p> <p>5.1.2 Describe the advantages of using PLCs over traditional relay-based control systems.</p>	5
<p>Generalized PLC Configuration</p> <p>CPU (Central Processing Unit)</p>	
<p>5.1.3 Explain the role of the CPU in a PLC system, including its function in executing control instructions and processing data.</p>	
<p>Power Supply</p> <p>5.2.1 Describe the importance of the power supply in a PLC system and how it provides necessary voltages to various components.</p>	
<p>Rack</p> <p>5.3.1 Understand the purpose of the rack in a PLC system and how it houses and connects various modules.</p>	
<p>I/O Modules</p>	
<p>Digital Input (DI) Modules</p>	
<p>5.4.1 Explain the function of DI modules and how they interface with digital input devices.</p>	
<p>5.4.2 Digital Output (DO) Modules</p>	
<p>5.4.3 Describe the function of DO modules and how they interface with digital output devices.</p>	
<p>Analog Input (AI) Modules</p>	
<p>5.4.4 Explain the role of AI modules in converting analog signals to digital data for the CPU.</p>	
<p>Analog Output (AO) Modules</p>	
<p>5.4.5 Describe the function of AO modules in converting digital data to analog signals for output devices.</p>	
<p>Specialty Modules</p>	
<p>5.4.6 Explain the use of specialty modules such as communication modules, high-speed counters, and temperature controllers.</p>	5
<p>5.4.7 PLC Rack Power Supply</p>	
<p>5.4.8 Describe the function of the rack power supply and its role in distributing power to the PLC modules.</p>	
<p>Addressing</p>	
<p>5.5.1 Understand and apply the concept of addressing in a PLC system to properly configure and access I/O modules and memory locations.</p>	
<p>5.5.2 Remote Input Output Terminals (RTU)</p>	
<p>5.5.3 Explain the function of remote I/O terminals and their role in extending the reach of a PLC system for remote monitoring and control.</p>	
<p>PLC Programming</p>	
<p>5.6.1 Describe the basic principles of PLC programming and the common programming languages used, such as Ladder Logic, Function Block Diagram (FBD), and Structured Text (ST).</p>	
<p>5.6.2 Develop, debug, and execute basic PLC programs to control simple industrial processes.</p>	5
<p>Creating Relay Logic Diagrams</p>	
<p>5.7.1 Explain the principles of relay logic and its significance in industrial automation.</p>	
<p>5.7.2 Create relay logic diagrams to represent control processes and convert these diagrams into PLC ladder logic programs.</p>	
<p>5.7.3 Interpret and troubleshoot relay logic diagrams and corresponding ladder logic programs.</p>	
<p>Programming Logic Gate Functions in PLCs</p>	
<p>5.7.4 Explain the basic logic gate functions (AND, OR, NOT, NAND, NOR, XOR, XNOR) and its importance in digital control systems.</p>	
<p>5.7.5 Program basic logic gate functions in PLCs using ladder diagrams.</p>	
<p>5.7.6 Combine multiple logic gate functions to create more complex control logic in ladder diagrams.</p>	
<p>PLC Timer Functions</p>	
<p>5.8.1 Explain the purpose and types of PLC timer functions, including on-delay, off-delay, and retentive timers.</p>	
<p>5.8.2 Program and implement timer functions in ladder diagrams to control the timing of events in industrial processes.</p>	
<p>PLC Counter Functions</p>	
<p>5.8.3 Explain the purpose and types of PLC counter functions, including up-counters, down-counters, and retentive counters.</p>	
<p>5.8.4 Program and implement counter functions in ladder diagrams to count events, items, or operations in industrial processes.</p>	

Functions of SCADA Systems

Data Acquisition

5.9.1 Explain how SCADA systems acquire data from field devices and sensors, and the importance of real-time data acquisition for process monitoring and control.

Data Communication

5.9.2 Describe the communication methods used in SCADA systems, including wired and wireless networks, and protocols like Modbus, DNP3, and OPC.

Data Processing and Analysis

5.9.3 Explain how SCADA systems process and analyse acquired data to provide meaningful information for decision-making.

5.9.4 Visualization and Human-Machine Interface (HMI)

5.9.5 Describe the role of HMI in SCADA systems, including how it provides operators with visual representation of the process data, alarms, and control interfaces.

Control Functions

5.9.6 Explain how SCADA systems can be used to send control commands to field devices and actuators to manage industrial processes.

Data Logging and Historical Data

5.10.1 Explain the importance of data logging in SCADA systems and how historical data is used for trend analysis, reporting, and optimizing processes.

Alarm Management

5.11.1 Describe the alarm management functions of SCADA systems, including how alarms are generated, monitored, and managed to ensure safe and efficient operation.

Subject Name /Code: Marine Auxiliary Machinery Lab/UG11P5501

Instructional hours

Practical : 45 hours

Total contact hours : 45 hours

Credits : 1.5

Teaching Methods

The practical training will be hands-on with focus on safety and skills.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments) : 50%

Final Exam : 50%

Exp.No.	Topic	Hour (P)
I	<p>Turbocharger Familiarization: Purpose of Turbocharger and Waste Heat Recovery Identify of Parts of Turbocharger</p> <ul style="list-style-type: none"> ● Compressor ● Turbine ● Turbine Blade ● Nozzle ● Labyrinth seal ● Rotor ● Suction filter ● Casing 	6
II	<p>Purifier Demonstration:</p> <ul style="list-style-type: none"> ● Oil used in Marine Propulsion ● Impurities in Marine Oil and ill effect of the impurities on Engine Performance ● Operation principles of an oil purifier ● Dismantling Procedure of Purifier ● Special tools requirement ● Identification and function of different parts Vertical Shaft ● Identification and purpose of Gravity Disc ● Selection of Gravity Disc and Nomogram ● Identify and function of Operating Water ● Identification and function of different parts Horizontal Shaft ● Sludge discharging mechanism of an oil purifier, Manual De-sludging procedure ● Transmission of power in purifier ● Starting and Stopping of the system 	12
III	<p>Heat Exchanger and its Maintenance:</p> <ul style="list-style-type: none"> ● Plate Heat Exchanger / Shell & Tube ● Function of Heat Exchangers ● Operation and Maintenance of Heat Exchangers 	9
IV	<p>2 and 4 Ram Steering Gear:</p> <ul style="list-style-type: none"> ● SOLAS requirement of Steering Gear ● Different Types of Steering gear on Ships ● Identify different parts of a 2 and 4 Ram Type Steering Gear ● Identify the Hydraulic Circuit ● Types of Pumps ● Operation of Steering Gear 	9

V	Marine Air Compressor: <ul style="list-style-type: none"> ● Purpose of Marine Air Compressor and Compressed Air System ● Understand constructional & operational details of Air compressors & air bottles used on board ● Identify different parts and function of each ● Identify the function of Unloader mechanism ● Starting and stopping of air compressors ● Identify air bottle mountings and function of each. ● Watch keeping on compressors and air bottle. 	9
TOTAL		45



Subject Name /Code: Marine Steam Engineering Lab/UG11P5502

Instructional hours

Practical : 45 hours
Total contact hours : 45 hours
Credits : 1.5

Teaching Methods

The practical training will be hands-on with focus on safety and skills.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments) : 50%
Final Exam : 50%

Exp.No.	Topic	Hour(p)
I	Different types of Boiler & utilization on ships	3
II	Layout of a Marine steam plant including Marine Boiler and Boiler Mountings	3
III	Starting marine steam plant from cold conditions - Flushing of HFO Line, and starting of DG	3
IV	Demonstration and safety of operation for Preparing Boiler for firing	3
V	Demonstration and safety of operation during Raising the Boiler Pressure	3
VI	Demonstration and safety of operation during Boiler fuel Change over boiler to HFO	3
VII	Demonstration and safety of operation during Parallel operation of two or more boilers including Automatic Operation of Boiler	3
VIII	Preparation of Turbo Generator and change over to TG from DG- Demonstration and safety of operation	3
IX	Preparation of the Main turbine for leaving port. - Demonstration and safety of operation	3
X	Demonstration and safety of operation during Leaving Port from Manoeuvring to full speed	3
XI	Demonstration and safety of operation during Arrival port Turbine and securing turbine after Finished with Turbine	3
XII	Emergency operation with turbine- Demonstration of operation	3
XIII	Manual / Emergency operations of Boiler- Demonstration of common problems Trouble shooting of Boiler operation	6
XIV	Demonstration of common problems Trouble shooting with turbine operation	3
XV	Demonstration of common problems Trouble shooting with Main Condenser & water treatment	3
Total		45

Subject Name/Code: Digital Electronics and PLC Lab/UG11P5503

Instructional Hours:

Practical	: 45 hours
Total contact hours	: 45 hours
Credits	: 1.5

Teaching Methods

The course shall be conducted AS practical in workshops and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments):	50%
Final Written Exam	: 50%



Exp.No.	Topic	Hours (P)
I	Module A-Digital Electronics Design basic logic gates and conversion of basic logic gates using universal gates. Understand anyone's logic equation using Demorgan's Law.	3
II	Combinational Circuits Half adder circuits Full adder circuits Multiplexer	3
III	Flip - Flop Circuits S-R Flip-Flop. J-k Flip-Flop. D Flip-Flop. T Flip flop.	3
IV	Counters Ring Counter Binary Ripple Counter	3
V	Register SISO SIPO PIPO	3
VI	Module B-Microprocessor 8085. Data Transfer. Shifting a block of memory Copying a block of memory Moving of data from one location to another location	3
VII	Arithmetic Operation. 16-bit addition of two hexadecimal numbers using 8085 Microprocessor. 16-bit subtraction of two hexadecimal numbers using 8085 microprocessor.	3
VIII	Logical Operation Loops Subroutine	6
IX	Module C-Programmable Logic Controller. System hardware identification PLC system configuration and installations. Introduction to PLC trainer & its installation with PC	3
X	PLC Programming. Write and implement a simple ladder logic program using digital inputs and outputs for PLC Write and implementation of simple ladder logic program using timer On delay timer Off delay timer Retentive timer Write an implementation of a simple ladder logic program using counters. UP counter Down counter.	9
XI	PLC to i/o Device Interface speed control of mini dc motor using DAC. Study of a SCADA system (Architecture) and Demonstration of P, PI, PID control. Interface SCADA with PLC and associate tags with memory and I/ O and operate the PLC inputs through the switch symbol from the computer screen and view the status of the outputs using lamp and motor graphics symbols in the screen.	6

Subject Name/Code: Seamanship and Safe Work Practices/UG11P5504

Instructional Hours:

Practical : 45 hours

Total contact hours : 45 hours

Credits : 1.5

Teaching Methods

The course shall be conducted AS practical in workshops and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments): 50%

Final Written Exam : 50%

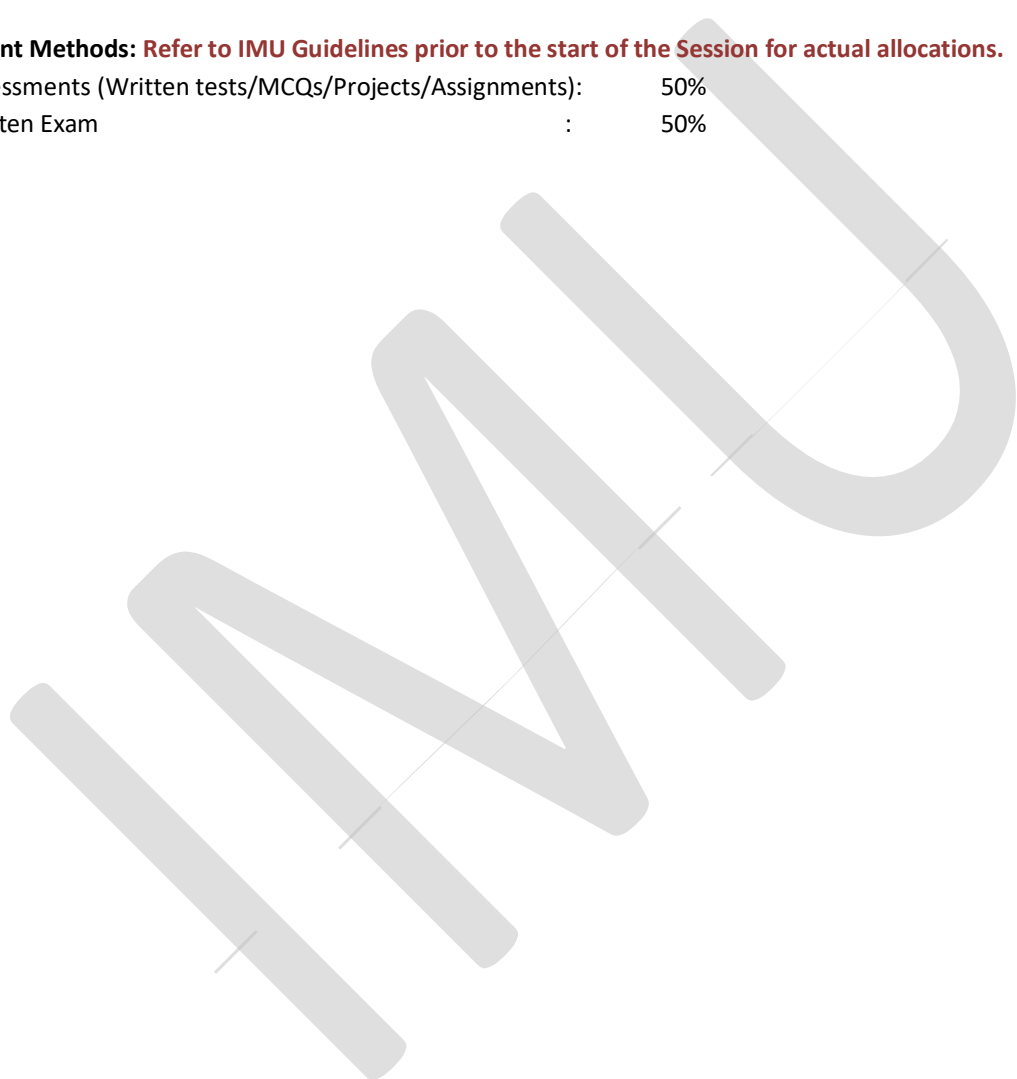


Table of Topics

Exp.No.	Topic	Hour (P)
I	Seamen and their Duties: Sub-Topics: Familiarization of Ship's Departments, General ship knowledge, Layout and Nautical terms, Bridge equipment arrangement.	3
II	Navigational Light and signals: Sub-Topics: Familiarization of Navigation lights, Colours, Locations and Visibility. Look-out, precautions in bad weather, Flags-etiquette, Morse and Semaphore signalling, Sound signals.	3
III	Rope knots and Moorings: Sub-Topics: Demonstration of Type of knots, Practice of knot formation, Material of ropes. Strength, Care and maintenance, use of mooring line, Heaving line, Rat guards, Canvas and its use.	3
IV	Anchors: Sub-Topics: Familiarization OF Different type of anchors, its uses, Dropping and Weighing anchor, Cable stopper.	3
V	Navigation: Sub-Topics: Familiarization OF Navigation Compass, Echo Sounder, Log and uses, Barometer and weather classifications, G.M.T. and zonal time, wireless navigational Instruments, radar satellite-navigation.	3
VI	Lifeboat and Life rafts: Sub-Topics: Demonstration of Davits and its launching operation, Launching of Life rafts (Inflatable type). Embarkation into Life boat and Life raft. Survival pack, Stowage and securing arrangement. Rescue Boat, immersion suit, Thermal protective aid.	3
VII	Abandon Ship drill: Sub-Topics: Demonstration of manning of lifeboat and life raft. Muster list, Radio and alarm signals, Distress Signal (S.O.S.). Distress call time and radio frequency. Pyro-techniques.	3
VIII	Survival at Sea: Sub-Topics: Familiarization of Survival difficulties and factors equipment available, Duties of crew members, initial action on boarding, maintaining the craft.	3
IX	Demonstration of Safe work practices while Sub-Topics: Working aloft, working in engine room taking care of slip, trips and falls, Above hazards to be explained/simulated to in still deep impression in the minds about safety	6
X	Demonstration of Safe work practices while Sub-Topics: Working with chemicals, working near rotating machineries, Above hazards to be explained/simulated to in still deep impression in the minds about safety	3
XI	Demonstration of Safe work practices while Sub-Topics: Working in enclosed spaces, working with electrical appliances, Above hazards to be explained/simulated to in still deep impression in the minds about safety	6
XII	Demonstration of Safe work practices while Sub-Topics: Working with high temperature and pressure fluids doing hot repair work.	6

	Above hazards to be explained/simulated to in still deep impression in the minds about safety	
Total		45

MANU

SEMESTER – VI

Subject Name/Code: Marine Information Technology / UG11T5601

Instructional hours:

Lecture	: 45 hours
Total contact hours	: 45 hours
Credits	: 3

Teaching Methods

The course shall be conducted in a combination of Classroom, tutorials.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments)	: 30%
Final Exam	: 70%

Text Book:

1. Artificial Intelligence and Machine Learning, Chandra S.S.V
2. Computer Networks, Andrew Tanenbaum
3. Fundamentals of Cyber Security, Bhushan/Rathore/Jamshed

Reference:

1. Machine Learning, Tom Mitchell, McGraw Hill, 0-07-042807-7
2. Elaine Rich and Kevin Knight: "Artificial Intelligence." Tata McGraw Hill
3. Stuart Russell & Peter Norvig: "Artificial Intelligence: A Modern Approach", Pearson Education, 2nd Edition.
4. Jacek M. Zurada, "Introduction to Artificial Neural System", JAICO publishing house.
5. Ivan Bratko : "Prolog Programming For Artificial Intelligence" , 2nd Edition Addison Wesley.
6. Eugene, Charniak, Drew McDermott: "Introduction to Artificial Intelligence.", Addison Wesley
7. Patterson: "Introduction to AI and Expert Systems", PHI
8. Nilsson : "Principles of Artificial Intelligence", Morgan Kaufmann.
9. Carl Townsend, "Introduction to turbo Prolog", Paperback.
10. Tom Mitchell , Machine Learning, , McGraw Hill, 0-07-042807-7
11. Ethem Alpaydin, "Introduction to Machine Learning", MIT press.
12. Jacek M. Zurada, "Introduction to Artificial Neural System, JAICO publishing house.
13. Aurelien Geron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems 2nd Edition, Oreilly publication
14. Oliver Theobald, Machine Learning for Absolute Beginners: A Plain English Introduction, Second Edition
15. Cybersecurity? Attack and Defense Strategies: Infrastructure Security with Red Team and Blue Team Tactics by Erdal Ozkaya and Yuri Diogenes
16. Cybersecurity: The Beginner's Guide: A Comprehensive Guide to Getting Started in Cybersecurity, by Erdal Ozkaya. Packt Publishing

Table of Topics

Unit	Topics	Hour (L)
I	Fundamentals of AI and ML: Sub-Topics: Introduction to AI, ML. Applications of AI and ML, of Artificial Intelligence in autonomous ships.	15
II	Fundamentals of Computer Security: Sub-Topics: Introduction to Cyber security, Cyber security terminology, types of hackers, Cyber-attacks, cyber netiquettes.	15
III	Fundamentals and Computer Networking Sub-Topics: Computer Network Types, Topology, Networking terms and concepts, Network devices, IP Address Format and Table	15
	Total	45

Learning Objectives		L
I Fundamentals of AI and ML: (MO 7.02,2014: Introduction/Computer Applications/DG guidelines)		15
General Learning Objective Understand Fundamentals of AI and Machine learning Sub-topic: Introduction to AI and Machine Learning Sub-subtopics & SLOs: Introduction to AI, ML. Applications of AI and ML, of Artificial, Intelligence in Autonomous Ships		
1.1 Introduction to Artificial Intelligence: 1.1.1 Definition and history of AI, 1.1.2 Basic concepts and goals of AI, 1.1.3 Applications and impact of AI in various fields, Problem-Solving and Search Algorithms- 1.1.4 Problem solving methods in AI, 1.1.5 Search algorithms: breadth-first search, depth-first search, A* search, etc, 1.1.6 Heuristic search techniques, 1.1.7 Knowledge Representation and Reasoning: Representing knowledge in AI systems, 1.1.8 Propositional and predicate logic, Inference rules and reasoning techniques		7
1.2 Fundamentals of Machine Learning and its Applications Sub-subtopics & SLOs: Introduction to AI, ML. Applications of AI and ML, of Artificial, Intelligence in Autonomous Ships		
Specific Learning Objectives: 1.2.1 Introduction to machine learning, 1.2.2 Supervised learning, unsupervised learning, and reinforcement learning, 1.2.3 Evaluation metrics in machine learning, 1.2.4 Regression and Classification Algorithms: Linear regression, Logistic regression, Decision trees and random forests, 1.2.5 Naive Bayes classifier, C 1.2.6 Clustering and Dimensionality Reduction: K-means clustering, Hierarchical clustering, 1.2.7 Principal Component Analysis (PCA) 1.2.8 Time Series Forecasting -Moving-average model, -ARIMA, -Exponential smoothing model		8

II. Fundamentals of Computer Security: Sub-subtopics & SLOs: Introduction to Cyber security, Cyber security terminology, types of hackers, Cyber-attacks, cyber netiquettes.	15
Specific Learning Objectives: <ul style="list-style-type: none"> 2.1 Define and describe Cyber Security, 2.2 Define different cyber security terminology, 2.3 Discuss types of cyber-attacks, 2.4 Discuss types of hackers, 2.5 Discuss different types of web. 2.6 Define and explain Cyber Forensics. 2.7 Demonstrate General firewall settings. 2.8 Discuss different measures to protect against cyber fraud, 2.9 Discuss Cyber-attacks, cyber netiquettes. 2.10 Discuss Cyber security on board ship with cyber netiquettes. 	
III. Fundamentals and Computer Networking Sub-subtopics & SLOs: Computer Network Types, Topology, Networking terms and concepts, Network devices, IP Address Format and Table	15
<ul style="list-style-type: none"> 3.1 What is a Computer Network? 3.2 Explain different types of computer networks 3.3 Explain in details different types of topology 3.4 Explain different types of IP address 3.5 Explain in details different types of networking devices 3.6 Explain OSI reference model with TCP/IP comparison 3.7 Explain different troubleshooting mechanism in computer networks 	

Subject Name/Code: Shipboard Safety Practices/ UG11T5602

Instructional hours:

Lecture : 45 hours
Tutorial : 15 hours

Total contact hours : 60 hours

Credits : 4

Teaching Methods

The course shall be conducted in a combination of classroom/online lectures, and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments) :30%

Final Written Exam :70%

Text Book:

1. Marine Auxiliary Machinery, H.D.Mc George, B.H.Publishers , latest edition

Reference:

1. Marine Engineering Practices, IME Publication
2. SOLAS- Bhandekar Publication
3. FSS / FTP Code - IMO Publication
4. Fire Aboard - Frankrush Brook.
5. Firefighting Aboard Ships - M. G Stavitsky
6. General Engineering Knowledge for Marine Engineers- Reeds Volume 8.

Table of Topics

Unit	Topic	Hour (L)
I	Fire Hazard Aboard Ships	10
II	Fire Protection Rules in Ships Construction	10
III	Fire Detection System	5
IV	Fire Fighting Equipment and Relevant Rules as per SOLAS	17
V	Fire Control	18
Total		60

Learning Objectives		L
<p>I. Fire Hazard Aboard Ships:</p> <p>1.1 Fire triangle, Fire Tetrahedron, 1.2 Fire-chemistry, Spontaneous Combustion, 1.3 Limits of inflammability. 1.4 Advantages of various fire extinguishing agents including vaporizing fluids and their suitability For ship's use. 1.5 Control of Class A, B, C & class D fires, 1.6 Combustion products & their effects on life safety.</p>	10	
<p>II. Fire Protection Rules in Ships Construction:</p> <p>2.1 SOLAS convention, requirements in respect of materials of construction and design of ships, (class A, B, C type Bulkheads), 2.2 Fire detection and extinction systems, 2.3 Fire test, means of escape, fire doors & fire zones, electrical installations in hazardous zones, ventilation system and venting system for tankers. 2.4 Statutory requirements for firefighting systems and equipment on different vessels.</p>		
<p>III. Fire Detection System:</p> <p>3.1 Types of detectors 3.2 Selection of fire detectors and alarm systems and their operational limits. 3.3 Commissioning and periodic testing of sensors and detection system.</p>		5
<p>IV. Fire Fighting Equipment and Relevant Rules as per SOLAS:</p> <p>4.1 Fire pumps, hydrants and hoses, Couplings, nozzles and international shore connection. 4.2 Construction, operation and merits of different types of portable, semi-portable and fixed fire extinguishers installations for ships. 4.3 Properties of Chemicals used, Water Sprinkler system, 4.4 Water-mist Fire suppression system. Bulk and bottled Carbon Di-Oxide system. Inert gas systems. 4.5 Fireman's outfit, its use and care. Maintenance, testing and recharging of appliances. 4.6 Fire Fighting Appliance Survey. 4.7 Breathing apparatus types, uses, method of operation. 4.8 Fixed Fire Fighting installation on LPG & LNG.</p>		17

<p>V. Fire Control:</p> <p>5.1 Fire Control Plan and IMO Symbols, Action required and practical techniques adopted for extinguishing fires in accommodation, machinery spaces, boiler front, Cargo holds, galley, pump room, paint locker.</p> <p>5.2 Fire fighting in port and dry dock.</p> <p>5.3 Procedure for re-entry after putting off fire,</p> <p>5.4 Rescue operations from affected compartments.</p> <p>5.5 First aid, Fire organization on ships, shipboard organization for fire. and emergencies.</p> <p>5.6 Combustion products and their effects on safety of life.</p> <p>5.7 Fire signal and muster.</p> <p>5.8 Fire drill. Leadership and duties, Human behavior, Special precautions for prevention/fighting fire in tankers, chemical carriers and gas carriers, Safe working practice</p>	<p>18</p>
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Subject Name/Code: Naval Architecture- Ship Resistance and Propeller/UG11T5603

Instructional hours:

Lecture	: 45 hours
Tutorial	: 15 hours
Total contact hours	: 60 hours
Credits	: 4

Teaching Methods

The course shall be conducted in a combination of classroom/online lectures, and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments)	:30%
Final Written Exam	:70%

Text Book:

1. Naval Architecture, Reeds Volume 4, E. A. Stokoe, Bloomsbury.
2. Principles of Naval Architecture: Resistance, Propulsion and Vibration, Lewis, E. V, United State: Society of Naval Architects and Marine Engineers.

Reference:

1. Gillmer, T. C., Johnson, B. Introduction to Naval Architecture. Netherlands: Island Press.
2. Dictionary of Ship Hydrodynamics - <https://ittc.info/media/1531/alphabetdictionary.pdf>.
3. Biran, A., Pulido, R. L. (2013). Ship Hydrostatics and Stability. Netherlands: Elsevier Science.
4. Bhattacharyya, R. Dynamics of Marine Vehicles. United Kingdom: Wiley.
5. Harvald, S. A. Resistance and Propulsion of Ships. United Kingdom: Wiley.
6. Molland, A. F., Turnock, S. R. Marine Rudders and Control Surfaces: Principles, Data, Design and Applications. Netherlands: Elsevier Science.
7. Ghose, J. P., Gokarn, R. P. Basic Ship Propulsion. India: Allied Publishers.

Table of Topics

Unit	Topic	Hour (L)
I	<p>Rudder Theory Subtopics: Basic requirements of rudder. Rudder nomenclature, area and shape of rudder, physics of control surfaces, properties of hydrofoils – lift and drag, action of the rudder in turning a ship, forces on rudder, torque on stock, angle of heel when turning, Types of rudders, position of rudder, stern rudders & bow rudders, Model experiments and full-scale Manoeuvring trials – course keeping, course changing, emergency manoeuvre qualities, turning test, Z-manoeuvre test, modified Z-manoeuvre test, direct spiral test, reversed spiral test, pull-out test, stopping test</p>	12
II	<p>Resistance and Fuel Consumption Subtopics: Components of ship resistance; Frictional Resistance, Residuary Resistance, Froude’s Law of comparison, Speed to Length Ratio, Froude’s Number, Reynold’s Number Determination of ship’s resistance. Model experiments, Effective power calculations, Ship correlation factor (SCF), Application of ITTC methods in solving problems related to estimation of total resistance. Admiralty coefficient, Fuel coefficient and Fuel consumption</p>	13
III	<p>Propellers and Power Subtopics: Propeller geometry and terminologies, Apparent and real slip, Wake and wake distribution, Thrust deduction fraction, Propulsion machinery layout, Power and efficiencies in ship propulsion system, QPC. Axial Momentum theory, Momentum theory including rotation and Blade element theory. Law of similitude, model tests with propellers, Ship model correlation, Open water characteristics, propeller in behind condition (Ship propeller interaction), slip, wake, augment of resistance, thrust deduction</p>	15
IV	<p>Cavitation Subtopics: cavitating flows, types of propeller cavitation, detrimental effects of cavitation, criteria for prevention of cavitation. Special types of propeller arrangements – FPP, CPP, Propellers in Nozzles, Paddle wheel, Vertical axis propellers – Voith Schneider, Jet propellers</p>	10
V	<p>Motion of ship on waves Subtopics: Theory of waves. Trochoidal waves. Sinusoidal waves. Irregular wave pattern, Wave spectra, Ship motions – Roll pitch yaw surge, sway and yaw Anti-rolling devices- (i) Bilge keels (ii) Fin Stabilizers (iii) Passive and active anti-roll tanks</p>	10
	Total	60

Learning Objectives		L
IMO Model Course 2014 references IMO Model Course 7.04 – 1.4.1.7, 4.2.2.6; IMO Model Course 7.02 – 1.2.2.4, 4.1.1.9		L
I. Rudder Theory		
<p>General Learning Objective Understand and utilize concepts related to forces on rudder causing ship to turn, torque on rudder stock and angle of heel when turning.</p> <p>Sub-topic: Basic requirements of rudder. Rudder nomenclature, area and shape of rudder, physics of control surfaces, properties of hydrofoils – lift and drag, action of the rudder in turning a ship, forces on rudder, torque on stock, angle of heel when turning, Types of rudders, position of rudder- stern rudders & bow rudders.</p> <p>Sub-subtopics & SLOs</p> <ul style="list-style-type: none"> 1.1.1 Explain the purpose of rudder in turning the ship. 1.1.2 Define and explain various terminologies related to rudder and turning of ship including pivoting point and drift angle. 1.1.3 Explain the physics of lift & drag acting on the hydrofoil surface and its application to the rudder in generating rudder torque about rudder axis, in turn, turning the ship. 1.1.4 Explain and utilize empirical formulae to calculate force acting on the rudder for various conditions of movement of the ship and various configurations of rudder. 1.1.5 Explain and utilize methodology to calculate the rudder stock diameter based on the force, torque and bending moment acting on the rudder. 1.1.6 Explain Turning circle test for the various angles of heel and drift during the entire turn. 1.1.7 Explain different types of rudders. 1.1.8 Explain efficient position of rudder in turning the ship – Bow and stern rudder. 		9
<p>General Learning Objective Explain different Maneuvering trials to be conducted as per the requirements of the IMO</p> <p>Sub-topic: Model experiments and full-scale maneuvering trials – course keeping, course changing, emergency manoeuvre qualities, turning test, Z-manoeuvre test, modified Z-manoeuvre test, direct spiral test, reversed spiral test, pull-out test, stopping test.</p> <p>Sub-subtopics & SLOs</p> <ul style="list-style-type: none"> 1.2.1 Explain following model and full-scale maneuvering trials with various terminologies related to particular trial. 1.2.2 Turning circle test, Z-manoeuvre test, modified Z-manoeuvre test, direct spiral test, reversed spiral test, pull-out test, stopping test. 		3
II. Resistance and Fuel Consumption		
<p>General Learning Objective: Understand and utilize concepts related to different types of resistance experienced by the ship's hull using Froude's Law of comparison.</p> <p>Sub-topic: Components of ship's resistance; Frictional Resistance, Residuary Resistance, Froude's Law of comparison, Speed to Length Ratio, Froude's Number, Reynold's Number</p> <p>Sub-sub topics & SLOs</p> <ul style="list-style-type: none"> 2.1.1 Define and explain resistance of the ship. 2.1.2 Define, explain and compare following components of resistances 2.1.3 Viscous Resistance, Wave-making Resistance, Residuary Resistance, Frictional Resistance, Viscous Pressure Resistance, Eddy making resistance. 2.1.4 Define and explain the utilization of Form factor. 2.1.5 Define and explain the wave-interference. 2.1.6 Define and explain coefficient of friction by Froude and ITTC 1957 friction Line. 		8

<p>2.1.7 solve related problems-</p> <p>2.1.8 Define and explain concept of Speed to Length Ratio, Froude's Number and Reynold's Number.</p>	
<p>General Learning Objective: Understand and utilize Froude's methodology and ITTC 1957 method to predict effective power of the ship.</p> <p>Sub-topic: Determination of ship's resistance. Model experiments, Effective power calculations, Ship correlation factor (SCF), Model ship correlation allowance, Application of ITTC methods in solving problems related to estimation of total resistance.</p> <p>Sub-sub topics & SLOs</p> <p>2.2.1 Define and utilize laws of similarity.</p> <p>2.2.2 Carry out dimensional analysis for the total resistance of the ship.</p> <p>2.2.3 Explain Froude's and Reynold's similarity of law.</p> <p>2.2.4 Develop equations for the model parameters from the ship parameters.</p> <p>2.2.5 Sketch and describe Model test setup to predict resistance of the ship.</p> <p>2.2.6 Describe and solve problems to estimate total resistance and in turn to predict effective power of the ship using Froude's methodology and ITTC methods.</p> <p>2.2.7 Define, explain and utilize ship correlation factor (SCF), Model ship correlation allowance.</p>	4
<p>General Learning Objective: Understand and apply concepts of Admiralty coefficient and Fuel coefficient to calculate fuel consumption for various routes and displacement of the ship.</p> <p>Sub-sub topics & SLOs</p> <p>2.3.1 Define, explain and utilize Admiralty coefficient, Fuel coefficient, specific fuel consumption and propulsive efficiency to calculate fuel consumption for various routes and displacement of the ship.</p>	1
III. Propellers and Power	
<p>General Learning Objective: Concepts related to geometry of the propeller, slip and wake of it on its various efficiencies.</p> <p>Sub topic: Propeller geometry and terminologies, Apparent and real slip, Wake and wake distribution, Thrust deduction fraction, Relative rotative efficiency, Propulsion machinery layout, Power and efficiencies in ship propulsion system, QPC.</p> <p>Sub-sub topics & SLOs</p> <p>3.1.1 Define, explain and utilize following parameters of the propeller in calculating various geometric parameters of the propeller blade Diameter, number of blades, RPM, Helix, helical surface, projected, developed & expanded areas & sections of blade, leading & trailing edge, face & back, root & tip, rake & rake angle, skew & skew angle, chord, pitch and pitch angle.</p> <p>3.1.2 Define, explain and utilize following parameters of the propeller in calculating various efficiencies of the propulsion plant layout and calculate different powers at various stages of layout.</p> <p>3.1.3 Speed of advance of the propeller, Wake, Froude's & Taylor's wake fraction, Real, apparent and effective slip of the propeller, thrust deduction factor, Hull efficiency, propeller efficiency, relative rotative efficiency, QPC</p>	5
<p>General Learning Objective: Explain different theories of propeller to calculate its efficiency.</p> <p>Sub topic: Axial Momentum theory and Blade element theory</p> <p>Sub-sub topics & SLOs</p> <p>3.2.1 Define, explain and utilize axial momentum theory in deriving expressions and calculating values of ideal efficiency and Thrust loading coefficient of the propeller.</p> <p>3.2.2 Explain the concept of tug applying a static pull at Bollard or of a ship at a dock trial.</p> <p>3.2.3 Blade element theory</p>	3

<p>General Learning Objective: Understand and utilize concepts of model testing of propeller both in open water and behind the ship to obtain different parameters out of it.</p> <p>Sub topic: Law of similitude, model tests with propellers, Ship model correlation, Open water characteristics, propeller in behind condition (Ship propeller interaction).</p> <p>Sub-sub topics & SLOs</p> <ul style="list-style-type: none"> 3.3.1 Utilize laws of similarity for the propeller model testing. 3.3.2 Define, explain and utilize Reynold's number, Advance coefficient, Froude's number, thrust coefficient, torque coefficient, open water efficiency and effective pitch to calculate various operating parameters of the model propeller and its prototype. 3.3.3 Explain Open water characteristics of the propeller. 3.3.4 Explain the concept of Bollard pull condition, 100% slip condition and feathering condition by drawing velocity diagrams for the same. 3.3.5 Explain the Bp-Delta diagram for the propeller. 3.3.6 Explain self-propulsion tests on ship 3.3.7 Indicate how Taylor's wake fraction, speed of advance, thrust deduction factor relative rotative efficiency are determined using thrust & torque identity to calculate hull & quasi-propulsive coefficient (QPC). 	7
<p>IV. General Learning Objective: Understand and explain cavitation of the propeller, it's effect and ways to mitigate it.</p> <p>Sub topic: Cavitation – cavitating flows, types of propeller cavitation, detrimental effects of cavitation, criteria for prevention of cavitation.</p> <p>Sub-sub topics & SLOs</p> <ul style="list-style-type: none"> 4.1.1 Define and explain the phenomenon of cavitation, vapour pressure and cavitation Number. 4.1.2 Explain different types of propeller cavitation: 4.1.3 Explain different detrimental effects of cavitation. 4.1.4 Explain different methods used to prevent the propeller cavitation. 4.1.5 Cavitation criteria and cavitation checks 	5
<p>General Learning Objective: Explain special types of propeller arrangements.</p> <p>Sub topic: Special types of propeller arrangements – FPP, CPP, Propellers in Nozzles, Paddle wheel, Vertical axis propellers – Voith Schneider, Jet propellers.</p> <p>Sub-sub topics & SLOs</p> <ul style="list-style-type: none"> 4.2.1 Briefly explain theory, advantages, disadvantages and applications of following special types of propeller arrangements. 4.2.2 FPP, CPP, Propellers in Nozzles, Paddle wheel, Vertical axis propellers – Voith Schneider, Jet propellers. 	5
V. Motion of ship on waves	
<p>General Learning Objective: Explain theories for the regular and irregular wave patterns.</p> <p>Sub Topic: Theory of waves. Trochoidal waves. Sinusoidal waves. Irregular wave pattern, Wave spectra.</p> <p>Sub-sub topics & SLOs</p> <ul style="list-style-type: none"> 5.1.1 Define and explain Regular and Irregular wave pattern. 5.1.2 Define and explain different types of regular waves. 5.1.3 Define and explain Trochoidal waves. Sinusoidal waves. 5.1.4 Define and explain wave period, wave energy, histogram of wave periods, energy spectrum, sea spectra, partially and fully developed sea. 	4
<p>General Learning Objective: Understand and utilize concepts of Added mass, Radius of Gyration to calculate period of motion for Roll, Heave and Pitch.</p> <p>Sub Topic: Ship motions – Roll, pitch, yaw, surge, sway and yaw; Forces caused by ship motions.</p>	4

<p>Sub-sub topics & SLOs</p> <p>5.2.1 Define and explain various undamped motions of ship in three dimensions.</p> <p>5.2.2 Derive expressions for period of motions for Rolling, Pitching and heaving.</p> <p>5.2.3 Define and utilize expressions for Added mass, Radius of Gyration and periods for Roll, Pitch and Heave motion.</p>	
<p>General Learning Objective: Explain theory and working principles of different Anti-rolling devices.</p> <p>Sub Topic: Anti-rolling devices- (i) Bilge keels (ii) Fin Stabilizers (iii) Passive and active anti-roll tanks.</p> <p>Sub-sub topics & SLOs</p> <p>5.3.1 Explain theory and working principles of following Anti-rolling devices</p> <p>5.3.2 Bilge keels, Fin Stabilizers, Passive and active anti-roll tanks</p>	2



Subject Name/Code: Marine Auxiliary and Deck Machinery/UG11T5604

Instructional Hours:

Lecture : 45 hours
Tutorial : 15 hours

Total contact hours : 60 hours

Credits : 4

Teaching Methods

The course shall be conducted in a combination of classroom/online lectures, practical in workshops and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments) : 30%
Final Written Exam : 70%

Text Book:

1. Marine Auxiliary machinery, D.W. Smith
2. Marine Auxiliary machinery, H.D. McGeorge

Reference:

1. Basic Marine Engineering - J.K. Dhar
2. Marine Engineering Practice - IMEI Publication
3. General Engineering Knowledge for Marine Engineers - Reeds Volume 8
4. Marine Machineries- Operation & Maintenance – T.B. Srinivasan, IMEI Publication.
5. The Running & Maintenance of Marine Machinery – J. Cowley by IMEI Publication.

Table of Topics

Unit	Topics	Hour (L)
I	Bunkering Bunker & Oil Transfer	5
II	Filters, Strainers and Oil Purifiers	15
III	Pollution Prevention Equipment-Oil Water Separator Incinerators, Sewage Treatment Plant, & BWTS	20
IV	Steering Gear including Automation and Control	10
V	Deck Machineries	10
Total		60

Learning Objectives		L
I. Bunker & Oil Transfer		
General learning Objective: A student should learn about standard practices followed for bunkering of fuel oil & sludge discharge.		5
Specific learning Objective To understand: Standard practices followed during bunkering, sludge transfer & fuel oil/Lubricating oil transfer on board the ship. Bunkering system for Fuel oil & Diesel Oil including safety equipment installed.		
1.1 Introduction to Bunkering procedure: 1.1.1 Explain Bunkering procedure on board ship along with safety and precaution 1.1.2 Line diagram for H.F.O & D.O 1.1.3 Introduction to sludge discharge to shore reception & other oil transfer procedures: 1.1.4 Line Diagram for sludge discharge to shore reception facility		

<p>II. Filter, Strainer: General learning Objective: A student learns about various types of filters used and how to specify them.</p> <p>Specific learning Objective:</p> <p>To understand:</p> <ul style="list-style-type: none"> 2.1 Difference between Filter & strainer 2.2 Different types of filters & their materials. 2.3 Auto clean filter, duplex filter, static filter. magnetic filter. micro filters 2.4 Filter maintenance & priming. <p>Filter & Strainer:</p> <ul style="list-style-type: none"> 2.1.1 Understand the requirements of filters. 2.1.2 Strainer & Filters 2.1.3 Explain specification of filters. 2.1.4 Various types of filters used on the Ship <p>Construction & working of:</p> <ul style="list-style-type: none"> 2.1.5 Auto Clean Filter 2.1.6 Duplex Filter 2.1.7 Magnetic Filter 2.1.8 Micro filter 2.1.9 Priming & core maintenance of filter 	5
<p>2.2 Oil Purification General Learning Objective: The student will learn about the various centrifuge and working principles. The student will also understand the purpose of settling & service tank & precautions taken before entering & cleaning tanks.</p>	10
<p>To understand:</p> <ul style="list-style-type: none"> Theory of lubrication, various methods of oil purification. Use of settling service tank & precautions taken before entering /cleaning tanks Principles of operation of different Centrifuges for heavy fuel oil & lubricating Oil. Operation of ALCAP System. <p>Introduction: Explain why fuel oil treatment is necessary</p> <p>Fundamentals of Purification:</p> <ul style="list-style-type: none"> 2.2.1 State principles of purifying to eliminate water or dirt particles from oil 2.2.2 Explain in simple terms, the purification by using gravity force and filters, and centrifugal separation 2.2.3 Explain how the force of gravity is used to separate out liquids and solids of different densities 2.2.4 Explain the velocity of separation due to “Stokes Law” -Explain why the use of centrifugal separation is much faster and more effective than gravity in the separation process <p>Construction and operation:</p> <ul style="list-style-type: none"> 2.2.5 Describe the operation principles of an oil purifier. 2.2.6 Describe the following with the aid of sketches: bowl, operating water valve, gravity disk, valve cylinder, plug screw, disk, 2.2.7 Describe, with the aid of simple sketches, a bowl separator and a tube separator, showing the main components and the principal differences between the two. 2.2.8 State the rotation speeds used in the equipment described in the above objective. 2.2.9 State sequence of discharging sludge 2.2.10 State why oil purifier needs following data concerning oil: Temperature, quantity of flow, density/specific gravity 2.2.11 Explain the function of gravity disk 2.2.12 Explain the function of low- and high-pressure water 2.2.13 Describe sludge discharging mechanism of an oil purifier 2.2.14 Explain the difference between purifying and clarifying 2.2.15 Describe the purification process of fuel oil, starting the approximate temperatures of the oil necessary both in the supply tank and immediately prior to centrifuging 2.2.16 Explain precautions for starting purifier and checking points to ensure a good working order 	

<p>2.2.17 Describe the correct procedures for the disposal of waste oil, sludge residue, etc.</p> <p>ALCAP Separators:</p> <p>2.2.18 Describe the operation of ALCAP system</p> <p>Settling Tank:</p> <p>2.2.19 Use of settling service tank & precautions taken before entering /cleaning tanks.</p>	
<p>III. Pollution prevention Equipment-Oil water separator Incinerators, sewage treatment plant, & BWTS (IMO 7.04,2014: F1/1.5.3)</p>	20
<p>3.1 Oily Water Separator</p> <p>3.1.1 Describe the requirements necessary for oily water separators/similar equipment.</p> <p>3.1.2 Describe the structure of oily water separators/similar equipment.</p> <p>3.1.3 Describe the oil separation principles of oily water separators/similar equipment.</p> <p>3.1.4 Describe the components constructing oily water separators/similar equipment.</p> <p>3.1.5 State the reasons to use positive-displacement pump for oily water separators/similar equipment.</p> <p>3.1.6 State the principles of oil content meter attached to oily water separators/similar equipment.</p> <p>3.1.7 Explain how to prevent oil being mixed into discharging bilge when oil content exceeds 15 ppm.</p> <p>3.1.8 State that fluid going through inside the pipe lines and oily-water separator/similar equipment can be correctly checked with pressure gauges.</p> <p>3.1.9 State that pollution of the sea is an offence under international law.</p> <p>3.1.10 State that the dumping of oil or oil-water mixtures is strictly prohibited.</p> <p>3.1.11 State that there is a legal maximum oil content of water to be discharged overboard.</p> <p>3.1.12 State that any discharge which could be contaminated must be passed through an oily-water separator which produces an effluent containing less than 100 ppm. of oil under all inlet conditions.</p> <p>3.1.13 State that the effluent should be further filtered to give an output containing a maximum of 15 ppm. of oil under all inlet conditions.</p> <p>3.1.14 Describe with the aid of a single line sketch, the operation of an automatic three-stage oily-water separator/similar equipment.</p> <p>3.1.15 List the information which must be entered in the Oil Record Book</p> <p>3.1.16 When pumping out bilges.</p>	8
<p>Explain BWTS construction, layout , types , operation of BWTP</p>	4
<p>3.2 Sewage Treatment Plant (IMO 7.04,2014: F1/1.5.2.2)</p> <p>3.2.1 Sketch and describe a typical Biological Sewage treatment plant used on board ships.</p> <p>3.2.2 Explain what is meant by a coliform count in sewage systems</p> <p>3.2.3 Explain what is meant by a sewage-retention system</p> <p>3.2.4 Explain the purpose of a sewage comminutor</p> <p>3.2.5 State that the effluent from a sewage plant must not be discharged in certain specified areas and that permission to discharge sewage must be obtained from the officer in charge of a navigational watch</p>	3
<p>3.3 Incinerator (IMO 7.04,2014: F1/1.5.2.2)</p> <p>3.3.1 Sketch and describe a typical Incinerator with an induced draft fan for the purpose of burning sludge and sold waste as per Annex 1 and Annex 5 of MARPOL</p>	3
<p>3.4 Explain briefly the purpose and operation of an incinerator for the disposal of:</p> <p>3.4.1 Sludge</p> <p>3.4.2 Refuse</p> <p>3.4.3 Explain the entries that need to be made in the Oil Record Book and the Garbage record Book with reference to the operation of the Incinerator.</p>	2
<p>IV. Steering Gear</p> <p>4.1 Operation and construction details of various types of steering machinery,</p> <p>4.2 ram, 4 ram & rotary type.</p> <p>4.3 Telemotor system,</p> <p>4.4 Hunting of steering gear,</p> <p>4.5 Emergency steering gear arrangement,</p> <p>4.6 Safematic steering gear with redundancy concept as per SOLAS,</p> <p>4.7 Care and maintenance of steering gear plants</p>	10

<p>V. Deck Machinery</p> <ul style="list-style-type: none">5.1 Explain the construction and operation of, Deck cranes, derricks and cargo access with visual Aids / illustrations of typical ones.5.2 Explain the construction and operation of, windlass and mooring winch with visual aids/illustrations of typical ones5.3 Explain the construction and operation of, boat winch with visual aids/illustrations of typical ones5.4 Explain the automation, monitoring and alarms of self-tensioning mooring winches.	10
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Subject Name/Code: Marine Components and Systems Design /UG11T5605

Instructional Hours

Lecture	: 45 hours
Tutorial	: 15 hours
Total contact hours	: 60 hours
Credits	: 4

Teaching Methods:

The course shall be conducted in a combination of classroom/online lectures, practical in workshops and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments)	:	30%
Final Written Exam	:	70%

Text Book:

1. Design of Machine Elements, V.B. Bhandari, TMH
2. Material Handling Equipment, Rudenko N, Latest Edition.

Reference:

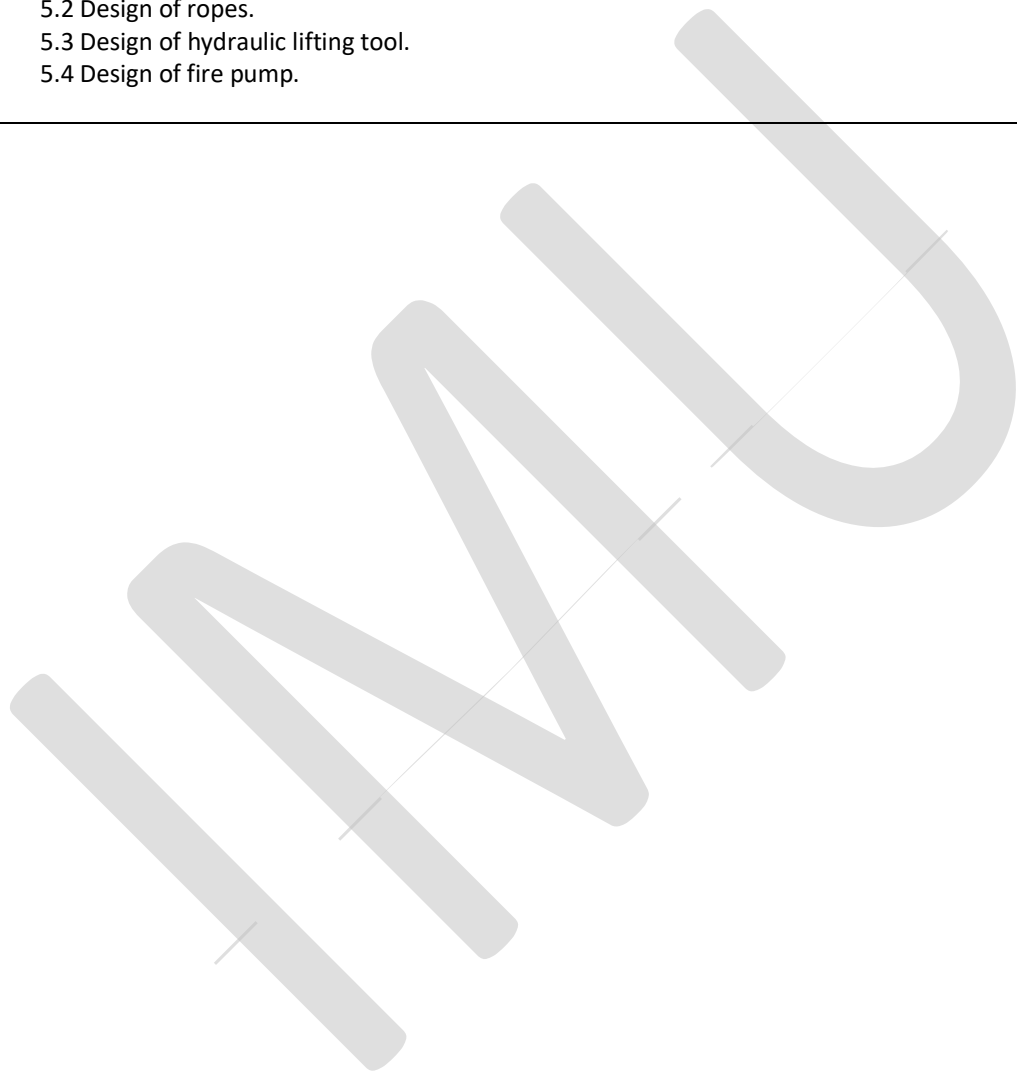
1. Machine Design, Pandya & Shah
2. IMO & Classification Society Publications
3. Motor Engineering Knowledge for Marine Engineers, REEDS Volume 12, Thomas d. Morton; Technical Editor, William Embleton; ISBN: 0900335521
4. Diesel Motor Ships Engines and Machinery; Christen Knak; G. E. C. Gad; ISBN: 978-8712467779
5. Materials for Marine Machinery, S. H. Frederick and H. Capper; Institute of Marine Engineers; ISBN: 0900976-42-x

Table of Topics

Unit	Topics	Hour (L)
I	Procedure in Mechanical Design Concepts of design, procedure & processes, Design synthesis and Feasibility, Use of Standards in design, limits, fits and tolerances, Selection of preferred sizes.	5
II	Components Design Design of: Helical springs, internal shoe brakes, centrifugal clutch.	15
III	Design of: Journal bearings, thick spherical shells, piston, and connecting rod.	15
IV	Design of Marine Systems Design of: Marine shafting system, propeller, rudder, thrust bearings, high lift safety valve.	15
V	Design of: chains, sprockets, ropes, Hydraulic lifting tool, fire pump.	10
	Total	60

Learning objectives	L
I. Procedure in Mechanical Design General Learning Objective Understand the procedure of design and apply in designing calculations.	5
Specific Learning Objectives Explain and apply the following: 1.1 Concepts of design procedure & processes. 1.2 Design synthesis and Feasibility. 1.3 Use of Standards in design, limits, fits and tolerances. 1.4 Selection of preferred sizes.	
II. Component Design General Learning Objective Design of some key components of marine systems.	15
Specific Learning Objectives 2.1 Design of compression and tension springs. 2.2 Design of internal shoe brakes. 2.3 Design of centrifugal clutch.	
III. Design of Bearings etc. General Learning Objective Design of some key components of marine systems.	15
Specific Learning Objectives 3.1 Design of journal bearings. 3.2 Design of thick spherical shells. 3.3 Design of piston. 3.4 Design of connecting rod.	

<p>IV. Design of Marine Systems General Learning Objective Design of some key components of marine systems.</p>	
<p>Specific Learning Objectives 4.1 Design of marine shafting system. 4.2 Design of propeller. 4.3 Design of rudder. 4.4 Design of thrust bearings. 4.5 Design of high lift safety valve.</p>	15
<p>V. Design of Chain, Rope and Lifting Tool General Learning Objective Design of some key components of marine systems.</p>	
<p>Specific Learning Objectives 5.1 Design of chains and sprockets. 5.2 Design of ropes. 5.3 Design of hydraulic lifting tool. 5.4 Design of fire pump.</p>	10



Subject Name: Code / Marine Instrumentation Engineering / UG11T5606

Instructional hours:

Lecture	: 45 hours
Tutorial	: 15 hours
Total contact hours	: 60 hours

Credits : 4

Teaching Methods

The course shall be conducted in a combination of classroom/online lectures, and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments)	:30%
Final Written Exam	:70%

Text Book:

1. A Course in Electrical and Electronic Measurements and Instrumentation, A.K Sahwney
2. A Course in Mechanical Measurements and Instrumentation and Control, A.K Sahwney

Reference:

1. Electrical Measurements and Measuring Instruments, R. Prasad (Khanna Publication)
2. Measurement and Control, A.K Sahwney (Dhanpat Rai Publication)
3. Modern Electronic Instrumentation and Measurement Techniques, Helfrick & Cooper
4. Electrical Measurement and Measuring Instruments, Golding & Waddis

Table of Topics

Unit	Topics	Hour(L)
I	Measurement and Error	10
II	Transducers and Sensors	18
III	Feedback Transducer System and Advanced Instruments System	10
IV	Actuators and Control Valves	15
V	Miscellaneous Instrumentation Onboard Ships	7
Total		60

Learning Objectives		L
<p>I. Measurement and Error</p> <p>1.1 Definitions,</p> <p>1.1.1 accuracy and precision, type of error, 1.1.2 statistical analysis, 1.1.3 probability of error, limiting errors</p> <p>1.2 System of units of Measurement-</p> <p>1.2.1 Fundamental and derived units, systems of unit, 1.2.2 Electric and Magnetic Units, 1.2.3 International system unit, other unit and conversion of unit.</p> <p>1.3 Standard of Measurements-</p> <p>1.3.1 Classification of standards, 1.3.2 standard of mass, 1.3.3 length and volume, 1.3.4 Time and frequency, 1.3.5 Electrical standards, 1.3.6 Standards of temperature and luminous intensity</p>	10	
<p>II. Transducers and Sensors-</p> <p>2.1 Active Electrical Transducer-</p> <p>2.1.1 Thermocouple. Magneto strictive Force transducer. 2.1.2 Hall effect Transducer. 2.1.3 Electromechanical Transducers- Tachometer, 2.1.4 Electromagnetic Flowmeter. 2.1.5 Photoelectric Transducer. 2.1.6 Ionization Transducer-Ionization Vacuum Gages. Digital Transducer-Digital Tachometer</p> <p>2.2 Passive Electrical Transducer-</p> <p>2.2.1 Resistive Transducer- Strain gauges, 2.2.2 Resistance Thermometers (RTD), 2.2.3 Thermistors. 2.2.4 Inductive Transducers- Displacement Transducer, 2.2.5 Inductive thickness transducer. 2.2.6 Capacitive Transducer- Capacitive thickness transducer, 2.2.7 capacitive moisture transducer.</p>		18

<p>2.3 Measurement of Physical Quantities</p> <p>2.3.1 Temperature Measurement- absolute thermodynamic, bimetallic element.</p> <p>2.3.2 Pressure Measurements- manometers- ring balance manometer, bell type manometer</p> <p>2.3.3 Force Measurement- helical spiral springs- cantilever beams- column and proving ring type load cell.</p> <p>2.3.4 Torque Measurement- torsion bar, flat spiral spring.</p> <p>2.3.5 Density Measurement – hydrometer system.</p> <p>2.3.6 Liquid level measurement – float element- level to pressure and force converter, torque-tube displace system, level measurement using Differential Pressure Detector.</p> <p>2.3.7 Viscosity measurement- viscosity to pressure, torque and displacement converter, displacement to pressure transducer.</p> <p>2.3.8 Flow measurement: orifice plate, Venturi tube, Pitot tube,</p> <p>2.3.9 Variable flow area meter: Rotameter</p> <p>2.4 Electrical and Electronic Transducer:</p> <p>Pressure Measurements:</p> <p>2.4.1 Linear variable differential transformers (LVDT),</p> <p>2.4.2 Piezoelectric Transducers</p> <p>2.5 Sensor Technology-</p> <p>2.4.1 Smart Sensor-Definition of smart sensor, configuration of smart sensor.</p> <p>2.4.2 Ultrasonic Sensors- Basics of ultrasonic sensor,</p> <p>2.4.3 SONAR.</p> <p>2.4.4 Optical Fiber Sensor-Basic of optical fiber sensor, optical fiber Humidity sensor, Semiconductor gas detector.</p>	
<p>III. Feedback Transducer System-</p> <p>3.1.1 Temperature balance system,</p> <p>3.1.2 Servo operated Electromagnetic</p> <p>3.1.3 Flowmeter,</p> <p>3.1.4 Non-contact position measurement.</p> <p>3.2 Advanced Instruments System-</p> <p>3.2.1 Digital multi meter,</p> <p>3.2.2 Digital storage Oscilloscope,</p> <p>3.2.3 Radiation Thermometer,</p> <p>3.2.4 thermal flowmeter,</p> <p>3.2.5 Condition monitoring- Vibration monitoring, Environmental Pollution Monitoring- Air pollution monitoring, water pollution monitoring.</p> <p>3.2.6 Introduction to interfacing transducer to electronic control and measuring system and computer-controlled test system (instruments used in computer-controlled instrumentation)</p>	10
<p>IV. Actuators and Control Valves</p> <p>4.1 Different types of Actuators</p> <p>4.1.1 Diaphragm actuators, Direct acting and Reverse acting actuators piston actuators (Single and Double acting) the various combinations of pneumatic diaphragm actuator and Valves,</p> <p>4.1.2 Air to open / air to close valves with actuators.</p> <p>4.1.3 Forward/ reverse acting actuators</p> <p>4.1.4 Electrohydraulic actuators</p> <p>4.1.5 Electric actuators, Electrical Servomotor, and Hydraulic servomotor</p> <p>4.2 Positioners</p> <p>4.2.1 Valve positioner and Volume Booster</p> <p>4.2.2 Cylindrical valve positioner with zero / span adjustment</p> <p>4.3 Valves</p> <p>4.3.1 Control valve characteristics (Linear, quick opening and equal percentage)</p> <p>4.3.2 Self-acting thermostatic valve</p> <p>4.3.3 Fail Safe and fail Set Strategies with respect to final control elements</p> <p>4.3.4 Proportional and servo valves</p>	15

V. Miscellaneous Instrumentation Onboard Ships

- 5.1 Fire detection system sensors
- 5.2 Flame eye sensor
- 5.3 Oil in water monitor
- 5.4 Echo sounder and Speed log (Pressure tube, Electromagnetic and Doppler log)
- 5.5 Instrument for UMS classification
- 5.6 ICCP system
- 5.7 Alarm and monitoring system
- 5.8 Cargo hold smoke detection system

7



Subject Name/Code: Shipboard Electrical Equipment and Protection Devices / UG11T5607

Instructional hours:

Lecture	: 45 hours
Tutorial	: 15 hours
Total contact hours	: 60 hours
Credits	: 4

Teaching Methods

The course shall be conducted in a combination of classroom/online lectures, and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments)	:30%
Final Written Exam	:70%

Text Book:

1. Marine Electrical Equipment and Practice (Marine Engineering Series); McGeorge, H. D; Publisher: Stanford Maritime; Year; ISBN 10: 0540073601 ISBN 13: 9780540073603

Reference:

1. Marine Electrical Equipment and Practice (Marine Engineering Series); McGeorge, H. D; Publisher: Stanford
2. Marine High Voltage Technology, J. Majumder, Elstan A. Fernandez, Lakshman Singh Yadav; Publisher: Shroff Publishers and Distributors; ISBN: 9788175981799.
3. High Voltage Engineering, M.S. Naidu, V Kamaraju; Publisher Tata McGraw–Hill
4. Practical Marine Electrical Knowledge, Dennis T. Hall.

Table of Topics

Unit	Topic	Hour (L)
I	Electrical Safety and Overview of a Ship's Electrical System	13
II	Isolated and Earthed Neutral Systems	11
III	Automatic Voltage Regulators, Exciters, Switchboards Switchgear and Fault Protection Devices	18
IV	Electric Cables, Insulation and Ingress Protection, Electrical Equipment for Hazardous Areas	18
V	High Voltage Installations, Lighting Systems and Deck Machinery	15
Total		60

Learning Objectives		L
<p>I. Electrical Safety and Overview of a Ship's Electrical System:</p> <p>1.1 The safety procedures to be adopted when working on electrical installations, effects of electric current on the human body, 1.2 Cause of electrical shock, safe voltage range, necessary safety precautions, isolation procedures, purpose of interlocks, bus bars, 1.3 Potential danger of instrument voltage / current transformer circuits and, the safe procedure for working on such circuits, 1.4 Safety and emergency procedures are documented in the ship's safety management system, Angles of heel and trim at which machinery should be capable of operating, Maximum temperatures of air and sea water used for design purposes, requirements regarding the provision of electrical power and lighting</p>	<p>13</p> <p>11</p> <p>18</p>	
<p>II. Isolated and Earthed Neutral Systems:</p> <p>2.1 Electrical interference, 2.2 Equipment susceptible to electrical interference, 2.3 Common sources of interference, 2.4 Method of suppression of interference, 2.5 Difference between insulated systems and earthed-neutral systems, 2.6 Resistance earthing, 2.7 Presence of earth faults in HV system</p>		
<p>III. Automatic Voltage Regulators, Exciters, Switchboards Switchgear and Fault Protection Devices:</p> <p>3.1 Voltage Regulation in an Alternator, 3.1.1 Main components of AVR, 3.1.2 Importance of paralleling alternators, 3.1.3 Methods of paralleling alternators, 3.1.4 Load sharing between generators running in parallel, 3.1.5 Automatic load sharing, 3.1.6 Excitation of rotor</p> <p>3.2 Purpose of Switches, 3.2.1 Circuit breakers and fuse, 3.2.2 Various types of closing mechanism of circuit breakers, 3.2.3 Tripping of CB, 3.2.4 Component parts of fault-protection equipment, 3.2.5 Short circuits, overcurrent protection, under voltage protection of generators and of motors,</p>		

<p>3.2.6 Purpose of reverse power protection, 3.2.7 Use of transformers for switchboard instruments, 3.2.8 Fault location to prevent damage</p>	
<p>IV. Electric Cables, Insulation and Ingress Protection, Electrical Equipment for Hazardous Areas: 4.1 Materials and Conductors, 4.1.1 Sheathing of cables, 4.1.2 Cable runs in machinery spaces; cargo holds and cold storage chambers, 4.1.3 Passing of cables through bulkheads and decks, 4.1.4 Reaction of electric cables to a fire, 4.2 Commonly used Insulation Materials on Ship, 4.2.1 Effect of temperature, oxidation, fire, oil, seawater, and solvents on insulation materials, 4.2.2 Salient Features of Insulating Materials (IP Notation; classification etc.) classes and applications of insulating materials, 4.2.3 Leakage in an insulated cable, insulation resistance, 4.2.4 Parameters affecting insulation resistance, 4.2.5 Ageing of insulating material 4.2.6 Equipment for Hazardous Areas</p>	18
<p>V. High Voltage Installations, Lighting Systems and Deck Machinery: Installations and Precaution while Working on High-voltage, significance of HV on ship, special characteristics and features of high-voltage installations in comparison with less than 1,000 V, 5.1 Principle of the Incandescent Lamp, 5.1.1 Power factor of fluorescent tubes, 5.1.2 Effect of radio interference on fluorescent, 5.1.3 Difference between lamps for general lighting and for rough service, principle of discharge lamps, 5.1.4 Effect of variation in voltage on both incandescent and gas-discharge lamps 5.2 Deck Machinery, 5.2.1 Fail safe brake, 5.2.2 Coil operated brake, 5.2.3 Deck winches and capstans, 5.2.4 Windlass and deck cranes</p>	15

Subject Name/Code: Marine Engine Simulator/UG11P5601

Instructional Hours

Practical : 45 hours

Credits

: 1.5

Teaching Methods

The course shall be conducted in a combination of Simulator room lectures / practical and self-learning.

Assessment Methods

Class Assessments (Written tests/MCQs/Projects/Assignments) : 50%

Final Written Exam : 50%

Unit	Topics	P
I	Aux Boiler Exercises <ul style="list-style-type: none"> • Preparing Boiler for firing, • Raising the Boiler Pressure, • Change over boiler to HFO, • connect the Two boilers 1 & 2 in parallel , Troubleshooting with Boiler operation 	6
II	Marine IC Engine Sub-Topics and Exercises for Various Operations and Troubleshooting: <ul style="list-style-type: none"> • Layout of Diesel Engine plant, • Operation & watch keeping, • Maintenance & Troubleshooting 	15
III	Marine Auxiliary Machinery Sub-Topics and Exercises for Various Operations: <ul style="list-style-type: none"> • Fresh water generator & hydrophore system, • Steering gear system, • Fresh water-cooling system, • Sea water cooling system, • Bilge system, • Ballast water system, • Fuel oil system, • Lubricating the oil system, • Compressed air & control air system 	12
IV	Marine Electrical Motor Starter & Control Drive Sub topics and Exercises for Various Operations: <ul style="list-style-type: none"> • Main air compressor 2 Nos. (Lead/lag) operation auto / manual circuit with all safeties, • Main Sea water pump 2 Nos. with auto stand-by starting circuit, • Starting from cold ship - Flushing of HFO Line, and • starting of DG Emergency Generator automatic starting & operation circuit 	12
Total		45

Subject Name/Code: Marine Electro Technology Lab/UG11P5602**Instructional Hours**

Practical : 45 hours

Credits : 1.5**Teaching Methods**

The course shall be conducted in a combination of ELECTRICAL LAB / practical and self-learning.

Assessment Methods

Class Assessments (Written tests/MCQs/Projects/Assignments) : 50%

Final Written Exam : 50%

List of Experiments

Exp.No.	Topic	P
I	Use of various measuring and testing instruments.	3
II	Familiarization of various Low tension switchgear components	3
III	Study and maintenance of MCB, MCCB	3
IV	Study and maintenance of ACB	3
V	Study and fault finding in tube light circuit	3
VI	Study and fault finding in fan (Single Phase A C. Induction Motor) circuit	3
VII	Overhauling of induction motor.	3
VIII	Study and fault finding in motor reversing circuit	3
IX	Study and fault finding in DOL starter	3
X	Study and fault finding in auto transformer starter	3
XI	Study and fault finding in star delta starter	3
XII	Study of VFD for three phase induction motor	3
XIII	Study of soft starter for three phase induction motor	3
XIV	Study of charging and discharging of lead acid battery	3
XV	Study and fault finding in delta-delta transformer low voltage feeder panel	3
Total		45

SEMESTER – VII

Subject Name/Code: Marine Diesel Engines – Modern Trends and Maintenance /UG11T5701

Instructional Hours:

Lecture	: 45 hours
Tutorial	: 15 hours
Total contact hours	: 60 hours
Credits	: 4

Teaching Methods

The course shall be conducted in a combination of classroom/online lectures and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments:	30%
Final Written Exam	: 70%

Text Book:

1. Pounder C.C: Marine Diesel Engines, Newnes-Butterworths, London.
2. Cowley J.K, The Running and Maintenance of Marine Machinery, Institute of Marine Engineers

Reference:

1. Marine Diesel Standard Practices (DEMA).
2. Jackson L & Morton T.D: General Engineering Knowledge for Marine Engineers, Thomas Reed Publications
3. Marine Engineering by group of authorities, Editor: Roy L Harrington, ISBN: 0-939773-10-4, SNAME (USA).
4. Hunt, E. C. Modern Marine Engineer's Manual. United State: Cornell Maritime Press.

Table of Topics

Unit	Topic	Hour (L)
I	Maintenance of Diesel Engines	13
II	Latest Developments in Marine Engines	12
III	Engine Hazards	9
IV	Engine Emission Control	13
V	Modern Trends in Engine Combustion	13
	Total	60

Learning Objectives		L
<p>I. Maintenance of Diesel Engines General Learning objective: Understand the maintenance routines of diesel engines and apply knowledge while working on them. Specific learning objectives:</p> <ul style="list-style-type: none"> 1.1 Dismantle and inspection for wear measurement and deterioration of: Pistons, rings, liners, bearings, 1.2 Cooling passages, Lubrication system, cross head, stuffing box, fuel injector, starting valve, Driving chain and gears. 1.3 Dismantle and inspection of for wear and deterioration of turbo charger: Erosion on air side, Impeller, Nozzles, blades, Condition of labyrinths- clearance checking during reassembling 1.4 Examine the causes, symptoms, effects, and methods of treatment of oils that have been infected with microbiological organisms 1.5 Maintenance of hydraulic jacks 1.6 Trouble shooting in Diesel engines 1.7 Explain the meaning of starting failure in diesel engines 1.8 Propulsion engine unit cut-out/ part load operation, slow speed, ultra-low speed running precautions. 	13	
<p>II. Latest Devolvement's in Marine Engines. General learning objective: Understand the changes and developments in marine diesel engines and associated systems. Specific learning objectives:</p> <ul style="list-style-type: none"> 2.1 Concept Intelligent engine (cam-less engine) 2.2 Salient features: MAN B&W ME and Sulzer/Wartsila RT-Flex marine diesel engines. 2.3 Computerized monitoring of marine diesel engines 2.4 Methods to increase the time between overhauls in diesel engine (PMI) 2.5 Explain Engine alarms and protection systems (Alarms, slowdown & Shutdown) 		12
<p>III. Engine Hazards General learning objective: Understand the safety and prevention of mishaps in marine diesel Engines. Specific learning objectives:</p> <ul style="list-style-type: none"> 3.1 Causes and prevention of crank-case explosions, scavenge fires & starting airline explosion. 3.2 Detection of same and safety fittings provided to prevent damage. 3.3 Uptake fires, and other engine safeties. 3.4 Oil mist detectors 		9

<p>IV. Engine Emission Control General learning objective: Understand the Emission regulations and systems on diesel engines to meet these regulations. Specific learning objectives: 4.1 NO_x – Control of marine Diesel Engines. 4.2 SO_x Control, and IMO regulations in ECA & SECA. MCR & CSR with Propeller curve relationships 4.3 Scrubbers (Open loop and closed loop) 4.4 Exhaust gas recirculation (EGR) 4.5 Catalytic converters (SCR)</p>	13
<p>V. Modern Trends in Engine Combustion General learning objective: Understand the modern trends in engine combustion with the use of alternate fuels. Specific learning objectives: 5.1 Dual fuel combustion (ME-GI/GA, WinGD X-DF engines) 5.2 Lean mixture combustion 5.3 Combustion of dual fuels like Methanol, Hydrogen 5.4 Control and safety in handling NH₃, LNG & Hydrogen 5.5 Dual fuel combustion in 4 stroke engines</p>	13

Subject: Name/Code: Ship Operations and Management / UG11T4702

Instructional hours:

Lecture	: 45 hours
Tutorial	: 15 hours
Total contact hours	: 60 hours
Credits	: 4

Teaching Methods

The course shall be conducted in a combination of classroom/online lectures, practical in workshops and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments)	: 30%
Final Written Exam	: 70%

Text Book:

1. A Practical Guide, Swift, Capt. A.J., Bridge Team Management the Nautical Institute, London (ISBN 1-870077-14-8)

Reference:

1. International convention on Standards of training, certification and watch keeping for STCW1978 as amended 2011 edition. (ISBN978-92-801-15284)
2. R4 International Safety Management Code (Ism Code) and Guidelines on Implementation of the ISM Code Code Ib117E ISBN 978-92- 801-51510
3. R59 Guidelines on Fatigue Code I968 E ISBN 978-92-801-51282
4. R60 Imo/Ilo Guidelines for the Development of Tables of Seafarers' Shipboard Working Arrangements and Formats of Records of Seafarers' Hours of Work or Hours of Rest (1999 Edition) Code I973E ISBN 978-92-801-60956
5. B1 Anderson, P. – Ism Code: A Guide to the Legal and Insurance Implications. London, Lloyd's of London Press. (ISBN: 1-859-786-21-9)

Reference (Videos):

1. V23 Crisis Management Code No. 507
2. V25 Theinternationalsafetymanagementcodeno.524
3. V36 Personalsafetyonpassengershipscodeno.563
4. V42 Marine risk assessment–Thefleetcodeno.735
5. V43 Management On Board – Part 1 Code No.607
6. V44 Gets mart: Organisation and Planning–Part2codeno.608
7. V45 Get Results: Planning for profit–Part3codeno.609
8. V46 Teamwork – Part 4 Code No.610
9. V47 Motivating individuals–Part5codeno.611
10. V48 Communication – Part 6 Code No.612

Table of Topics

Unit	Topic	Hour (L)
I	Engine Room Resource Management	9
II	Application of Effective Resource Management at Management Level	9
III	Task and Workload Management	9
IV	Safety Management System , ISM and Safety Measures	9
V	Risk Management and Decision Making Techniques	9
VI	Shipboard Personnel Management	8
VII	Training Methods	7
Total		60

Learning objectives		L
<p>I. Engine Room Resource Management (IMO 7.04,2014: F1/1.1.4)</p> <p>1.1 Explain ERM principles ERM principles 1.2 Discuss STCW Code, Ch VIII, section A-VIII/2, part 3, para 8 1.3 Explain ERM in terms of maintaining Safe engineering watches 1.4 Resources and Importance in ERM 1.5 Explain personal Management, Information management and equipment management 1.6 Practicing ERM- Allocation, assignment, and prioritization of the resources</p>	9	
<p>II. Application of Effective Resource Management at Management Level (IMO 7.02,2014: F4 :4.5.4)</p> <p>General learning objectives Learn how to effectively apply resource management at management level</p> <p>Specific Learning Objectives</p> <p>2.1 Review theories on effective communication 2.2 Demonstrate effective communication in simulated or real situations involving communications on board ship and between ship and shore 2.3 Discuss how management level officers can encourage other personnel to use effective Communications 2.4 Review theories on effective resource allocation, assignment and prioritization 2.5 Demonstrate the effective allocation, assignment and prioritization of resources when managing simulated or real shipboard activities 2.6 Review theories on decision making that considers team experience demonstrate the ability to involve team member effectively in decision making when managing simulated or real shipboard activities 2.7 Review theories on assertiveness and leadership 2.8 Demonstrate the ability to obtain and maintain situational awareness when managing complex simulated or real shipboard activities 2.9 Review theories on the use of short- and long-term strategies 2.10 Demonstrate the ability to apply short- and long-term strategies when managing simulated or real shipboard activities 2.11 Discuss appropriate leadership styles and levels of assertiveness for management level officers in a range of shipboard activities 2.12 Demonstrate the ability to apply appropriate leadership styles and levels of assertiveness when managing simulated or real shipboard activities 2.13 Review theories on obtaining and maintaining situational awareness</p>	9	

<p>III. Task and Workload Management (IMO 7.02,2014: F4 :4.5.1)</p> <p>General learning objective Learn to effectively manage the workload and task distribution to avoid overloading and underutilizing crew members</p> <p>Specific Learning Objectives</p> <p>3.1 Review theories on applying task and workload management from IMO model course 1.39, Leadership and teamwork explain that the scope of activity and conflict between activities managed by management level officers is broader than for operational level officers and requires greater task and workload management ability</p> <p>3.2 Plans the task and workload allocation for significant shipboard activities so that the following are considered:</p> <ul style="list-style-type: none"> - Human limitations - Personal abilities - Time and resource constraints - Prioritization - Workload, rest and fatigue <p>3.3 Discuss strategies to monitor the effectiveness of task and workload management during an activity and to adjust the plan as necessary</p> <p>3.4 Discuss strategies to ensure that all personnel understand the activity to be undertaken and their tasks in this</p> <p>3.5 Discuss whether the encouragement of a challenge and response environment is appropriate to the task and workload management of particular shipboard tasks</p> <p>3.6 Discuss the importance of debriefs and reflection after activities have been conducted to identify opportunities for improving task and workload management</p>	9
<p>IV. Safety Management System, ISM and Safety Measures (IMO 7.04,2014: F 3, 3.2.1)</p> <p>Specific Learning Objectives</p> <p>4.1 Explain ISM code, and its need.</p> <p>4.2 Explain briefly how a SMS (safety Management system) should be established.</p> <p>4.3. List the documents included in a typical SMS.</p> <p>4.4. List documents, checklists and others for safety measures for maintenance and repair</p>	9
<p>V. Risk Management and Decision Making Techniques (IMO 7.02,2014: F4 :4.5.5)</p> <p>5.1 Situation and risk assessment</p> <p>5.1.1 Review theories of situation and risk assessment</p> <p>5.1.2 Discuss formal and informal approaches to risk assessment</p> <p>5.1.3 Identify typical risks that management level officers may have to assess</p> <p>5.1.4 Demonstrate the ability to effectively assess risk in the planning and conduct of simulated or real shipboard activities</p> <p>5.2 Identify and generate options</p> <p>5.2.1 Review theories on identifying and generating options</p> <p>5.2.2 Demonstrate the ability to identify and generate options when 1</p> <p>5.2.3 making decisions as a management level officer in simulated or real shipboard activity</p> <p>5.3 Selecting course of action</p> <p>5.3. 1 Review theories on selecting the course of action in making decisions</p> <p>5.3.2 Demonstrate the ability to select appropriate courses of action when making</p> <p>5.3.3 Decisions as a management level officer in simulated or real shipboard activity</p> <p>5.4 Evaluation of outcome effectiveness</p> <p>5.4.1 Explain how to carry out the evaluation of outcome effectiveness and the importance of doing it</p>	9

<p>5.5 Standard operating procedures (SOP):</p> <p>5.5.1 Discuss approaches to developing standard operating procedures(SOPs)</p> <p>5.5.2 Explain the methods to implement the SOPs</p> <p>5.5.3 Explain why it may be desirable for there to be oversight and approval of many SOP's</p>	
<p>VI. Shipboard Personnel Management Principles of controlling subordinates and maintaining good relationships and crew employment (IMO 7.02,2014: F4 :4.5.1) General learning objectives Understand Shipboard Personnel Management including Principles of controlling subordinates and maintaining good relationships and crew employment Specific Learning Objectives</p> <p>6.1 Identify sources of authority and power</p> <p>6.2 Discuss theories on how effective authority and power may be enhanced or diminished by management level officers on ships</p> <p>6.3 Review theories in cultural awareness and cross-cultural communication</p> <p>6.4 Discuss strategies that management level officers could adopt to enhance their effectiveness in managing crews of different culture</p> <p>6.5 Review theories in human error, situational awareness, automation awareness, complacency and boredom</p> <p>6.6 Discuss strategies that management level officers can adopt to optimize situational awareness and to minimize human error and complacency of individuals and teams</p> <p>6.7 Discuss strategies that management level officers can adopt to enhance leadership and teamwork</p> <p>6.8 Discuss theories of personnel motivation and relates these to shipboard situations encountered by management level officers</p> <p>6.9 Explain that an individual's motivation and wellbeing may be affected by both real and perceived influences on board ship and at home</p> <p>6.10 Discuss strategies that management level officers could adopt to optimize the motivation of individuals and teams</p> <p>6.11 Discuss theories on coaching individuals and teams to improve performance</p> <p>6.12 Discuss approaches to managing and improving the performance of oneself, individuals and teams</p> <p>6.13 Prepare for and conducts a simulated formal performance review</p> <p>6.14 Identify the impact of repeated harassment including bullying on individuals</p> <p>6.15 Recognizes indications that crew members may be physically or mentally unwell or badly demotivated describe strategies that can be adopted when a crew member is believed to be physically or mentally unwell or badly demotivated</p> <p>6.16 Describe strategies that management level officers can take to ensure that crew remain physically well and are encouraged to remain physically active</p> <p>6.17 Explain the need for management level officers to be fully familiar with the requirements of national law relating to crew employment and of all crew agreements in place on the ship</p> <p>6.18 Discuss the process for signing on and discharging crew under national law</p> <p>6.19 Discuss the need to ensure that new crew are appropriately certificated, competent and familiarized with the safety management system, security plan, working procedures and equipment of the ship</p> <p>6.20 Explain that procedures for conducting investigations and applying consequences in disciplinary situations are governed by national law, codes of conduct, employment agreements and company procedures</p> <p>6.21 Explain the process for investigating and applying consequences in Disciplinary situations</p> <p>6.22 Explain the formal process for addressing continuing levels of unacceptable performance by a crew member including harassment and bullying under national law</p> <p>6.23 Explain requirements for handling crew wages, advances and allotments when this is done by management level officers on board ship</p>	8
<p>VII. Training Methods: (IMO 7.02,2014: F4 :4.5.1)</p> <p>7.1 Discuss the resources that may be available on-board ship that can be used for Training</p> <p>7.2 Review training methods that could be adopted on board ship</p> <p>7.3 Discuss the effectiveness of training methods that can be adopted for training:</p>	

<ul style="list-style-type: none">- in attitude- in skills- in knowledge <p>7.4 Describe the preparation needed before the start of a training session</p> <p>7.5 Discuss methods for ensuring that crew are motivated to participate fully in training</p> <p>7.6 Demonstrate how to conduct a training session for a given topic</p> <p>7.7 List the areas in which training is required by regulation</p>	7
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Subject Name/Code: Marine Conventions and Maritime Law / UG11T5703

Instructional Hours

Lecture	: 60 hours
Tutorial	: 15 hours
Total contact hours	: 60 hours
Credits	: 4

Teaching Methods

The course shall be conducted in a combination of classroom lectures, practical in workshops and self-learning.

Assessment Methods

Class Assessments (Written tests/MCQs/Projects/Assignments)	: 30%
Final Written Exam	: 70%

Text Book:

1. UNCLOS 1982
2. Shipboard Management, Simon Daniels 1st Edition 2024
3. The Law of the Sea, M. E. ALIYAR, 1st Edition 2022

Reference:

1. Commentary on SOLAS, Bhandarkar Publications
2. International Convention on Load Line, IMO Publication
3. Code of Safe Working Practices for Merchant Seafarers, Maritime & Coast Guard Agency
4. International Ship and Port Facility Security Code, IMO Publications
5. BMP5: Best Management Practices to Deter Piracy and Enhance Maritime Security in Red sea, Gulf of Aden, Indian Ocean and Arabian sea, Witherbys
6. Maritime Labour Convention, ILO Publication
7. International Medical Guide for Ships, WHO Publications
8. International Convention on Salvage.
9. Convention on limitation of Liability for Maritime Claims.
10. Civil Liability Convention.
11. Bunker Convention

Table of Topics

Unit	Topics	Hour (L)
I	Maritime Law	5
II	Conventions on Safety	15
III	Safety and Security, Labour and Health	15
IV	Port State Control, Salvage Convention, LLMC, Oil Pollution Compensation, London Dumping Convention	15
V	Shipping Business	10
	Total	60

Learning objectives	L
<p>I. Introduction to maritime law (IMO 7.04, 2014: Competence 4.6.1 /1.2) Explain the need of Maritime Law Explain the role of UN, IMO and ILO Explain the role of Flag state and Port state in implementation of Law Introduction to UNCLOS, SOLAS, MARPOL, STCW and MLC</p>	2
<p>1.1 UNCLOS (IMO 7.04, 2014: Competence 4.6.1 /1.1) 1.1.1 Explain the need of UNCLOS 1.1.2 Explain why it is referred as Umbrella Convention. 1.1.3 Explain Baseline and Straight Baseline 1.1.4 Explain Territorial Sea and its limits 1.1.5 Explain Internal Waters 1.1.6 Explain Contiguous zone 1.1.7 Explain Exclusive Economic Zone 1.1.8 Explain Continental shelf 1.1.9 Explain High Seas 1.1.10 Explain Innocent Passage 1.1.11 Explain Criminal and Civil Jurisdiction on board a foreign vessel 1.1.12 Explain Freedom of the High Seas 1.1.13 Explain Piracy and right of hot pursuit 1.1.14 Explain Pollution and Dumping</p>	3
<p>II. SOLAS (IMO 7.04, 2014: Competence 4.6.1 /1.3) 2.1.1 Explain the need of SOLAS 2.2.2 Explain the factors which lead to convening of 1914 International SOLAS convention 2.1.3 Explain Tacit acceptance amendments procedure and development of SOLAS 1974 2.1.4 Explain general obligations of contracting governments. 2.1.5 Explain important definitions such as Passenger ship, cargo ship, tanker, age of ship, international voyage. 2.1.6 Explain role of Flag state and Port state in implementing SOLAS</p>	5
<p>2.2 Fire protection, detection and extinction: (IMO 7.04, 2014: Competence 4.6.1 /1.3) 2.2.1. State special requirements for ships carrying dangerous goods 2.2.2 Explain the basic principles of the regulation on fire protection 2.2.3 Explain regulations for Fire Hydrant, Hoses and Fire Pumps.</p>	3

2.2.4 Describe fire alarm and detection system regulations.	
2.3 LSA and arrangements :(IMO 7.04, 2014: Competence 4.6.1 /1.3) 2.3.1. Explain inspection and certification by Flag State - Certified Person, Float-free launching, Inflatable appliance, Inflated appliance, Launching appliance or arrangement, Life boat, rescue boat, survival craft	3
2.4 Carriage of dangerous goods (IMO 7.04, 2014: Competence 4.6.1 /1.3) 2.4.1 Explain the regulations concerning carriage of dangerous goods in packaged form- IMDG Code including classification of goods. Specifications of documents, PSN 2.4.2 Explain the regulations concerning carriage of dangerous goods in bulk- IBC Code 2.4.3 Explain the regulations of International Gas Carrier Code- IGC Code 2.4.4 List the survey requirements of a Chemical Tanker	2
2.5 Load Line Convention (IMO 7.04, 2014: Competence 4.6.1 /1.3) 2.5.1 Explain the need of Load Line Convention 2.5.2 Explain to which ships convention applies. 2.5.3 Describe the items to checked during load line survey 2.5.4 Explain features of Load Line Certificate, validity, who issues and when it can be cancelled	2
2.6 Code of Safe Working Practices for Merchant Seaman (IMO 7.04, 2014: Competence 4.6.1 /1.3) 2.6.1 Explain the need and purpose of the safe working practices code 2.6.2 Explain the duties of ship-owner and seafarer w.r.t code. 2.6.3 Describe safe working culture 2.6.4 Explain Occupational Safety 2.6.5 Explain precautions taken while handling heavy loads. 2.6.6 Explain the role of Safety Committee and Safety Officials onboard.	3
2.7 International Ship and Port Facility Security Code (ISPS Code) (IMO 7.04, 2014: Competence 4.6.1 /1.3) 2.7.1 Explain the need and purpose of the code and its implementation 2.7.2 Explain the obligations of contracting governments and Companies / Ship w.r.t code 2.7.3 Describe features of Ship Security Plan 2.7.4 Explain the role of CSO and SSO 2.7.5 Explain different security levels 2.7.6 Describe the need and features of AIS	3
III. BIMCO 3.1. Explain the role of BIMCO 3.2 Baltic Exchange	3
3.1 Maritime Labour Convention (IMO 7.02, 2014: Competence 4.2 /1.6.2) 3.1.1 Explain the role of International Labour Organisation 3.1.2 Explain the need and purpose of the Maritime labour Convention 3.1.3 Explain the purpose of medical fitness certificate 3.1.4 Explain the regulations for wages, rest hours, leave, repatriation 3.1.5 Describe duties of ship owner w.r.t. occupational safety and health 3.1.6 Explain Social Security 3.1.7 Describe the responsibilities of flag state in implementation of MLC 3.1.8 Explain Inspection and certification of MLC 3.1.9 Explain complaints procedure 3.1.10 Explain responsibilities of Port state 3.1.11 Explain the responsibility of Labour Supplier	3
3.2 International Health Regulations (IMO 7.02, 2014: Competence 4.2 /1.5)	2

<p>3.2.1 Explain the role of WHO in Shipping.</p> <p>3.2.2 Describe features of International Medical Guide for Ships.</p> <p>3.2.3 Describe features of Maritime Declaration of Health</p> <p>3.2.4 Describe the regulations for control of Plague, Cholera and Yellow fever.</p> <p>3.2.5 Explain how the spread of communicable disease on ship is achieved.</p>	
<p>IV International Convention on Salvage 1989 (IMO 7.02, 2014: Competence 4.2 /1.6.3)</p> <p>4.1.1 Define Salvage.</p> <p>4.1.2 Explain Duty of Life Salvage</p> <p>4.1.3 Explain the duties and rights of Salvor</p> <p>4.1.4 Explain the principal of “No Cure No Pay”.</p> <p>4.1.5 Describe the features of Salvage Convention.</p> <p>4.1.6 Explain the features of LOF</p> <p>4.1.7 Explain the criteria for assessing reward.</p> <p>4.1.8 Explain SCOPIIC.</p> <p>4.1.9 Explain Salvor’s Maritime Lien</p>	4
<p>4.2 Oil Pollution Compensation Conventions (IMO 7.02, 2014: Competence 4.2 /1.8)</p> <p>4.2.1 Explain the financial impact of Oil Pollution.</p> <p>4.2.2 Describe the important features of Civil Liability Convention 1969</p> <p>4.2.3 Describe the changes in above convention in 1992</p> <p>4.2.4 Describe the features of Fund Convention.</p> <p>4.2.5 Describe the features of Supplementary Fund Convention.</p> <p>4.2.6 Describe the features of Bunker Convention.</p>	3
<p>4.3 London Dumping Convention (IMO 7.02, 2014: Competence 4.2 /1.8)</p> <p>4.3.1 Explain the need of the convention.</p> <p>4.3.2 Describe the features of the Three annexes</p> <p>4.3.3 Describe the 1996 protocol</p>	2
<p>4.4 Classification Society (IMO 7.02, 2014: Competence 4.2 /1.6.5)</p> <p>4.4.1 Explain the need of the classification.</p> <p>4.4.2 Describe the role of Classification Society in approving plan, supervising ship building, Testing of material and equipment.</p> <p>4.4.3 Describe the features of survey conducted by classification society for hull and safety.</p> <p>4.4.4 Explain continuous survey of machinery.</p> <p>4.4.5 Explain features of Annual, docking and special survey.</p> <p>4.4.6 Explain “Condition of Class”</p> <p>4.4.7 Explain the impact of suspension and withdrawal of class on ship operation.</p> <p>4.4.8 List the surveys conducted on passenger ship and cargo ship and certificates issued and their validity.</p> <p>4.4.9 Describe the requirements of Radio Survey, and Machinery survey.</p>	3
<p>4.5 Port State Control (IMO 7.02, 2014: Competence 4.2 /1.7)</p> <p>4.5.1 Explain the need of the inspection of ship by Port state.</p> <p>4.5.2 Explain primary responsibility of Port State with respect to shipping</p> <p>4.5.3 Explain Concentrated Inspection Campaign.</p> <p>4.5.4 Describe the features of inspection conducted by Port State Control when a ship visits the port.</p> <p>4.5.5 Explain meaning of “clear grounds” for inspection and its significance.</p> <p>4.5.6 Describe the deficiencies which can lead to detention.</p>	3
<p>V. General Average and Marine Insurance (IMO 7.02, 2014: Competence 4.2 /1.6.6)</p> <p>5.1.1 Define General Average Act.</p> <p>5.1.2 Explain how GA Compensated.</p> <p>5.1.3 Explain the need of Insurance.</p>	3

<p>5.1.4 Explain the Principles of Insurance as per MIA 1963 such as UGF, Insurable Interest, Indemnity, Proximate Cause, Subrogation and Contribution.</p> <p>5.1.5 Explain the Practices of Insurance such as Warranty, Institute warranties, Duty of Assured, Sue and labour, Actual Total Loss and Constructive Total loss</p> <p>5.1.6 Explain Voyage, Time and Floating Policies</p> <p>5.1.7 Explain the perils usually covered in Hull & Machinery and Cargo Policies</p> <p>5.1.8 Explain the need of Protection and Indemnity Insurance.</p> <p>5.1.9 Discuss the duties and perils covered by P & I clubs.</p>	
<p>5.2 Charter parties (IMO 7.02, 2014: Competence 4.2 /1.6.7)</p> <p>5.2.1 Explain the concept of chartering</p> <p>5.2.2 Explain Bareboat, Voyage and Time Charter with responsibilities of Charterer and Ship Owner.</p> <p>5.2.3 Explain Freight and Hire</p> <p>5.2.4 Explain Lay days and cancelling date (Lay can).</p> <p>5.2.5 Explain Lay time, Demurrage and Dispatch.</p> <p>5.2.6 Explain Notice of Readiness.</p> <p>5.2.7 Explain Delivery and Redelivery along with On-Hire and Off-Hire survey</p> <p>5.2.8 Explain Off hire.</p> <p>5.2.9 Bill of Lading</p> <p>5.2.10 Functions</p> <p>5.2.11 COGSA</p> <p>5.2.12 Types of bill of lading- Electronic Bill of lading</p>	7

Subject Name/Code: Sustainable Development Goals/UG11T5704

Instructional hours:

Lecture : 45 hours

Total contact hours : 45 hours

Credits : 3

Teaching Methods

The course shall be conducted in a combination of classroom/online lectures and self-learning.

Assessment Methods:

Class Assessments (Written tests/MCQs/Projects/Assignments) : 30%

Final Exam : 70%

Text Book:

1. Sustainable Development Goals: An Indian Perspective (Sustainable Development Goals Series) Hardcover – Import, 28 July 2020, Anindya Bhukta (Editor), Somnath Hazra (Editor)

Reference:

1. Ann E. Burg Illustrator: Sean Qualls ISBN: 978-0545535670 Publisher: Scholastic Press
2. Katie Smith Milway Illustrator: Sylvie Daigneault ISBN: 978-1554534883 Publisher: Kids Can Press
3. Thich Nhat Hahn Illustrator: Wietske Vriezen ISBN: 978-1937006211 Publisher: Plum Blossom
4. Elizabeth Suneby Illustrator: Suana Verelst ISBN: 978-1554538164 Publisher: Kids Can Press
5. Malala Yousafzai ISBN: 978-1526361592 Publisher: Hachette Childrens Group
6. William Kamkwamba and Bryan Mealer Illustrator: Elizabeth Zunon ISBN: 978-0147510426 Publisher: Puffin Books
7. Gayathri Bashi ISBN: 978-9386667632 Publisher: Tulika Publishers

Table of Topics

Unit	Topic	Hour (L)
I	Introduction to Global Goals	1
II	Brief Introduction - About Goals	4
III	Good Health and Well-Being (SDG 3)	8
IV	Quality Education (SDG 4)	8
V	Gender Equality (SDG 5)	8
VI	Affordable and Clean Energy (SDG 7)	8
VII	Life Below Water and Climate Action (SDG 14 & SDG 15)	8
Total		45

Learning Objectives	L
I. SDG of UN Familiarization with Sustainable development goals of UN	1
<p>The 17 Global Goals, also known as the Sustainable Development Goals (SDGs), are a universal call to action to end poverty, protect the planet, and ensure prosperity for all by 2030. Adopted by all United Nations Member States in 2015, these goals are integrated and indivisible, balancing the economic, social, and environmental dimensions of sustainable development.</p> <p>II. The 17 Global Goals:</p> <ul style="list-style-type: none"> 2.1 No Poverty 2.2 Zero Hunger 2.3 Good Health and Well-Being 2.4 Quality Education 2.5 Gender Equality 2.6 Clean Water and Sanitation 2.7 Affordable and Clean Energy 2.8 Decent Work and Economic Growth 2.9 Industry, Innovation and Infrastructure 2.10 Reduced Inequalities 2.11 Sustainable Cities and Communities 2.12 Responsible Consumption and Production 2.13 Climate Action 2.14 Life Below Water 2.15 Life on Land 2.16 Peace, Justice and Strong Institutions 2.17 Partnerships for the Goals 	4
III. Good Health and Well-Being (SDG 3) Objective: Ensure healthy lives and promote well-being for all at all ages. Key Actions: Reduce maternal and child mortality, combat diseases, ensure access to essential health services, and promote mental health.	

<p>3.1 Physical Health Nutrition Exercise Sleep Preventive Care</p> <p>3.2 Mental Health Stress Management Social Connections Mental Health Services</p> <p>3.3 Social Well-Being Community Engagement Work-Life Balance Safe and Healthy Environment</p> <p>3.4 Lifestyle Choices Avoiding Harmful Behaviours Hygiene Practices, Healthy Relationships</p> <p>Achieving Good Health and Well-Being (SDG 3) is essential for the overall well-being and sustainable development of societies. It requires a comprehensive approach that includes strengthening healthcare systems, ensuring universal health coverage, emphasizing preventive care, addressing both infectious and non-communicable diseases, improving maternal and child health, and fostering global partnerships. By prioritizing health and well-being, we can create more resilient and prosperous communities worldwide.</p>	<p>2</p> <p>2</p> <p>2</p> <p>2</p>
<p>IV. Quality Education (SDG 4)</p> <p>Objective: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.</p> <p>Key Actions: Increase access to education, improve learning outcomes, and ensure lifelong learning opportunities.</p> <p>4.1 Components of Quality Education Inclusive and Equitable Access Qualified Teachers Relevant Curriculum Safe and Supportive Learning Environment Early Childhood Education Assessment and Accountability</p> <p>4.2 Strategies for Achieving Quality Education Policy and Investment Public-Private Partnerships Community Involvement Technology Integration Focus on Marginalized Groups Lifelong Learning Opportunities</p> <p>Achieving Quality Education (SDG 4) is essential for creating a sustainable and equitable world. By addressing the barriers to education and implementing comprehensive strategies, we can ensure that all individuals have the opportunity to receive quality education and lifelong learning opportunities, thereby contributing to a better future for all.</p>	<p>4</p> <p>4</p>
<p>V. Gender Equality (SDG 5)</p> <p>Objective: Achieve gender equality and empower all women and girls.</p> <p>Key Actions: Eliminate discrimination and violence against women and girls, ensure equal opportunities, and promote gender equality.</p> <p>5.1 Components of Gender Equality Equal Access to Education Economic Participation Political Representation</p>	<p>4</p>

Habitat Destruction

5.1.2 Strategies

- Sustainable Fishing Practices
- Reducing Pollution
- Marine Protected Areas
- Research and Monitoring

5.2 Climate Action

Goal: Take urgent action to combat climate change and its impacts.

5.2.1 Importance

- Global Warming
- Extreme Weather Events
- Health Impacts
- Economic Stability

5.2.2 Challenges

- Greenhouse Gas Emissions
- Policy and Governance
- Financial Constraints
- Public Awareness

5.2.3 Strategies

- Renewable Energy Transition
- Energy Efficiency
- Carbon Pricing
- Climate Adaptation
- International Cooperation

5.3 Interconnection between Life Below Water and Climate Action

- 5.3.1 Ocean Health and Climate Regulation
- 5.3.2 Marine Ecosystem Resilience
- 5.3.3 Integrated Policies

Both SDGs recognize the interconnectedness of terrestrial and marine ecosystems and the importance of integrated approaches to conservation and sustainable development. By working towards the targets outlined in SDG 14 and SDG 15, countries can contribute to global efforts to combat climate change, conserve biodiversity, and achieve a more sustainable future for all.

In conclusion, addressing the challenges outlined in SDG 14 and SDG 15 requires collective action, international cooperation, and commitment from governments, civil society, businesses, and individuals. By taking decisive steps to protect and restore life below water and on land, we can ensure the health and well-being of current and future generations while safeguarding the planet's natural resources for years to come.

Subject: Name/Code: Elective - 1 /UG11E5701-07

Instructional hours: : 45 hours
Total contact hours : 45 hours
Credits : 3

Teaching/Demonstration Methods

The practical training will be hands-on with focus on safety and skills.

Assessment Methods: RefertoIMUGuidelinespriortothestartoftheSessionforactualallocations.

Class Assessments (Written tests/MCQs/Projects/Assignments) : 30%
Final Exam : 70%



Subject: Name/Code: Elective - 2 /UG11E5708 - 14

Instructional hours: : 45 hours
Total contact hours : 45 hours
Credits : 3

Teaching/Demonstration Methods

The practical training will be hands-on with focus on safety and skills.

Assessment Methods: RefertoIMUGuidelinespriortothestartoftheSessionforactualallocations.

Class Assessments (Written tests/MCQs/Projects/Assignments) : 30%
Final Exam : 70%



Subject Name/Code: Technical Paper Writing and Engineering Models/UG11P5701

Instructional Hours

Practical : 45 hours

Credits : 1.0

Teaching Methods

The course shall be conducted in a combination of classroom lectures, practical and self-learning.

Assessment Methods

Class Assessments (Written tests/MCQs/Projects/Assignments) : 50%

Final Written Exam : 50%

Text Book:

1. Rizvi, M Ashraf. Effective Technical Communication. McGraw Hill, New Delhi.
2. Kumar, Sanjay, and Pushp Lata. English for Effective Communication. Oxford University Press.

Reference:

1. Grover T. K., Basic Marine Engineering. (Anmol Publications PVT. Ltd, Pedro D. L. F., Operational readiness of Float – free arrangements for liferaft and EPIRB: analysis of implications on safety training standards and procedures. (World Maritime University.
2. Yukl G. A., Leadership in organizations. (Harlow: Pearson)
3. Mitchell P., Management for seafarers. (London, Videotel Marine International)
4. Ship's Main Engine Manual
5. Ship's Main Engine Spare Parts List
6. Ship's Marine Boiler Manual
7. Ship's Engine Room Arrangement
8. Engine Log Book

Table of Topics

Unit	Topics	P
I	Report writing in Engineering Practices 1. Discuss ABC of report writing 2. Discuss structure of interpretive report 3. Identify, organize and list point from the given document applying unity and coherence 4. Interpret and analyse the document related to engineering publication	16
II	Critical thinking in professional practices 1. Discuss Problem Solving Techniques 2. Explain Counterfactual Thinking 3. Identify the Root Cause by Applying 8-D Methodology 4. Write Incident Investigation Report 5. Define premises, argument and conclusion 6. Decision Making Styles/Types of Leaders	12
III	Model making in marine areas 1. Engineering model making and, 2. Mathematical modelling using Simulink	15
IV	Book review Book review should at least comprise three critical parts: the summary and background, details about the author and critical analysis. The layout of most book reviews is as follows: bibliographical information, introduction, thesis, supportive context, summary, critical analysis, and conclusion.	2
Total		45

Learning Objectives	P
<p>I. Report writing in engineering practices IMO 7.04.,2014: F1/1.2/1.2.1 Draft Model Course on Maritime English” HTW 2/3/4 Annex, page 155 -159</p> <p>Apply English language skills (LSRW) for Report writing in engineering practices</p> <ul style="list-style-type: none"> 1.1 Interpret documents, Analyse, describe, explain and report different aspects of marine diesel engines, marine auxiliary machinery 1.2 Discuss ABC of report writing 1.3 Identify, organize and list point from the given document applying unity and coherence 1.4 Interpret and Analyse the document related to engineering publication. 1.5 Write a report on status of engine room machinery to shipping company. 1.6 Write a maintenance report on given data proposing renewal/replacement/retrofit of machinery 1.7 Write a report on the status of pollution prevention machinery 1.8 Write a report on new adaption of technology in main engine/any other machinery 	16
<p>II. Critical thinking in professional practices IMO 7.04.,2014: F1/1.2/1.2.1 STCW Code Section A-III/1</p> <ul style="list-style-type: none"> 2.1 Discuss Problem Solving Techniques 2.2 Explain Counterfactual Thinking 2.3 Identify the Root Cause by Applying 8-D Methodology 2.4 Write Incident Investigation Report 2.5 Define premises, argument and conclusion 2.6 Decision Making Styles/Types of Leaders 	12
<p>III. Model making in marine areas - Engineering model making and Mathematical modelling using Simulink</p> <ul style="list-style-type: none"> 3.1 Explain the process and importance of planning during model making 3.2 Explain the process and importance of execution in model making 3.3 Explain application of Simulink in mathematical modelling. 3.4 Develop and demonstrate a mathematical model using Simulink for At least one electrical system or component 3.5 Develop and demonstrate a mathematical model using Simulink for At least one mechanical system or component 	15
<p>IV. To carry out a book review of an English book which can be choice of student approved by faculty.</p> <ul style="list-style-type: none"> 4.1 Salient points of book review to be explained- 4.2 A book review comprises three critical parts: The summary and background details about the author, and critical analysis. 4.3 The layout of most book reviews is as follows: bibliographical information, Introduction, thesis, supportive context, summary, critical analysis, and conclusion. 	2

Subject Name/Code: Hydraulics and Pneumatics Lab/UG11P5702

Instructional Hours

Practical	: 45 hours
Total contact hours	: 45 hours
Credits	: 1.5

Teaching Methods

The course shall be conducted in a combination of classroom tutorials, lab tutorials, lab practical exercises and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Internal	- 50%
External	- 50%

Text Book:

1. Andrew Parr – Hydraulics and Pneumatics, 3rd Edition, Elsevier
2. Vickers Industrial Hydraulics Manual, Vickers

Table of Topics

Unit	Topics	Hour (P)
I	Hydraulics Sub topics: Introduction to Hydraulics, Hydraulic System Components, Hydraulic Fluids, Hydraulic Piping and Sealing, Filters, Servo and Proportional Valves, Maintenance & Troubleshooting, Industrial Hydraulic Circuits	31
II	Pneumatics Sub topics: Introduction to Pneumatics, Pneumatic System Components, Maintenance & Troubleshooting, Industrial Pneumatic Circuits, Simulation tools	14
Total		45

Learning objectives	P
<p>I. Hydraulics</p> <p>General Learning Objective (GLO): To understand and operate hydraulic systems. (Vickers Industrial Hydraulics Manual) (IMO 7.02 -1.3.3.12, 7.01-2.1.5; IMO 7.04 -1.4.1.09, 1.4.1.10, 2.2.3.8, 3.2.7)</p> <p>Sub-topics and SLOs</p> <ul style="list-style-type: none"> 1.1 Introduction to Hydraulics: Relationship between force & pressure, Pascal's Law 1.2 Hydraulic System Components 1.3 Hydraulic Fluids 1.4 Hydraulic piping and sealing 1.5 Filters 1.6 Servo valves & Proportional valves 1.7 Maintenance & troubleshooting in Hydraulic systems 1.8 Industrial Hydraulic Circuits 	31
<p>Specific Learning Objectives: Explain the following:</p> <p>1.1 Introduction to Hydraulics: Relationship between force & pressure, Pascal's Law</p> <ul style="list-style-type: none"> 1.1.1 Non-compressibility of liquids 1.1.2 Pressure intensification explained with Conservation of Energy principle, 1.1.3 Definition of Hydraulics, Purpose of hydraulic systems, Hydraulic system for power transmission, 1.1.4 Basic components of a hydraulic system, 1.1.5 Block Diagram of a hydraulic system, 1.1.6 Advantages of Hydraulic system, On-board applications, 1.1.7 How pressure is created in a hydraulic system, Pressure drop through an orifice, 1.1.8 Pressure drop increases with reduced pipe diameter, 1.1.9 Flow velocity through pipes, 1.1.10 Relationship between hydraulic pressure and load on actuator, Relationship between hydraulic fluid flow rate and speed of an actuator, 1.1.11 Pipe size requirements of hydraulic systems, Pipe size ratings, 1.1.12 Power and Torque output of a hydraulic actuator, 1.1.13 Concept of Absolute and Gauge pressure. 	2
<p>Specific Learning Objectives: Explain the following:</p> <p>1.2. Hydraulic System Components</p> <p>Types, construction, purpose and graphical symbols of the hydraulic system components.</p> <ul style="list-style-type: none"> 1.2.1 Hydraulic system reservoir: Internal baffle plate, oil return line, return line magnetic filters, oil drain line, pump suction with strainer, air breather and filler, oil gauge glass, manhole/hand hole for access, thermometer, drain plug/valve, 	9

<p>Size/capacity of reservoir, heat transfer area</p> <p>1.2.2 Filters: Filters & strainers, purpose, Location & types</p> <p>1.2.3 Heat exchangers: Purpose, location & types, Natural convection cooling, forced Cooling – air cooled, water cooled.</p> <p>1.2.4 Pumps: Types of pumps – Vane type-balanced and un-balanced type, gear pump, lobe pump, radial piston pump, axial piston pump, fixed delivery & variable Delivery variants of pumps. Construction & working of swash plate type of pump, Pressure compensation, Pressure compensated swash plate type pump. Pump ratings, displacement, delivery, volumetric efficiency</p> <p>1.2.5 Accumulators: Weighted, Bladder, Piston and other types of accumulators – Construction, Purpose and operation of accumulators</p> <p>1.2.6 Direction Control Valves: Construction, operation, application and graphical symbols of various types of DCVs – poppet, rotary spool & sliding spool type, based on no. of flow paths-2-way, 3-way, 4-way etc., based on method of actuation cam, manual, mechanical, solenoid, pneumatic, hydraulic or Combination. Check valve, pilot operated check valves. Spool centre positions for linear spool DCVs</p> <p>1.2.7 Flow control – Needle valves, Check-choke valves, Pressure & temperature compensated flow control, Meter-in, Meter-out and bleed-off flow control Pressure control – Relief Valves-Simple and compound relief, unloading valve, Sequence valves, Counter balance valves, Pressure reducing valves, Regulating valves, Brake valves</p> <p>1.2.8 Actuators: Linear, Rotary & Semi rotary actuators</p> <p>1.2.8.1 Linear actuators: Overview, application and graphical symbols of Single acting, double acting – differential & non-differential cylinders, ram type and piston type actuators, solid type & telescoping type cylinders. Cushioned and variable cushioning cylinders</p> <p>1.2.8.2 Rotary actuators (motors): Displacement, torque and pressure ratings of Hydraulic motors. Types of motors: Gear, vane, axial piston, radial piston motors, Pressure compensation</p> <p>1.2.9 Distributors, Pipes & Hoses.</p> <p>1.2.10 Instrumentation: Pressure gauges, pressure switches, thermometers, flow Meters.</p> <p>1.2.11 Examples of Actual hydraulic circuit with all major components.</p> <p>1.2.12 Cut-away sections of components explained.</p>	
<p>Specific Learning Objectives: Explain the following:</p> <p>1.3 Hydraulic Fluids</p> <p>1.3.1 Purpose/significance of hydraulic fluid,</p> <p>1.3.2 Properties-definition & significance of Viscosity-Absolute & Kinematic, SAE number, Viscosity Index, Pour point, Lubricity, Oxidation Resistance, Rust & Corrosion Prevention, Demulsibility, Additives.</p> <p>1.3.3 Additives-compatibility with seals,</p> <p>1.3.4 Types of hydraulic fluids: Fire resistant – Water-glycols, Water-oil emulsions, Synthetics</p> <p>1.3.5 Storage, handling, maintenance</p> <p>1.3.6 Condition monitoring of hydraulic fluids: Debris analysis, Viscosity, Water percentage tests</p>	2
<p>Specific Learning Objectives: Explain the following:</p> <p>1.4. Hydraulic piping and sealing</p> <p>1.4.1 Tubing, Sealing of tubes by Flaring, Sleeve or O-ring compression fittings,</p> <p>1.4.2 Straight thread O-ring connector, Ferrule compression fitting</p>	1

<p>1.4.3 Flexible hoses – construction, pressure rating, sealing, safety</p> <p>1.4.4. Pipes– Taper threads, Compression O-ring seals</p> <p>1.4.5 Sealing of hydraulic components: Types of sealing mechanism. Static seals, Dynamic seals, Importance of back-up rings in hydraulic sealing, Example of Fuel pump seals with back-up rings, Lip seals, Cup seals, T-seals, Piston rings, Labyrinth seals, V-type compression seal, Seal materials, Seal maintenance</p>	
<p>Specific Learning Objectives: Explain the following:</p> <p>1.5. Filters</p> <p>1.5.1 Types of filters based on flow and location of filter- Pressure line filters, return line filters, by-pass filters, Full flow filters, Proportional flow filter, Surface filters, depth filters, edge type filters, Filters with indicators</p> <p>1.5.2 Mesh size-Nominal and Absolute rating</p> <p>1.5.3 Beta Ratio,</p> <p>1.5.4 Pressure rating,</p> <p>1.5.5 Flow rating,</p> <p>1.5.6 Pressure drop across filters,</p> <p>1.5.7 Filter protection against blocking,</p> <p>1.5.8 Types of filtering material – Mechanical filters, Absorbent filters, Adsorbent Filters</p>	3
<p>Specific Learning Objectives: Explain the following:</p> <p>1.6. Servo valves & Proportional valves</p> <p>1.6.1 Servo Valves-Purpose, construction, operation.</p> <p>1.6.2 Servo Valves- Types- Mechanical, Electro-hydraulic servo valves.</p> <p>1.6.3 Proportional DCVs.</p>	6
<p>Specific Learning Objectives: Explain the following:</p> <p>1.7. Maintenance & troubleshooting in Hydraulic systems (Hydraulic Hints & Trouble Shooting Guide, Vickers)</p> <p>1.7.1 Excessive noise</p> <p>1.7.2 Excessive heat</p> <p>1.7.3 Incorrect flow</p> <p>1.7.4 Incorrect pressure</p> <p>1.7.5 Faulty, Jerky or sluggish operation</p> <p>1.7.6 Contamination control</p> <p>1.7.7 Aeration</p> <p>1.7.8 Leakage control</p>	2
<p>Specific Learning Objectives: Explain the following:</p> <p>1.8 Industrial Hydraulic Circuits</p> <p>1.8.1 Unloading circuits,</p> <p>1.8.2 Extension and retraction of a linear cylinder</p> <p>1.8.3 Meter-in and meter-out flow control</p> <p>1.8.4 Lifting and lowering a load cylinder</p> <p>1.8.5 Pilot operated DCV</p> <p>1.8.6 Check valve significance in holding a load</p> <p>1.8.7 Pilot operated check valve</p> <p>1.8.8 Clamping and Sequencing circuits</p> <p>1.8.9 Counterbalance circuits</p> <p>1.8.10 Braking circuit</p> <p>1.8.11 Rotary motor</p>	6
<p>II. PNEUMATICS</p> <p>General Learning Objective (GLO): To understand and operate pneumatic systems. (Hydraulics & Pneumatics by Andrew Parr) (IMO 7.02 -1.3.3.12, 7.01-2.1.5) (IMO 7.04 -1.4.1.09, 1.4.1.10, 2.2.3.8, 3.2.7)</p>	

<p>Specific Learning Objectives: Explain the following:</p> <p>2.1. Introduction to Pneumatics</p> <p>2.1.1 Definition, Purpose.</p> <p>2.1.2 Typical Pneumatic system components, block diagram of Pneumatic system.</p> <p>2.1.3 Comparison of Hydraulic and Pneumatic system</p> <p>2.1.4 Application of Pneumatics in Industry and on board ships</p>	4
<p>Specific Learning Objectives: Explain the following:</p> <p>2.2. Pneumatic system components</p> <p>2.2.1 Compressors: Overview of types of Compressors-Reciprocating type-single acting, double acting, single stage, two-stage, tandem type; Screw type, Vane Type, Lobe type, Centrifugal type. Unloaders, Air compressor safeties and Instrumentation.</p> <p>2.2.2 Oil separators</p> <p>2.2.3 Reservoirs: Construction, mountings and instrumentation</p> <p>2.2.4 Air treatment: Filters, Driers, Lubricators, Pressure Regulators, FRC unit, FRL unit, Relief valves,</p> <p>2.2.5 DCVs, Other control valves – Logic valves, check valves, time delay valves,</p> <p>2.2.6 Actuators – Linear, Rotary, semi-rotary</p> <p>2.2.7 Graphic symbols of various components</p>	4
<p>Specific Learning Objectives: Explain the following:</p> <p>2.3. Maintenance & troubleshooting in Pneumatic system</p> <p>2.3.1 Excessive moisture</p> <p>2.3.2 Oil carryover</p> <p>2.3.3 Dust</p> <p>2.3.4 Safety, alarms and trips</p> <p>2.3.5 Poor compressor performance – specific cases of dirty intercooler, after cooler or suction/discharge valve leaky</p> <p>2.3.6 DCV wear out and seal leakage</p> <p>2.3.7 Actuator internal and external leakages and seal wear out.</p>	2
<p>Specific Learning Objectives: Explain the following:</p> <p>2.4. Industrial Pneumatic circuits</p> <p>2.4.1 Shuttle valve operation- operating a cylinder from two locations</p> <p>2.4.2 Embossing application</p> <p>2.4.3 Sequencing Circuit-Oscillating cylinder</p> <p>2.4.4 Memory Function circuit</p> <p>2.4.5 Delay function circuit</p> <p>2.4.6 Flow control circuit</p> <p>2.4.7 Logic circuits – AND, OR, NOT function circuits</p> <p>2.4.8 Practical Starting and Manoeuvring interlock circuit-MAN B&W</p>	5

Subject: Name/Code: Shipboard Safety and Appliances Lab/UG11P5703

Instructional hours: : 45 hours
Total contact hours : 45 hours
Credits : 1.5

Teaching/Demonstration Methods

The practical training will be hands-on with focus on safety and skills.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments) : 50%
Final Exam : 50%



Exp.No.	Topic	P
I	Testing and Operation of Jet and spray type Nozzles and Fire hoses. Operation of Emergency Fire Pump	6
II	Operation, Charging and maintenance of Portable Fire Extinguishers Water type Foam type Dry Powder type CO2 type	6
III	Operation, use and functions of breathing apparatus Self-contained type Bellow Type	6
IV	Use of Fireman's outfit, Immersion suit, TPA, SCBA, EEED.	6
V	Study and operate total CO2 flooding of Engine room and Cargo holds. Operation of different types of Fire detectors.	6
VI	Study of working of life boat and provisions for life boat. Use of life jackets. Use of on-board Life Saving Appliances.	6
VII	Construction and operational details of, life raft giving importance to manual and hydrostatic release device.	6
VIII	Study of high expansion foam applicator system	3
Total		45

SEMESTER – VIII

Subject: Name/Code: Practical Training /UG11P5801

Instructional hours:	: 990 hours
Total contact hours	: 990 hours
Credits	: 12

Teaching/Demonstration Methods

The practical training will be hands-on with focus on safety and skills.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments	: 50%
Final Exam	: 50%

Afloat/Ship-in-Campus/Approved Workshop/On Board

Semester VIII will be completed to achieve various competencies as is required by national and international regulations.

There will be total of 20 weeks, 49.5 hours per week, a total of 990 hours in Semester VIII.

These competencies will have to be completed at any of the combinations of the facilities given below.

Internal workshops / external marine workshops / various engine room systems installed in the institution individually / various engine room systems installed in the institution collectively (also called ship-in-campus) / watch-keeping on such systems during their running/ advanced marine laboratories / advanced marine simulators. These competencies may also be completed as afloat training onboard ships.

A TAR Book for the Practical Exercises may be used.

Subject: Name/Code: Project Work /UG11P5802

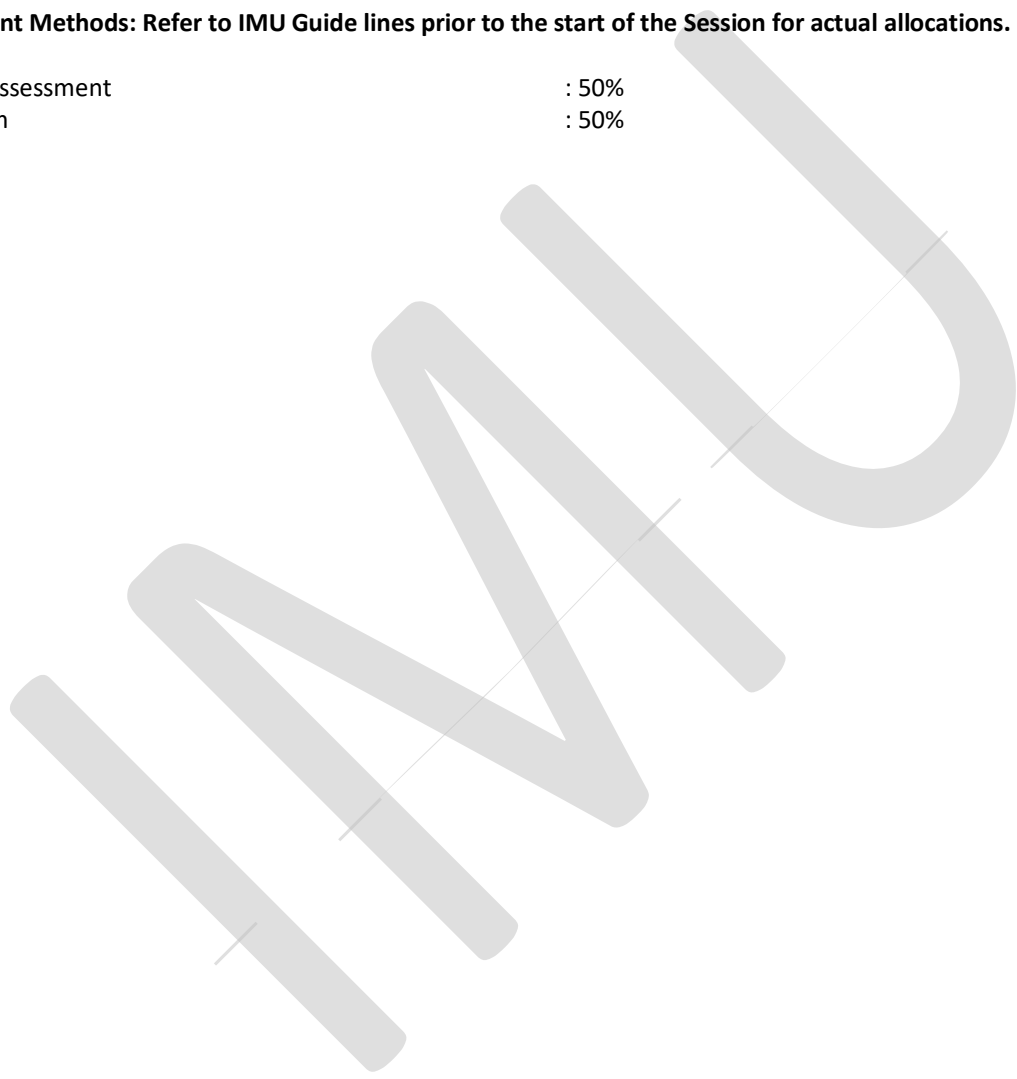
Instructional hours:	: 90 hours
Total contact hours	: 90 hours
Credits	: 3

Teaching/Demonstration Methods

The project work will be on topics related to Marine Environment Protection or Energy Management in Maritime Industry.

Assessment Methods: Refer to IMU Guide lines prior to the start of the Session for actual allocations.

Internal Assessment	: 50%
Final Exam	: 50%



ELECTIVE-1 (Professional Elective)

S.No.	Subject	Credit
1	ADVANCED MARINE VEHICLES	3
2	SHIP RECYCLING	3
3	OFF SHORE TECHNOLOGY	3
4	ADVANCED HEAT ENGINES	3
5	DREDGER AND HARBOUR ENGINEERING	3
6	MARINE SURVEY AND CERTIFICATION	3
7	MARINE INSURANCE	3
8	AUTONOMOUS SHIPS	3
9	UNDERWATER VEHICLES	3

ELECTIVE-2 (Open Elective)

S.No.	Subject	Credit
1	ELEMENTS OF PORT MANAGEMENT	3
2	AI & ML	3
3	MODERN MANUFACTURING TECHNOLOGY	3
4	CYBER SECURITY	3
5	OCCUPATIONAL SAFETY AND HEALTH	3
6	DISASTER MANAGEMENT	3
7	COMPUTATIONAL FLUID DYNAMICS	3
8	INTERNET OF THINGS	3
9	ELECTRIC AND HYBRID VEHICLES	3

Elective – I

Subject Name/Code: Advanced Marine Vehicles/UG11E5701

Instructional hours:

Lecture : 45 hours

Total contact hours : 45 hours

Credits : 3

Teaching Methods

The course shall be conducted in a combination of classroom lectures, case study analysis, writing assignments and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments) : 30%

Final Exam : 70%

Text Book:

1. Shipboard Operations - H. I. Lavery
2. Marine Diesel Engines - C. C. Pounder

Reference:

1. Liquefied Gas Handling Principles on - McGuire & White Ships and in terminals
2. Tanker Safety Guide Liquefied Gas: International Chamber of Shipping
3. International Safety Guide for Oil Tankers and Terminals (ISGOTT): International Chamber of Shipping

Table of Topics

Units	Topics	Hours (L)
I	Study of LPG and LNG Ships	15
II	Chemical Tankers	10
III	Oil Tankers	10
IV	Car Carrier	5
V	Bulk Carrier	5
	Total	45

Learning Objectives	L
<p>Course Objective:</p> <p>1) To provide the latest knowledge and operation incorporated in different types of Tankers Car carrier, Bulk carrier</p> <p>2) To know the arrangement in car carriers</p> <p>3) To understand the safety and handling of cargo in LPG, Chemical , oil and carriers</p>	
<p>1. Study of LPG and LNG Ships:</p> <p>1.1 Various controls of deck equipments including pneumatic and electronic equipments.</p> <p>1.2 Study of re-liquefaction plants & its operation, Study of structure of various types of tanks for LNG and LPG vessels, IG and Pure Nitrogen gas systems for gas tankers, Glycol systems, Electric motor room and compressor room safeties.</p> <p>1.3 Study of compressors and compressor safety devices and other safety devices in Gas tankers. Cargo pumping system and its operation, cargo operations.</p> <p>1.4 Boil-off gas supply system for Boilers and IC Engines.</p>	15
<p>2. Chemical Tankers:</p> <p>2.1 Classification, Construction, Pumps for chemicals, Tank cleaning procedures, IG systems for Chemical Tankers, Controls and safety devices associated with loading and discharging.</p> <p>2.2 Tank gauging systems.</p>	10
<p>3. Oil Tankers:</p> <p>3.1 Types & classification, Construction, Cargo & Crude Oil Washing operation, I.G Systems, Pumping arrangements and safety devices associated with loading & discharging.</p> <p>3.2 Automatic Unloading System (AUS), Cargo Oil Pump Turbine (COPT) Lube Oil system.</p>	10
<p>4. Car Carrier:</p> <p>4. 1 Construction, Ventilation, Fire Fighting system, Stability, Strength considerations, RO-RO arrangement.</p>	5
<p>5. Bulk Carrier:</p> <p>5.1 Construction, Stress considerations with regard to loading & discharging, Condition assessment system, Enhanced survey, Safety considerations, Stability considerations.</p>	5

Subject Name/Code: Ship Recycling/UG11E5702

Instructional hours:

Lecture : 45 hours

Total contact hours : 45 hours

Credits : 3

Teaching Methods

The course shall be conducted in a combination of classroom lectures, case study analysis, writing assignments and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments) : 30%

Final Exam : 70%

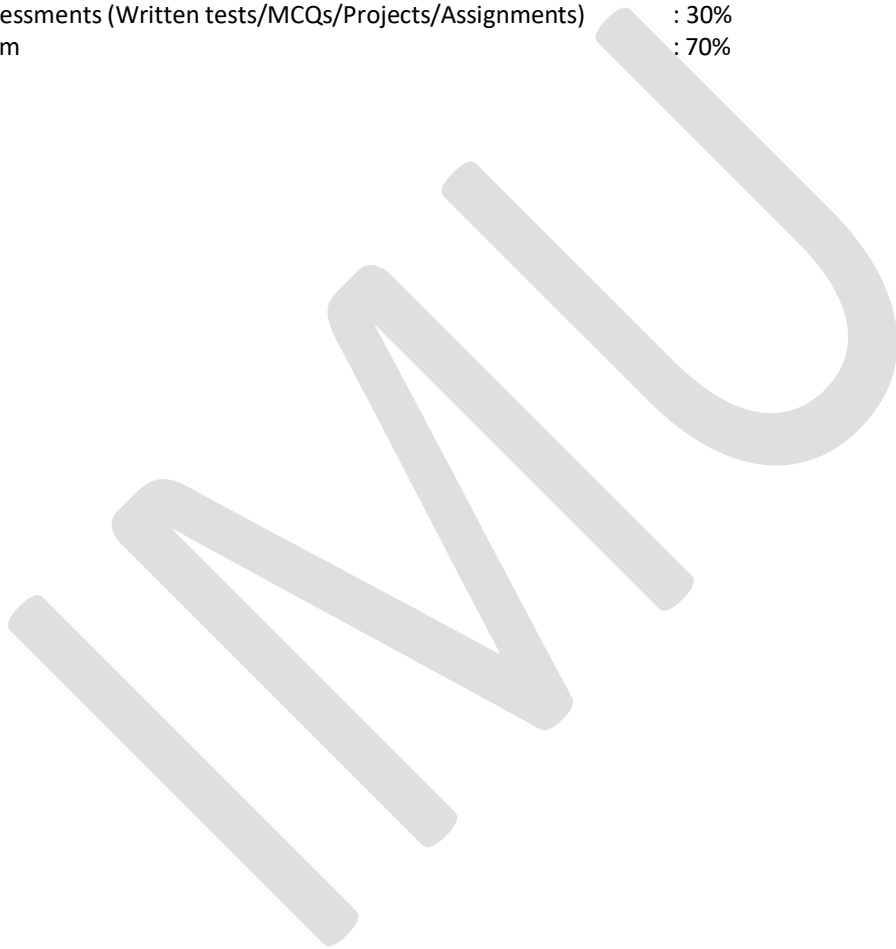


Table of Topics

Units	Topics	Hours (L)
I	Introduction to Ship Recycling & Regulatory Framework	10
II	Ship Design & Recycling Process	10
III	Environmental and Economic Aspects	10
IV	Emerging Technologies and Case Studies	5
V	Legal Considerations & Future Trends	5
	Total	45

Learning Objectives		L
<p>1. Introduction to Ship Recycling & Regulatory Framework</p> <p>1.1 Historical overview of ship recycling. 1.2 Importance of ship recycling in the maritime industry. 1.3 Key environmental and safety concerns related to ship recycling. 1.4 International regulations and conventions governing ship recycling (e.g., Hong Kong Convention, Basel Convention). 1.5 National regulations and policies related to ship recycling.</p>	10	
<p>2. Ship Design & Recycling Process</p> <p>2.1 Overview of ship construction materials and their properties. 2.2 Design considerations for easier and safer ship recycling. 2.3 Preparatory phase: Inventorying, hazardous material identification, and preparation for recycling. 2.4 Dismantling phase: Techniques and methods for dismantling ships safely and efficiently. 2.5 Recycling phase: Recycling of various ship components (steel, machinery, electronics, etc.). 2.6 Waste management and disposal: Handling of hazardous materials and waste generated during ship recycling.</p>	10	
<p>3. Environmental and Economic Aspects</p> <p>3.1 Environmental impact assessment of ship recycling activities. 3.2 Pollution prevention measures during ship recycling operations. 3.3 Occupational health and safety practices for workers involved in ship recycling. 3.4 Economic viability of ship recycling. 3.5 Socio-economic impacts on local communities and workers in ship recycling yards. 3.6 International trade and market dynamics in ship recycling.</p>	10	
<p>4. Emerging Technologies and Case Studies</p> <p>4.1 Innovations in ship recycling techniques (e.g., green ship recycling methods). 4.2 Best practices for sustainable and environmentally friendly ship recycling. 8.1 Case studies of successful ship recycling projects. 8.2 Perspectives from industry experts and stakeholders in ship recycling.</p>	10	
<p>5. Legal Considerations & Future Trends</p> <p>5.1 Ethical dilemmas in ship recycling (e.g., labor rights, environmental justice). 5.2 Legal challenges and disputes in the ship recycling industry. 5.3 Trends and developments shaping the future of ship recycling. 5.4 Potential advancements in technology and regulations impacting ship recycling practices.</p>	5	

Subject Name/Code: Offshore Technology /UG11E5703

Instructional hours:

Lecture : 45 hours

Total contact hours : 45 hours

Credits : 3

Teaching Methods

The course shall be conducted in a combination of classroom lectures, case study analysis, writing assignments and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments) : 30%

Final Exam : 70%



Table of Topics

Units	Topics	Hours (L)
I	Introduction and fundamentals to Offshore Technology	10
II	Offshore Structure Design & Installation	10
III	Offshore Drilling and safety	10
IV	Offshore Construction and Installation Techniques	8
V	Environmental Considerations & Future Trends	7
	Total	45

Learning Objectives		L
<p>1. Introduction and fundamentals to Offshore Technology</p> <p>1.1 Overview of offshore structures and their significance in the maritime industry. 1.2 Types of offshore structures (e.g., platforms, floating production systems) and their functions. 1.3 Principles of offshore hydrodynamics and wave mechanics. 1.4 Load and structural analysis for offshore structures. 1.5 Lifecycle assessment of structures</p>	10	
<p>2. Offshore Structure Design & Installation</p> <p>2.1 Design considerations for different types of offshore platforms (e.g., fixed, floating, compliant). 2.2 Structural components and materials used in offshore structure construction. 2.3 Installation techniques for offshore platforms and equipment. 2.4 Maintenance strategies for ensuring the integrity and safety of offshore structures.</p>	10	
<p>3. Offshore Drilling and safety</p> <p>3.1 Offshore drilling operations and equipment (e.g., drilling rigs, subsea wellheads). 3.2 Subsea production systems and equipment (e.g., pipelines, risers, subsea trees). 3.3 Environmental impact of offshore resources and exploitation 3.4 Risk assessment and mitigation strategies for offshore activities. 3.5 Emergency response planning and offshore safety protocols. 3.6 Routine survey of structure and equipment</p>	10	
<p>4. Offshore Construction and Installation Techniques</p> <p>4.1 Offshore construction methods (e.g., jacket installation, float over installation). 4.2 Subsea equipment installation and integration. 4.3 Project planning and scheduling for offshore projects. 4.4 Cost estimation and budgeting considerations for offshore developments.</p>	8	
<p>5. Environmental Considerations & Future Trends</p> <p>5.1 Environmental impact assessment of offshore projects. 5.2 Sustainable practices and regulations for minimizing environmental impact. 5.3 Emerging technologies (e.g., digitalization, automation) in offshore operations. 5.4 Potential challenges and opportunities in the future of offshore engineering. 5.5 Legal aspect of offshore technology</p>	7	

Subject Name/Code: Advanced Heat Engines /UG11E5704

Instructional hours:

Lecture : 45 hours

Total contact hours : 45 hours

Credits : 3

Teaching Methods

The course shall be conducted in a combination of classroom lectures, case study analysis, writing assignments and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments) : 30%

Final Exam : 70%

Text Book:

1. Steam Turbine Theory and Practice – J. Kearton
2. Thermodynamics – Applied to heat Engines – E. H. Lewitt

Reference:

1. Applied Thermodynamics – Joel Rayner
2. Internal combustion engines – Heywood.
3. Marine steam Boilers – J.H. Milton
4. Thermal Engineering – R.K. Rajput
5. Heat Engine – P. L. Ballaney

Table of Topics

Units	Topics	Hours (L)
I	Complex Heat Engine Plants	15
II	Turbo Blowers and Turbo Compressors	12
III	Combustion and Flame Stabilization	10
IV	Heat Exchanger	8
	Total	45

Learning Objectives		L
OBJECTIVE: To develop knowledge of cadets on various marine heat engines and heat exchangers.		
1. Complex Heat Engine Plants 1.1 Combined Steam Turbine and Diesel Engine Cycles. Combined steam Turbine and Gas Turbine cycles. 1.2 Combined Gas Turbine and Diesel Engine cycles/Plants. 1.3 Different Methods of Improving the Overall Thermal Efficiency of the entire plant. 1.4 Design of the most optimum condition and combination of complex plants. 1.5 Cascade Refrigeration plants. 1.6 Free piston Gas Generators.	15	
2. Turbo Blowers and Turbo Compressors: 2.1 Compressor Characteristics for Axial Flow compressors and Centrifugal compressors. 2.2 Stalling of compressors. 2.3 Turbine characteristics. 2.4 Matching of components like compressor and Turbine. 2.5 Performance of different units in combination in single shaft arrangement. 2.6 Minimum work required to run the compressors.	12	
3. Combustion and Flame Stabilization: 3.1 Combustion of liquid Fuels, Atomisation, mixing, combustion curve and different methods of Flame stabilization, Design & combustion chamber. 3.2 Spray of Fuel. 3.3 Pre- mixing of Gaseous Fuels for combustion. 3.4 Stability of the Flame. 3.5 Adiabatic flame temperature.	10	
4. Heat Exchanger: 4.1 Design of different types of compact Heat Exchangers for different Applications, e.g. Air preheater, Gas and Oil Heaters.	8	

Subject Name/Code: Dredging and Harbour Engineering/UG11E5705

Instructional hours:

Lecture : 45 hours

Total contact hours : 45 hours

Credits : 3

Teaching Methods

The course shall be conducted in a combination of classroom lectures, case study analysis, writing assignments and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments) : 30%

Final Exam : 70%

Text Book:

1. Hans Agerschou, et. al. (2004), Planning and Design of Ports and Marine Terminals, Thomas Telford
2. John Herbich, Handbook of Dredging Engineering, Mc Grow Hill Inc.

Reference:

1. Gregory Tsinker, Handbook of Port and Harbour Engineering, Springer-Science +Business Media BV.
2. Introduction to Naval Architecture – Thomas C. Gillmer
3. Basic Ship Theory – E.C. Tupper and K.J Rawson
4. Offshore structures, Volume 1 D.V. Reddy, M. Arockiasamy

Table of Topics

Units	Topics	Hours (L)
I	Sedimentation and Dredging	10
II	Dredging Equipment	10
III	Elements of Harbour	10
IV	Harbour Development	10
V	Structural Components	5
	Total	45

Learning Objectives	L
Objective: To provide basic understanding of Harbour elements, structural details, sedimentation and dredging	
<p>I. Sedimentation and Dredging</p> <p>Marine Sediments – Source, transportation, deposition and erosion. Littoral transport – effect of harbour structures and channels on littoral transport – Requirement of dredging, Basics of dredging, Types of dredgers, operational requirement of dredgers, economics of operation, design features – equipment and processes used, capital and maintenance dredging, production in dredging projects, operational aspects, introduction to dredging costs and contracts, Dredged material management – disposal, Beneficial uses, environmental issues.</p>	10
<p>II. Dredging Equipment</p> <p>Dredge pumps – centrifugal pumps – pump characteristics – effect of solid water mixture on pump performance – cavitation – gas effect and removal – pipe line transport – head loss with distance – booster requirement – Instrumentation and Automation – flow and velocity meters – density meters – production meters – Automation in dredging – Survey.</p>	10
<p>III. Elements of Harbour</p> <p>Port classifications – details and definitions, Navigational and operational parameters, environmental parameters. Layout, breakwater, channel, entrance, basin. Water front facilities – Quay, berths, Jetty, Sheet – pile bulkheads, piled structures. Mooring accessories – Anchors, fender, bollard. Harbour crafts – tugs and supply vessels and their function, equipment and design features: crane vessels, launches for port operation, pilot</p>	10
<p>IV. Harbour Development</p> <p>Port planning – Facilities requirement – general considerations – economic feasibility – evaluation of cost and benefit – evaluation of financial feasibility – influence of ships on port facilities – dimensions – cargo capacity – cargo handling gear – motion and moorings – manoeuvrability at low speeds – access channels and basin – design of channel – safety criteria – basins – open and closed. Environmental considerations – effect of capital dredging and reclamation – water pollution – noise and vibration</p>	10

<p>pollution – adverse effect on littoral drift due to maintenance dredging – hazardous cargo handling and accidents – environmental impact assessment.</p>	
<p>V. Structural Components</p> <p>Breakwaters: Types functional requirements – rubble mound breakwaters – design – construction – modes of failure – overtopping – caisson type breakwater. Berth and terminal design: general cargo berths – berth surface elevations – apron width – transit sheds – pavements – cargo handling systems. Container terminals: elevation and width, yard equipment – yard layout and stacking pattern. Roll on/Roll off terminals – ferry terminals – liquid bulk terminals – dry bulk terminals.</p>	<p>5</p>



Subject Name/Code: Marine Survey and Certification/UG11E5706

Instructional hours:

Lecture : 45 hours

Total contact hours : 45 hours

Credits : 3

Teaching Methods

The course shall be conducted in a combination of classroom lectures, case study analysis, writing assignments and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments) : 30%

Final Exam : 70%



Table of Topics

Units	Topics	Hours (L)
I	Introduction to ship surveys & classification societies	5
II	Enhanced special survey programs	10
III	Certificates and other documents required to be carried onboard ships by International conventions	10
IV	Class Renewal / Special Survey	10
V	Continuous Survey of Machinery	10
	Total	45

Learning Objectives		L
<p>1. Introduction to ship surveys & classification societies</p> <p>1.1 Historical overview of ship inspections and surveys. 1.2 Classification societies: What why and how they do it 1.3 Continuous survey of hull Additional methods of hull surveys</p>	5	
<p>2. Enhanced special survey programs</p> <p>2.1 The International code on the enhanced programme of inspections during surveys of bulk carriers and oil tankers. 2.2 Assignment, maintenance, suspension and withdrawal of class 2.3 Ship inspections for first entry into Indian flag Section 27(1) of the M.S. Act –‘Survey and Measurement of Ships before Registry’</p>	10	
<p>3. Certificates and other documents required to be carried onboard ships by International conventions.</p> <p>3.1 How certificates may be obtained and the period of their legal validity Harmonized system of ship survey and certification (HSSC) 3.2 Classification society and class certificates. Statutory certification of ships. Surveys for maintenance and renewal of class</p>	10	
<p>4. Class Renewal / Special Survey</p> <p>4.1 Annual Survey 4.2 Intermediate Survey 4.3 Bottom / Docking Survey 4.4 Tail shaft Survey 4.5 Non Periodical Surveys</p>	10	
<p>5. Continuous Survey of Machinery</p> <p>5.1 Harmonized System of Survey and Certification 5.2 Statutory certificates: 5.3 Mandatory Certificates 5.4 Other Mandatory Documents 5.5 Certificates and Documents related to National Legislation 5.6 Relevant Surveys Certificates Under SOLAS 5.7 Relevant Surveys and Certificates Under the International Convention for the 5.8 Prevention of Pollution from Ships 5.9 Load Line Surveys and International Load Line certificate</p>	10	

Subject Name/Code: Marine Insurance/UG11E5707

Instructional hours:

Lecture : 45 hours

Total contact hours : 45 hours

Credits : 3

Teaching Methods

The course shall be conducted in a combination of classroom lectures, case study analysis, writing assignments and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments) : 30%

Final Exam : 70%

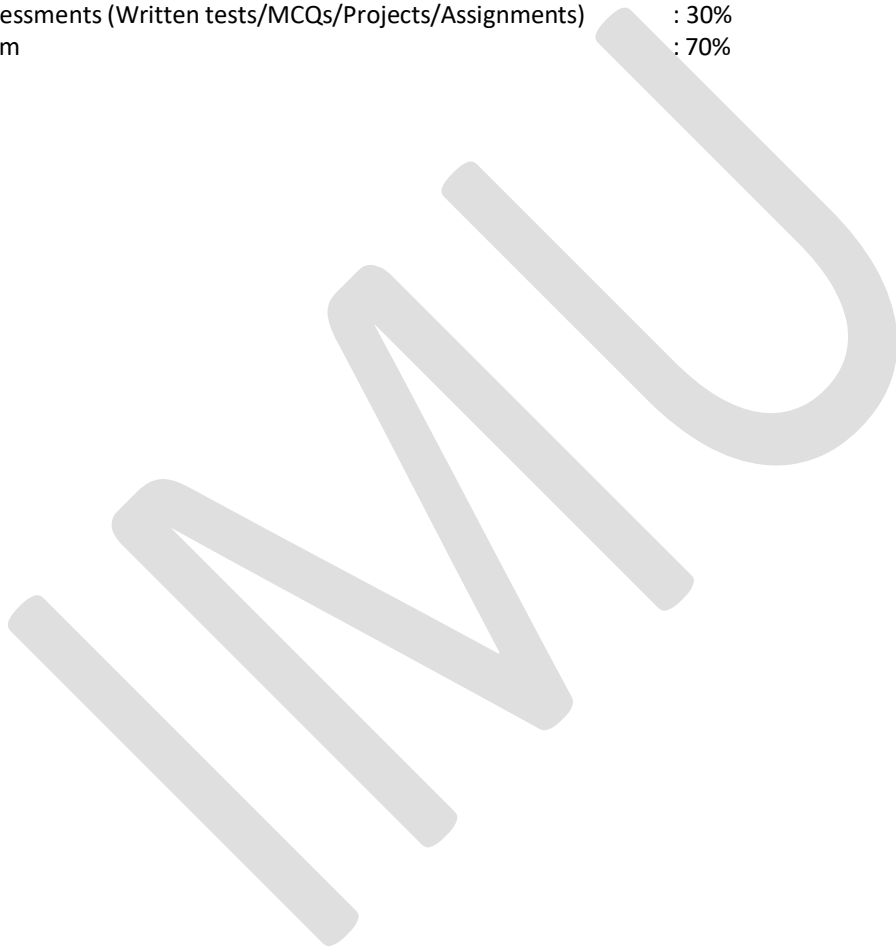


Table of Topics

Units	Topics	Hours (L)
I	Introduction to Marine Insurance	6
II	Introduction to Principles and Practices of Insurance	8
III	Insurance Business	8
IV	Hull Insurance	8
V	Cargo Insurance	8
VI	Protection & Indemnity Insurance	7
	Total	45

Learning Objectives		L
<p>I. Introduction to Marine Insurance</p> <p>1.1 Introduction to Marine Insurance</p> <p>1.1.1 Explain Insurance</p> <p>1.1.2 Explain the need of Insurance in Shipping Industry</p> <p>1.1.3 Explain how 'Underwriting' was carried out earlier</p> <p>1.2 Organization of Lloyd's of London</p> <p>1.2.1 Describe the history of Lloyd's of London</p> <p>1.2.2 Describe how Lloyd's of London Operate</p> <p>1.2.3 Explain the role of International Underwriting Association of London (IUA) and International Union of Marine Insurance (IUMI)</p> <p>1.3 Conduction of Insurance Business</p> <p>1.3.1 Explain Original Slip, Broker's Cover Note, Insurance Policy and Insurance Certificates, Premium and Brokerage</p>	6	
<p>II. Introduction to Principles and Practices of Insurance</p> <p>2.1 Introduction to MIA 1963(India)</p> <p>2.1.1 Explain the need of MIA 1963</p> <p>2.1.2 Define: Marine Insurance, Insurable Property, Marine Adventure, Maritime Perils, Freight and Goods</p> <p>2.2 Principles of Insurance</p> <p>2.2.1 Explain Principle of Utmost Good Faith</p> <p>2.2.2 Explain Insurable Interest</p> <p>2.2.3 Explain Proximate Cause</p> <p>2.2.4 Explain Principle of Indemnity including its corollaries – Subrogation and Contribution.</p> <p>2.3 Practices of Insurance</p> <p>2.3.1 Explain Warranties (Implied and Express)</p> <p>2.3.2 Explain Statutory Exclusions</p> <p>2.3.3 Explain Different types of Losses – Total (Actual total loss and Constructive total loss.) and Partial (Particular Average and General Average)</p> <p>2.3.4 Explain Deductible</p> <p>2.3.5 Explain Types of Policies: Time, Voyage, Valued, Unvalued, Mixed, Floating</p>	8	

<p>III. Insurance Business</p> <p>3.1 Underwriting</p> <p>3.1.1 Explain Underwriting Procedure: Proposal Form, Declaration, Documents required, and valuation of subject matter</p> <p>3.1.2 Explain factors considered for initial rating and renewal rating</p> <p>3.1.3 Explain Physical and Moral hazards in Underwriting</p> <p>3.2 Claims</p> <p>3.2.1 Explain the procedure for claim in Insurance.</p> <p>3.2.2 Explain the role of Master in preparation of claim documents.</p> <p>3.2.3 List the documents required in claim settlement</p> <p>3.2.4 Explain the methods of resolution of disputes between Insurer and Assured</p> <p>3.3 Reinsurance</p> <p>3.3.1 Explain Reinsurance and why is it required</p> <p>3.3.2 Explain Different types of Reinsurances: Facultative, Different types of Treaties</p> <p>3.4 General Average</p> <p>3.4.1 Explain General Average Act</p> <p>3.4.2 Explain important features of York Antwerp Rules</p>	8
<p>IV. Hull Insurance</p> <p>4.1 Insurable Interests</p> <p>4.1.1 Explain the Insurable Interest of Assured in Hull & Machinery, Freight, Disbursements, Builder's & Repairers Liability, Third Party Liability</p> <p>4.2 Important Clauses of IHC 03</p> <p>4.2.1 Explain Perils clause</p> <p>4.2.2 Explain Pollution Hazard</p> <p>4.2.3 Explain Collision liability with Sister ship</p> <p>4.2.4 Explain General Average absorption clause</p> <p>4.2.5 Explain Sue & Labour</p> <p>4.2.6 Explain New for Old</p> <p>4.2.7 Explain Classification & ISM Clause</p> <p>4.2.8 Explain Return for Layup</p> <p>4.2.9 Explain Continuation and Termination clauses.</p> <p>4.2.10 Explain Institute Warranties</p> <p>4.2.11 Explain Disbursement Clause</p> <p>4.3 Other Important Clauses.</p> <p>4.3.1 Explain features of Institute Voyage Clause Hull</p> <p>4.3.2 Explain features of Freight Insurance</p> <p>4.3.3 Explain features of Builder's Risk Insurance</p> <p>4.3.4 Explain features of War and Strikes Insurance</p> <p>4.3.5 Explain features of Container Insurance</p>	8
<p>V. Cargo Insurance</p> <p>5.1 Institute Cargo Clauses A, B and C</p> <p>5.1.1 Explain Risks covered under ICC A, B and C</p> <p>5.1.2 Explain various exclusions</p> <p>5.1.3 Explain Transit Clause</p> <p>5.1.4 Explain Change of Voyage</p> <p>5.1.5 Explain Termination of Contract of Carriage clause</p> <p>5.1.6 Explain Increased Value Clause</p> <p>5.1.7 Explain Forwarding Charges Clause</p> <p>5.2 Other Clauses</p> <p>5.2.1 Explain features of Institute War clause (Cargo)</p> <p>5.2.2 Explain features of Institute Strike clause (Cargo)</p> <p>5.2.3 Explain Incidental Clauses such as Pair & Set Clause, Cutting Clause, Label Clause,</p>	8

<p>Brand & Trade mark Clause, Picking Clause, Replacement Clause and Second-hand Replacement Clause</p> <p>5.3 Long Term Cargo Insurance</p> <p>5.3.1 Explain features of Open Cover</p> <p>5.3.2 Explain features of Floating Policy</p> <p>5.3.3 Explain Limit per Bottom; Limit per Location; Classification Clause; Declaration; Certificate of Insurance</p>	
<p>VI. Protection & Indemnity Insurance</p> <p>6.1 Introduction to P& I</p> <p>6.1.1 Explain the Concept of Liability and Need of Insuring liability</p> <p>6.1.2 Explain historical Background of P&I Clubs</p> <p>6.1.3 Explain Principle of Mutual Insurance, Concept and types of Calls.</p> <p>6.1.4 Explain How do Club operates</p> <p>6.1.5 Explain services provided by P&I Club</p> <p>6.1.6 Explain Role of Club Correspondent</p> <p>6.1.7 List different Risks covered by Clubs</p> <p>6.1.8 Explain Freight Demurrage and Defence</p> <p>6.1.9 Explain features of Trough Transport Clubs</p> <p>6.1.10 Explain the role of International Group of P&I Clubs</p>	<p>7</p>

Elective – II

Subject Name/Code: Port and Ship Management/UG11E5708

Instructional hours:

Lecture : 45 hours

Total contact hours : 45 hours

Credits : 3

Teaching Methods

The course shall be conducted in a combination of classroom lectures, case study analysis, writing assignments and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments) : 30%

Final Exam : 70%

Text Book:

1. Business and Economics of Port Management – Wei Routledge, London & New York.
2. JOHN. W. DICKE, Reeds 21st Century Ship Management. Bloomsbury Publishing, UK.

Reference:

1. LUNY. H.V., LAIK. –H., CHENGT.C.E CHENG, Shipping and Logistics Management, Springer, U.K
2. POSHANTOK.MUKHERJEE. MARK BROWN RIGG, Farthing on International Shipping, 4th edition, Springer.

Table of Topics

Units	Topics	Hours (L)
I	Port and its unique character	8
II	Operation, Finance and Technology of Port	10
III	Marketing aspects of port Industry	10
IV	Functions of Shipping	9
V	Ship Management	8
	Total	45

Learning Objectives		L
<p>Objective: To study the numerous processes that one involved in the port and shipping business.</p> <p>Learning Outcomes: To understand the entire functions and complex structure of shipping and ports in the global supply chain.</p>		
<p>I. Port and its unique character</p> <p>Importance and role of the port sector – Challenges faced by port Management – Port governance and institutional structure – Definition of port demand & supply - Port and Logistics; Connected ports – Mega Ports – Smart ports (Industry 4.0), Key developments in seaborne trade – factors affecting demand and supply of port services – Economics of scale in the port sector.</p>		8
<p>II. Operation, Finance and Technology of Port</p> <p>Operational and Financial Performance in the Port Business – Perspective of port performance – Assessing port performance (KPI) – Yard planning; Vessel Planning – port pricing technology and the port sector – Characteristics and cargo handling systems of port terminals – Impact of growing ship size – Role of port technology and artificial intelligence – port safety and the human factor – Disaster management.</p>		10
<p>III. Marketing aspects of port Industry</p> <p>Competition in the port industry – Scale and intensity and perspective of competition – Assessing the competition – Competitive and competitive advantage of ports – Transshipment ports – Sustainable Green Ports – Port marketing and customer management – Market structure and contestability in the port sector.</p>		10
<p>IV. Functions of Shipping</p> <p>Type of ships – Tamp & Liner world seaborne trade and merchant fleet – challenges facing the shipping industry in the twenty – first century – Main features of hull and machinery – Types and methods of tonnage measurements – Ship productivity – general principles and factors influencing designs, type and size of ship safety and other regulations.</p>		9
<p>V. Ship Management</p> <p>Main Ship Management models – Fleet Management, Machinery, Technical, Financial, Purchasing, investment aspects of Ship Management – Ship Management legal disciplines – Risk Management in the modern shipping industry.</p>		8

Subject Name/Code: Artificial Intelligence and Machine Learning/UG11E5709

Instructional hours:

Lecture	: 45 hours
Total contact hours	: 45 hours
Credits	: 3

Teaching Methods

The course shall be conducted in a combination of classroom lectures, case study analysis, writing assignments and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments)	: 30%
Final Exam	: 70%

Text Book:

1. Deisenroth, Faisal, Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.
2. B Joshi, Machine Learning and Artificial Intelligence, Springer, 2020.
3. Parag Kulkarni and Prachi Joshi, "Artificial Intelligence – Building Intelligent Systems", PHI learning Pvt. Ltd., ISBN – 978-81-203-5046-5, 2015
4. Stuart Russell and Peter Norvig (1995), "Artificial Intelligence: A Modern Approach," Third edition, Pearson.

Reference:

1. Solanki, Kumar, Nayyar, Emerging Trends and Applications of Machine Learning, IGI Global, 2018.
2. Mohri, Rostamizdeh, Talwalkar, Foundations of Machine Learning, MIT Press, 2018.
3. Kumar, Zindani, Davim, Artificial Intelligence in Mechanical and Industrial Engineering, CRC Press, 2021.
4. Zolt Nagy - Artificial Intelligence and Machine Learning Fundamentals-Apress (2018)
5. Artificial Intelligence by Elaine Rich, Kevin Knight and Nair, TMH

Web Resource:

1. <http://nptel.ac.in/courses/111101003/>
2. <https://nptel.ac.in/courses/106/106/106106202/>
3. <https://nptel.ac.in/courses/112/103/112103280/>
4. <https://www.analyticsvidhya.com/>

Table of Topics

Units	Topics	Hours (L)
I	Introduction to AI & ML	9
II	Feature Extraction and Selection	9
III	Classification & Regression	9
IV	Development of ML Model	9
V	Reinforced and Deep Learning	8
	Total	45

Learning Objectives		L
<p>OBJECTIVES:</p> <ul style="list-style-type: none"> • Acquaint with fundamentals of artificial intelligence and machine learning. • Learn feature extraction and selection techniques for processing data set. • Understand basic algorithms used in classification and regression problems. • Outline steps involved in development of machine learning model. • Familiarize with concepts of reinforced and deep learning. • Implement and analyze machine learning model in mechanical engineering problems 		
<p>1. Introduction to AI & ML</p> <p>1.1 History of AI, Comparison of AI with Data Science, Need of AI in Mechanical Engineering, Introduction to Machine Learning.</p> <p>1.2 Basics: Reasoning, problem solving, Knowledge representation, Planning, Learning, Perception, Motion and manipulation.</p> <p>1.3 Approaches to AI: Cybernetics and brain simulation, Symbolic, Sub-symbolic, Statistical.</p> <p>1.4 Approaches to ML: Supervised learning, Unsupervised learning, Reinforcement learning.</p>		9
<p>2. Feature Extraction and Selection</p> <p>2.1 Feature extraction: Statistical features, Principal Component Analysis.</p> <p>2.2 Feature selection: Ranking, Decision tree - Entropy reduction and information gain, Exhaustive, best first, Greedy forward & backward, Applications of feature extraction and selection algorithms in Mechanical Engineering</p>		9
<p>3. Classification & Regression</p> <p>3.1 Classification: Decision tree, Random Forest, Naive Bayes, Support vector machine.</p> <p>3.2 Regression: Logistic Regression, Support Vector Regression.</p> <p>3.3 Regression trees: Decision tree, random forest, K-Means, K-Nearest Neighbor (KNN).</p> <p>3.4 Applications of classification and regression algorithms in Mechanical Engineering.</p>		9
<p>4. Development of ML Model</p> <p>4.1 Problem identification: classification, clustering, regression, ranking.</p> <p>4.2 Steps in ML modeling, Data Collection, Data pre-processing, Model Selection, Model training (Training, Testing, K-fold Cross Validation), Model evaluation (understanding and interpretation of confusion matrix, Accuracy, Precision,</p>		9

<p>Recall, True positive, false positive etc.), Hyper parameter Tuning, Predictions.</p>	
<p>5. Reinforced and Deep Learning</p> <p>5.1 Characteristics of reinforced learning; Algorithms: Value Based, Policy Based, Model Based; Positive vs Negative Reinforced Learning;</p> <p>5.2 Models: Markov Decision Process, Q Learning.</p> <p>5.3 Characteristics of Deep Learning, Artificial Neural Network, Convolution Neural Network.</p> <p>5.4 Application of Reinforced and Deep Learning in Mechanical Engineering.</p>	<p>9</p>



Subject Name/Code: Modern Manufacturing Technology/UG11E5710

Instructional hours:

Lecture : 45 hours

Total contact hours : 45 hours

Credits : 3

Teaching Methods

The course shall be conducted in a combination of classroom lectures, case study analysis, writing assignments and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments) : 30%

Final Exam : 70%



Table of Topics

Units	Topics	Hours (L)
I	Advanced Machining Processes	12
II	Advanced Welding Processes	6
III	Advanced Forming Processes	8
IV	Additive Manufacturing (AM)	9
V	Additive Manufacturing Advanced Techniques	10
	Total	45

Learning Objectives	L
1. Advanced Machining Processes	12
1.1 Introduction 1.2 Principle, working and application of the following 1.2.1 Ultrasonic Machining (USM) 1.2.2 Electro Chemical Machining (ECM) 1.2.3 Electro Discharge Machining (EDM) 1.2.4 LASER Beam Machining (LBM) 1.2.5 Electron Beam Machining (EBM) 1.2.6 Water Jet Machining (WJM) 1.2.7 Abrasive Jet Machining (AJM)	
2. Advanced Welding Processes	6
2.1 Electron Beam Welding (EBW) 2.2 Laser Beam Welding (LBW) 2.3 Ultrasonic Welding (USW)	
3. Advanced Forming Processes	8
3.1 High Energy Rate Forming (HERF) Process 3.2 Electro Magnetic Forming 3.3 Explosive Forming 3.4 Electro Hydraulic Forming 3.5 Stretch Forming	
4. Additive Manufacturing (AM)	9
4.1 Introduction 4.2 Need for Additive Manufacturing 4.3 Fundamental of Additive Manufacturing 4.4 Advantages and disadvantages of AM 4.5 Distinction between AM and CNC 4.6 Classification of Additive Manufacturing Processes 4.10 LASER Engineered Net Shaping (LENS)	
5. Additive Manufacturing Advanced Techniques	
5.1 Liquid based AM Processes 5.2 Stereo Lithography Apparatus (SLA) 5.3 Solid Ground Curing (SGC) 5.4 Poly Jet 5.5 Solid Based AM Processes 5.5.1 Laminated Object Manufacturing (LOM)	10

5.5.2 Fused Deposition Modelling (FDM) 5.6 Powder Based AM Processes 5.5.1 Selective LASER Sintering (SLS) 5.5.2 3D Printing	
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MMU

Subject Name/Code: Cyber Security/UG11E5711

Instructional hours:

Lecture : 45 hours

Total contact hours : 45 hours

Credits : 3

Teaching Methods

The course shall be conducted in a combination of classroom lectures, case study analysis, writing assignments and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments) : 30%

Final Exam : 70%

Text Book:

1. Charles P. Pfleeger Shari Lawrence Pfleeger Jonathan Margulies, Security in Computing, 5th Edition, Pearson Education, 2015

Reference:

1. George K. Kostopoulos, Cyber Space and Cyber Security, CRC Press, 2013.
2. Martti Lehto, Pekka Neittaanmäki, Cyber Security: Analytics, Technology and Automation edited, Springer International Publishing Switzerland.
3. Nelson Phillips and Enfinger Steuart, -Computer Forensics and Investigations||, Cengage Learning, New Delhi.

Web Resource:

1. <http://acl.digimat.in/nptel/courses/video/106106248/L14.html>
2. <https://nptel.ac.in/courses/106106129>
3. <https://nptel.ac.in/courses/106106248>

Table of Topics

Units	Topics	Hours (L)
I	Introduction to Cyber Security	9
II	Security In Operating System & Networks	9
III	Digital Security	9
IV	Privacy in Cyberspace	9
V	Management and Incidents	9
	Total	45

Learning Objectives		L
<p>Objectives:</p> <ul style="list-style-type: none"> • Students should be able to understand. • The difference between threat, risk, attack and vulnerability. • How threats materialize into attacks. • Where to find information about threats, vulnerabilities and attacks. • Typical threats, attacks and exploits and the motivations behind them. 		
<p>I. Introduction to Cyber Security</p> <p>Introduction -Computer Security - Threats -Harm - Vulnerabilities - Controls - Authentication Access Control and Cryptography - Web—User Side – Browser Attacks - Web Attacks Targeting Users - Obtaining User or Website Data – Email Attacks</p>		9
<p>II. Security In Operating System & Networks</p> <p>Security in Operating Systems - Security in the Design of Operating Systems -Rootkit – Networking basics (home network and large-scale business networks), Networking protocols, Security of protocols, sample application hosted on-premises.</p>		9
<p>III. Digital Security</p> <p>Basics of digital security, protecting personal computers and devices, protecting devices from Virus and Malware, Identity, Authentication and Authorization, need for strong credentials, keeping credentials secure, protecting servers using physical and logical security, World Wide Web (www), the Internet and the HTTP protocol, security of browser to web server Interaction</p>		9
<p>IV. Privacy in Cyberspace</p> <p>Introduction to cyber-attacks, application security (design, development and testing), operations security, monitoring, identifying threats and remediating them, Principles of data security - Confidentiality, Integrity and Availability, Data Privacy, Data breaches, preventing attacks and breaches with security controls, Compliance standards, Computer Ethics.</p>		9
<p>V. Management and Incidents</p> <p>Security Planning - Business Continuity Planning - Handling Incidents – Risk Analysis - Dealing with Disaster - Emerging Technologies - The Internet of Things - Economics - Electronic Voting - Cyber Warfare- Cyberspace and the Law - International Laws - Cybercrime - Cyber Warfare and Home Land Security.</p>		9

Subject Name/Code: Cyber Security/UG11E5712

Instructional hours:

Lecture : 45 hours

Total contact hours : 45 hours

Credits : 3

Teaching Methods

The course shall be conducted in a combination of classroom lectures, case study analysis, writing assignments and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments) : 30%

Final Exam : 70%

Text Book:

1. Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective", CRC Press.
2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet of Things", Springer.
3. David Easley and Jon Kleinberg, "Networks, Crowds, and Markets: Reasoning About a highly connected World", Cambridge University Press.
4. Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things – Key Applications and Protocols", Wiley.

Reference:

1. Vijay Madiseti and ArshdeepBahga, "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT.
2. Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications.
3. CunoPfister, Getting Started with the Internet of Things, O'Reilly Media, 2011, ISBN: 978-1-4493-9357-1

Web Resource:

1. <https://nptel.ac.in/courses/106105166>
2. <http://nitttrc.edu.in/nptel/courses/video/106105166/L40.html>

Table of Topics

Units	Topics	Hours (L)
I	IOT	9
II	IOT Protocols	9
III	IOT Architecture	9
IV	Web of Things	9
V	IOT Applications	9
	Total	45

Learning Objectives		L
<p>Objectives</p> <p>The Internet is evolving to connect people to physical things and also physical things to other physical things all in real time. It's becoming the Internet of Things (IoT). The course enables student to understand the basics of Internet of things and protocols. It introduces some of the application areas where Internet of Things can be applied. Students will learn about the Middleware for Internet of Things. To understand the concepts of Web of Things</p>		
<p>I. IOT</p> <p>What is the IoT and why is it important? Elements of an IoT ecosystem, Technology drivers, Business drivers, Trends and implications, Overview of Governance, Privacy and Security Issues.</p>		9
<p>II. IOT Protocols</p> <p>Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols - Issues with IoT Standardization – Unified Data Standards –Protocols – IEEE802.15.4–BAC Net Protocol– Modbus – KNX – Zigbee– Network layer – APS layer – Security</p>		9
<p>III. IOT Architecture</p> <p>IoT Open-source architecture (OIC)- OIC Architecture & Design principles- IoT Devices and deployment models- IoTivity: An Open source IoT stack -Overview- IoTivity stack architecture- Resource model and Abstraction.</p>		9
<p>IV. Web of Things</p> <p>Web of Things versus Internet of Things – Two Pillars of the Web– Architecture Standardization for WoT– Platform Middleware for WoT – Unified Multitier WoT Architecture – WoT Portals and Business Intelligence.</p>		9
<p>V. IOT Applications</p> <p>IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications. Study of existing IoT platforms /middleware, IoT- A, Hydra etc.</p>		9

Subject Name/Code: Occupational Safety and Health/UG11E5713

Instructional hours:

Lecture : 45 hours

Total contact hours : 45 hours

Credits : 3

Teaching Methods

The course shall be conducted in a combination of classroom lectures, case study analysis, writing assignments and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments) : 30%

Final Exam : 70%

Reference:

1. Industrial Safety Management – LM Deshmukh
2. ILO Convention – 155 & Recommendation – 164
3. Indian Factories Act 1948
4. ILO Encyclopedia of occupational health and safety
5. Management of International Health & Safety – Roger Passey
6. Occupational Safety & Health Management – Thomas J Anton
7. Safety Professional's reference & study guide – W David Yates
8. Fundamental Principles of Occupational Health & Safety – Benjamin.O.Alli
9. Guidelines for implementing the occupational safety and health provisions of the MLC- 2006 (ILO)

Table of Topics

Unit	Topic	Hours (L)
I	Health & Safety Management Systems	9
II	Occupational Hazards	9
III	Organising for Health & Safety	9
IV	Risk Management	9
V	Monitoring OHS	9
Total		45

Learning Objectives		L
<p>I. Health & Safety Management Systems</p> <p>General Learning Objective: Understand the basics of health and safety management systems</p> <p>Subtopics & SLOs:</p> <ul style="list-style-type: none"> 1.1 Defining an effective safety and health management system - The management models – PDCA cycle - ISO 45001 OHSAS 18001 standard 1.2 Policy – Purpose and importance of setting Policy – Key features and contents of Health & Safety Policy <p>Specific Learning Objectives:</p> <ul style="list-style-type: none"> 1.1 Defining an effective safety and health management system - The management models- PDCA – ISO 45001 <ul style="list-style-type: none"> 1.1.1 Define the concept of effective safety and health management system 1.1.2 Discuss about PDCA cycle 1.1.3 Explain ISO 45001 <p>Specific Learning Objectives:</p> <ul style="list-style-type: none"> 1.2 Policy – Purpose and importance of setting Policy – Key features and contents of Health & Safety Policy <ul style="list-style-type: none"> 1.2.1. State the purpose and importance of setting policy 1.2.2 Discuss about the key features and contents of health and safety policy 	9	
<p>II. Occupational Hazards</p> <p>General Learning Objective: Identify the various types of occupational hazards, formulate solutions to control the occupational hazards and collaborate with others in their respective organizations to minimize occupational hazards, Communicable diseases. Drug and alcohol abuse and dependency, Fatigue</p> <p>Subtopics & SLOs: Concepts of biological hazards, chemical hazards, electrical hazards, natural hazards, radiation hazards</p> <p>Specific Learning Objectives</p> <ul style="list-style-type: none"> 2.1 Concepts of biological hazards, chemical hazards, electrical hazards, natural hazards, radiation hazards <ul style="list-style-type: none"> 2.1.1 What are the various types of biological agents? 2.1.2 How do you identify the bio hazards agents? 		9

<p>2.1.3 Discuss the methods of controlling bio hazards.</p> <p>2.1.4 How to recognize the common occupational health hazards: gases, vapours, mists, fumes, etc.</p> <p>2.1.5 What are the potential sources of occupational exposure to particulates & fibers, solvents, acids & bases?</p> <p>2.1.6 Explain the concepts of severity of shock, arc flash, arc blast.</p> <p>2.1.7 What are the various protective devices and measures used in case of electrical hazards?</p> <p>2.1.8 Discuss the causation and threshold of natural hazards.</p> <p>2.1.9 Discuss about the exposure guidelines for physical agents like thermal stress, heat stress, cold stress, noise & vibration</p> <p>2.1.10 Explain the following terms like ionising radiation, activity, half-life, etc.</p> <p>2.1.11 Discuss about the principles of radiation protection.</p> <p>2.1.12 What are the precautionary procedures to protect against radiation hazards?</p> <p>2.1.13 Discuss about the various communicable diseases in this regard.</p> <p>2.1.14 Write notes on drug and alcohol abuse and dependency and fatigue.</p>	
<p>III. Organising for Health & Safety</p> <p>General Learning Objective: Understanding the role of organization in ensuring health and safety</p> <p>Subtopics & SLOs:</p> <p>3.1 Organising for Health & Safety - setting goals & objectives – Management leadership – Employee involvement – Concept & significance of Safety Culture</p> <p>3.2 Internal and external factors influencing Safety behavior – Improving safety culture and climate- Improving human reliability – Communication -consultation - Work site Analysis – Review of culture</p> <p>Specific Learning Objectives:</p> <p>3.1 Organising for Health & Safety - setting goals & objectives – Management leadership – Employee involvement – Concept & significance of Safety Culture</p> <p>3.1.1 Discuss about the role of management in setting the goals and objectives for health and safety in the organizational setup.</p> <p>3.1.2 Discuss the role of employee engagement in ensuring health and safety. Explain the concept of safety culture in an organization.</p> <p>3.2 Internal and external factors influencing safety behavior – Improving safety culture and climate- Improving human reliability – Communication -consultation - Work site Analysis – Review of culture</p> <p>3.2.1 State and explain the roles of internal and external factors influencing safety behaviour.</p> <p>3.2.2 Discuss the roles played in terms of communication, consultation, work site analysis and review of culture in terms of improving safety culture and climate.</p> <p>3.2.3 Discuss about the reporting and investigation of occupational accidents, injuries and diseases.</p>	9
<p>IV. Risk Management</p> <p>General Learning Objective: Understand the intricacies of risk management</p> <p>Subtopics & SLOs:</p> <p>4.1 Risk Analysis & Risk Management – Principles of hazard identification – Hazard analysis & risk control - Quantitative & qualitative assessment - Carrying out a Risk assessment</p> <p>4.2 Preventive and protective measures – Process safety management - Safe Systems of Work – Permit to Work Systems</p>	9

<p>Specific Learning Objectives:</p> <p>4.1 Risk Analysis & Risk Management – Principles of hazard identification – Hazard analysis & risk control - Quantitative & qualitative assessment - Carrying out a Risk assessment</p> <p>4.1.1 Explain the concepts of risk analysis and risk management.</p> <p>4.1.2 What are the principles of hazard identification?</p> <p>4.1.3 Explain the methodology for conducting a quantitative and qualitative assessment.</p> <p>4.1.4 Explain the method of carrying out a risk assessment.</p> <p>4.1.5 What are the risks involved on board ships?</p> <p>4.1.6 Discuss about the hazards inherent in working on board ships and in closed spaces.</p> <p>4.1.7 Write a note on ‘Mental Occupational Health’.</p> <p>Specific Learning Objectives:</p> <p>4.2 Preventive and protective measures – Process safety management - Safe Systems of Work – Permit to Work Systems</p> <p>4.2.1 What are the preventive and protective measures related to safety?</p> <p>4.2.2 Explain the process of safety management.</p> <p>4.2.3 Write a note on safe systems to work and the permits required for work systems.</p> <p>4.2.4 Discuss about the role of PPE used for seafarers.</p>	
<p>V. Monitoring OHS</p> <p>General Learning Objective: Learn about the various methods of monitoring so as to mitigate the risk of hazards.</p> <p>Subtopics and SLOs:</p> <p>5.1 Investigating Incidents, Fault Tree Analysis, Failure Modes and Effects Analysis Recording & Reporting incidents, LTI – LTIFR</p> <p>5.2 Safety Training, Safety Auditing, Performance Review</p> <p>Specific Learning Objectives</p> <p>5.1 Investigating Incidents, Fault Tree Analysis, Failure Modes and Effects Analysis Recording & Reporting incidents</p> <p>5.1.1 Explain the procedure for investigating incidents.</p> <p>5.1.2 Explain the concept of Fault Tree Analysis.</p> <p>5.1.3 Discuss about Failure Modes and Effects Analysis.</p> <p>5.1.4 Discuss the methods of recording and reporting incidents</p> <p>Specific Learning Objectives</p> <p>5.2 Safety Training, Safety Auditing, Performance Review</p> <p>5.2.1 Discuss the types of safety trainings to be imparted by organizations.</p> <p>5.2.2 Explain the method of safety audit</p> <p>5.2.3 Discuss the method of performance review done by organizations</p> <p>5.2.4 Discuss about the responsibilities of the competent authority of the flag state.</p> <p>5.2.5 What are the responsibilities of ship-owners and seafarers?</p> <p>5.2.6 Discuss the roles of the master.</p> <p>5.2.7 Explain the functions performed by the safety committee and safety officers.</p>	9

Subject Name/Code: Disaster Management/UG11E5714

Instructional hours:

Lecture : 45 hours

Total contact hours : 45 hours

Credits : 3

Teaching Methods

The course shall be conducted in a combination of classroom lectures, case study analysis, writing assignments and self-learning.

Assessment Methods: Refer to IMU Guidelines prior to the start of the Session for actual allocations.

Class Assessments (Written tests/MCQs/Projects/Assignments) : 30%

Final Exam : 70%

Text Book:

1. Dr. Mrinalini Pandey, Disaster Management, Wiley India Pvt. Ltd.
2. Tushar Bhattacharya, Disaster Science and Management, McGraw Hill Education (India) Pvt. Ltd.

Reference:

1. Jagbir Singh, Disaster Management: Future Challenges and Opportunities, K W Publishers Pvt. Ltd.
2. J. P. Singhal, Disaster Management, Laxmi Publications.
3. Shailesh Shukla, Shamna Hussain, Biodiversity, Environment and Disaster Management, Unique Publications
4. C. K. Rajan, Navale Pandharinath, Earth and Atmospheric Disaster Management: Nature and Manmade, B S Publication

Table of Topics

Units	Topics	Hours (L)
I	Introduction on Disaster	9
II	Risk and Vulnerability Analysis	10
III	Disaster Preparedness and Response	8
IV	Response	8
V	Rehabilitation, Reconstruction and Recover	10
	Total	45

Learning Objectives	L
<p>Objectives: The course is intended to provide a general concept in the dimensions of disasters caused by nature beyond human control as well as the disasters and environmental hazards induced by human activities with emphasis on disaster Preparedness, response and recovery.</p>	
<p>I. Introduction on Disaster</p> <p>1.1.1 Different Types of Disaster :</p> <p>1.1.2 Natural Disaster: such as Flood, Cyclone, Earthquakes, Landslides etc</p> <p>1.1.3 Man-made Disaster: such as Fire, Industrial Pollution, Nuclear Disaster, Biological Disasters, Accidents (Air, Sea, Rail & Road), Structural Failures (Building and Bridge), War & Terrorism etc.</p> <p>1.1.4 Causes, effects and practical examples for all disasters.</p>	9
<p>II. Risk and Vulnerability Analysis</p> <p>2.1.1. Risk : Its concept and analysis</p> <p>2.1.2 Risk Reduction</p> <p>2.1.3 Vulnerability : Its concept and analysis</p> <p>2.1.4 Strategic Development for Vulnerability Reduction</p>	10
<p>III. Disaster Preparedness and Response</p> <p>3.1 Preparedness-</p> <p>3.1.1 Disaster Preparedness: Concept and Nature</p> <p>3.1.2 Disaster Preparedness Plan</p> <p>3.1.3 Prediction, Early Warnings and Safety Measures of Disaster.</p> <p>3.1.4 Role of Information, Education, Communication, and Training,</p> <p>3.1.5 Role of Government, International and NGO Bodies.</p> <p>3.1.6 Role of IT in Disaster Preparedness</p> <p>3.1.7 Role of Engineers on Disaster Management.</p>	8
<p>IV. Response-</p> <p>4.1.1 Disaster Response: Introduction</p> <p>4.1.2 Disaster Response Plan</p> <p>4.1.3 Communication, Participation, and Activation of Emergency Preparedness Plan</p> <p>4.1.4 Search, Rescue, Evacuation and Logistic Management</p> <p>4.1.5 Role of Government, International and NGO Bodies</p> <p>4.1.6 Psychological Response and Management (Trauma, Stress, Rumor and Panic)</p> <p>4.1.7 Relief and Recovery</p> <p>4.1.8 Medical Health Response to Different Disasters</p>	8

V. Rehabilitation, Reconstruction and Recovery 5.1.1 Reconstruction and Rehabilitation as a Means of Development. 5.1.2 Damage Assessment 5.1.3 Post Disaster effects and Remedial Measures. 5.1.4 Creation of Long-term Job Opportunities and Livelihood Options, 5.1.5 Disaster Resistant House Construction 5.1.6 Sanitation and Hygiene 5.1.7 Education and Awareness, 5.1.8 Dealing with Victims' Psychology, 5.1.9 Long-term Counter Disaster Planning 5.1.10 Role of Educational Institute.	10
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