

Indian Maritime University
(A Central University, Govt of India)
Supplementary Examinations – September/October 2024
Programme Name: B Tech (Marine Engineering)
Semester: II
Subject Code: UG11T4205
Subject Name: BASIC THERMODYNAMICS

Date: 19.09.2024

Max Marks: 70

Duration: 03 Hrs

Pass Marks: 35

General Instructions

- (i) All Sections (A, B & C) are to be attempted.
- (ii) Options, if any, are specified in respective section.
- (iii) Usage of Steam and Thermodynamic Property Tables permitted

Section A

Ten MCQs/Fill in the Blanks of 01 Mark each – Choose the correct answer as applicable.

1. If the value of n is zero in the equation $PV^n = C$, then the process is called
 - (a) Constant volume process
 - (b) Constant pressure process
 - (c) Adiabatic process
 - (d) Isothermal process
2. Irreversibility of the process is equal to
 - (a) $W_{\max} - W$
 - (b) $W - W_{\max}$
 - (c) W_{\max}
 - (d) W
3. In a steady flow process, across the control volume mass and energy flow
 - (a) Varies continuously
 - (b) Remain constant
 - (c) Depends on control surface

- (d) Depends on type of process
4. A Carnot cycle has following processes
- (a) 4 reversible isotherms
 - (b) 4 reversible adiabatics
 - (c) 2 reversible isotherms and 2 reversible adiabatics
 - (d) 2 reversible isochoric and 2 reversible isobars
5. The internal energy of an ideal gas is function of
- (a) pressure only
 - (b) absolute temperature only
 - (c) pressure and volume
 - (d) pressure, volume and temperature
6. Which among the following is an extensive property?
- (a) Temperature
 - (b) Specific Enthalpy
 - (c) Pressure
 - (d) Entropy
7. Consider The general energy equation for a closed system is
- (a) $Q = \Delta KE + \Delta PE - \Delta U + W$
 - (b) $Q = \Delta KE + \Delta PE - \Delta U - W$
 - (c) $Q = -\Delta KE - \Delta PE + \Delta U + W$
 - (d) $Q = \Delta KE + \Delta PE + \Delta U + W$
8. The value of $\oint dQ/T$ for an reversible cycle is
- (a) Equal to zero
 - (b) Greater than zero
 - (c) Less than zero
 - (d) Unity
9. For a given temperature T_1 and T_2 , as the difference T_1 and T_2 increases, the COP of a Carnot Heat Pump
- (a) Increases
 - (b) First increases, then decreases

- (c) Does not change
 - (d) Decreases
10. During throttling process:
- (a) internal energy does not change
 - (b) pressure does not change
 - (c) enthalpy does not change
 - (d) volume does not change

Section B

Five Questions of 02 Marks each

11. Write Vander Waals Equation of state and mention meaning of each term involved in it.
12. Define exergy and dead state
13. Write 1st and 2nd T-ds relationships.
14. Define point function and path function
15. Define Heat Engine's Thermal Efficiency.

Section C

Seven Questions of 10 Marks each of which any 05 questions to be answered.

16. a) A cyclic heat engine operates between a source temperature of 1000°C and a sink temperature of 40°C . Find the least rate of heat rejection per kW net output of engine. (6 marks)
- b) State Kelvin Plank and Clausius Statement of second law of thermodynamics (4 marks)
17. Derive the equation for pdV-Work in adiabatic process? (10 Marks)
18. a) A heat engine receives heat from a source at 1200 K at a rate of 500 kJ/s and rejects waste heat to a medium at 300 K. The power output of heat engine is 180 kW. Determine the reversible power & the irreversibility rate for this process. (7 marks)
- b) Describe Second-Law efficiency? (3 marks)

19. A vessel of volume 0.03 m^3 contains a mixture of saturated water and saturated steam at a temperature of 250°C . The mass of the liquid present is 10 kg . Calculate the mass, the specific volume, the enthalpy, the entropy, and the internal energy.

At 250°C , take

$$p_{\text{sat}} = 3.973 \text{ MPa}$$

$$v_f = 0.0012512 \text{ m}^3/\text{kg}, v_g = 0.05013 \text{ m}^3/\text{kg}$$

$$h_f = 1085.36 \text{ kJ/kg}, h_{fg} = 1716.2 \text{ kJ/kg}$$

$$s_f = 2.7927 \text{ kJ/kgK}, s_{fg} = 3.2802 \text{ kJ/kgK}$$

(10 Marks)

20. a) Explain an adiabatic process (03 marks)
b) What is Dryness Fraction? Does it have any meaning in the superheated vapour region? (03 marks)
c) Explain the difference between Heat Engine and Heat Pump? (04 marks)

21. Two Carnot Engines A and B are connected in series between two thermal reservoirs. Engine A receives 1600 kJ of heat from the high temperature reservoir maintained at 1200 K and rejects heat to the Carnot engine B. Engine B takes in heat rejected by engine A and rejects heat to the low temperature reservoir maintained at 200 K . If engines A and B have equal thermal efficiencies, determine

- the heat rejected by engine B
- temperature at which heat is rejected by engine A
- Calculate the work done by engine A and B.

(10 Marks)

22. (a) Define specific heat C_p & C_v . Derive relation $C_p = C_v + R$ using enthalpy.

(b) Steam at 0.4 MPa , 300°C , enters an adiabatic nozzle with a low velocity and leaves at 0.2 MPa with a quality of 90% . Sketch the diagram of the adiabatic nozzle & find the exit velocity, in m/s . Consider $h_{g@300^\circ\text{C} \text{ \& } 0.4 \text{ MPa}} = 3067.1 \text{ kJ/kg}$, $h_{f@0.2 \text{ MPa}} = 504.7 \text{ kJ/kg}$ & $h_{fg@0.2 \text{ MPa}} = 2201.6 \text{ kJ/kg}$.

(4 + 6 marks)