**Indian Maritime University**
(A Central University, Govt. Of India)
End Semester Examination Dec 19 / Jan 20
**B. Tech(Marine Engineering)**
Semester IV
**Marine Heat Engines and Air Conditioning**
**(UG11T1406-2406)**

Date:11-01-2020 Max Marks: **70**
Time:3 Hrs Pass Marks: **35**

**Note: Use of Steam Tables, Psychrometric Chart / Tables, Property Tables of gases are permitted.**

**Part – A (compulsory)**
**Answer the following (10x2=20 Marks)**

1. Explain the difference between the impulse and the reaction principles with reference to turbo-machinery
2. List at-least 5 methods of improving efficiency of an ideal Rankine cycle power plants.
3. Explain the principle of throttling and relate it to a thermodynamic process.
4. What is dew point and relative humidity with reference to air conditioning
5. What is a heat pump and refrigerator? Show with a simple sketch for each.
6. Develop an equation for efficiency for a De Laval turbine.
7. Explain reheat factor using free hand sketch of a Mollier diagram.
8. Draw a T-s diagram with appropriate labeling for a combined cycle gas and steam power plant
9. Derive the relationship for enthalpy of a moist air sample
10. Draw a T-s diagram with appropriate labeling for a Regenerative Rankine cycle employing closed type feed heater.

**Part – B**

**Answer any 5 out of 7 questions (5 x 10= 50 marks)**

11. A De Laval turbine runs with steam supplied at 16 bar, 250°C. The nozzle efficiency is 90%, blade velocity coefficient is 0.98, mechanical efficiency is 95%, nozzle angle is 15°, symmetrical blades with 30° angle, mean diameter of wheel is 80 cm, back pressure is 0.15 bar. Determine
    (a) the speed of rotation,
    (b) the steam consumption per-kW-hr,
    (c) The stage efficiency
    (d) The percentage energy loss at exit

    10 Marks

12. A gas turbine cycle has two stages of compression, with an intercooler between the stages. Air enters the first stage at 100 kPa, 300 K. The pressure ratio across each compressor stage is 5 to 1, and each stage has an isentropic efficiency of 82%. Air exits the intercooler at 330 K. Calculate the temperature at the exit of each compressor stage and the total specific work required.

    10 Marks

13. Refrigerant-134a enters the compressor of a refrigerator as superheated vapor at 0.14 MPa and -10°C at a rate of 0.05 kg/s and leaves at 0.8 MPa and 50°C. The refrigerant is cooled in the condenser to 26°C and 0.72 MPa and is throttled to 0.15 MPa. Disregarding any heat transfer and pressure drops in the connecting lines between the components, Determine :
    (a) The rate of heat removal from the refrigerated space and the power input to the compressor
    (b) the isentropic efficiency of the compressor
    (c) the coefficient of performance of the refrigerator.

(4+3+3) Marks

14. A 5-m x 5-m x 3-m room contains air at 25°C and 100 kPa at a relative humidity of 75 percent. Determine
    (a) The partial pressure of dry air
    (b) The specific humidity
    (c) The enthalpy per unit mass of the dry air
    (d) The masses of the dry air and water vapor in the room.

    Take $C_P$ of air = 1.005 kJ/kg

(3+3+2+2) Marks

15.
    (a) Moist air, saturated at 2 deg.C enters a heating coil at a rate of 10 m3/s. Air leaves the coil at 40 deg.C. Find the required rate of heat addition.

5 Marks

    (b) A stream of 2 m3/s out of atmospheric air at 4 deg.C dry-bulb temperature and 2 deg.C thermodynamic wet-bulb temperature is adiabatically mixed with 6.25 m3/s of recirculated air at 25 deg.C dry-bulb temperature and 50% RH. Find the dry-bulb temperature and thermodynamic wet-bulb temperature of the resulting mixture. 5 Marks

16. What is the thermodynamic relation for work done on a fluid by a turbo-compressor? Describe the effect of interstage cooling in a ideal compressor using a PV diagram. 10 Marks

17. What is a curtis stage with regard to steam turbines ? Draw velocity diagram for one curtis stage. Obtain relations for diagram power and maximum efficiency. 10 Marks