

INDIAN MARITIME UNIVERSITY

Time Bound Assignment September/October 2020

B Tech (ME) Arrear Examinations

Applied Thermodynamics-I

UG11T1203/UG11T2203

Date: 25/09/2020

Maximum Marks: 70

Time: 3 Hrs

Pass Marks: 35

Note: Use of steam table is allowed

PART-A (Marks: 10×2 = 20 Marks)
(All Questions are compulsory)

1. Define COP of refrigerator and heat pump
2. Write Carnot's principles
3. Draw T-s diagram of simple Rankine cycle
4. Define Work ratio for Rankine cycle
5. Draw the theoretical P-v diagram of steam engine?
6. What is isothermal efficiency of a reciprocating compressor?
7. Show saving in work done in a multi-stage compressor with p-v graph
8. What is free air delivery of a reciprocating compressor?
9. What is dew point?
10. Write Amagat's law of additive volumes

PART-B (Marks: 5×10 = 50)

(Answer any 5 of the following 7 Questions)

- 11.a)** A Carnot cycle operates between the source and sink temperatures of 250°C and -15°C. If the system receives 90 kJ from the source, find
(i) Efficiency of the system; (ii) The net work transfer;
(iii) Heat rejected to sink. **(5 Marks)**
- b)** Explain Carnot cycle with p-v and T-s diagram **(5 Marks)**

12.a) Explain simple Rankine cycle with T-s diagram **(5 Marks)**

b) A steam turbine operating on Rankine cycle receives steam from boiler at 3.5 MPa and 300°C. It is exhausted to condenser at 10 kPa, calculate, Rankine efficiency including pump work. **(5 Marks)**

13. In a test on vertical double acting steam engine, the following observations were taken:
Indicator card area (cover end side) = 10.5 cm²
Indicator card area (crank end side) = 10.2 cm²
Length of indicator card = 7.6 cm
Spring constant for indicator used = 0.08 MPa/cm (0.8 bar/cm)
Speed = 120 rpm, Diameter of piston = 21.5 cm
Diameter of piston rod = 3.7 cm, Stroke = 30.5 cm
Calculate the indicated power. If mechanical efficiency of engine is 80 % at given load, find the brake torque developed. **(10 Marks)**

14.a) Explain the working of reciprocating air compressor. **(5 Marks)**

b) A single stage single acting air compressor delivers 0.6 kg of air per minute at 6 bar. The temperature and pressure at the end of suction stroke are 30°C and 1 bar. The clearance is 3% of the stroke volume. Assuming the index of compression and expansion to be 1.3, find i) Volumetric efficiency of the compressor, ii) Power required if the mechanical efficiency is 85%. **(5 Marks)**

15.a) Explain multistage compression with the help of p-V diagram. **(5 Marks)**

b) Air at 103 kPa and 27°C drawn in LP cylinder of a two stage air compressor and is isentropically compressed to 700 kPa. The air is then cooled at constant pressure to 37°C in an intercooler and is then again compressed isentropically to 4 MPa in the HP cylinder, and is delivered at this pressure. Determine the power required to run compressor if it has to deliver 0.5 m³ of air per minute measured at inlet conditions. **(5 Marks)**

16.a) State and explain Gibb's Dalton's law **(5 Marks)**

b) A vessel of 1.8 m^3 capacity contains oxygen at 8 bar and 50°C . The vessel is connected to another vessel of 3.6 m^3 capacity containing carbon monoxide at 1 bar and 20°C . A connecting valve is opened and the gases mix adiabatically. Calculate: (i) The final temperature and pressure of the mixture; (ii) The change of entropy of the system.

Take: For oxygen $C_v = 21.07 \text{ kJ/mole K}$.

For carbon monoxide $C_v = 20.86 \text{ kJ/mole K}$. **(5 Marks)**

17.a) Derive the energy balance equation obtained when two streams of fluid mix to form one common stream. **(5 Marks)**

b) Explain adiabatic saturation process and show it on the psychrometric chart. **(5 Marks)**
