INDIAN MARITIME UNIVERSITY

(A Central University, Government of India)
End Semester Examination Dec-2019/Jan-2020
B. Tech (Marine Engineering)
Semester-II
Applied Thermodynamics-I
(UG11T1203/2203)

Date: 06/01/2020 Maximum marks: 70
Time: 3 Hrs Pass Marks: 35

Note: Use of steam table and Mollier chart is allowed

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

1. State the Clausius statement of Second Law of Thermodynamics.
2. What is Carnot's Theorem?
3. What is a reversible process? Write examples of it.
4. What is regenerative Rankine Cycle?
5. Draw the T-s diagram for Rankine cycle when the boiler gives superheated steam.
6. Why are multistage compressors required?
7. What is perfect intercooling in multistage reciprocating compressors?
8. What are the advantages of a regenerative cycle?
9. Define dew point.
10. What is Dalton's Law of partial pressures?

PART-B (Marks: 5×10 = 50)
(Answer any 5 of the following 7 Questions)

11. a) State the Kelvin-Planck statement of Second Law. What is PMM2? (3)

b) A reversible engine is supplied with heat from two constant temperature sources at 900 K and 600 K and rejects heat to a constant temperature sink of 300 K. The engine develops a work of 90 KW and rejects heat at the rate of 56 KJ/sec. Find the heat supplied by each sources and efficiency of the engine. (7)

12. In a steam power cycle, the steam supply is at 15 bar and dry and saturated. The condenser pressure is 0.4 bar. Calculate the Carnot and Rankine efficiencies of the cycle. Neglect pump work. (10)

13. 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 bore and stroke of the compressor are 100 mm and 150 mm respectively. The clearance is 3% of the swept 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%, and (iii) Speed of the compressor in r.p.m.(Take R for air = 0.287 kJ/kgK) (10)

14. A double acting single cylinder steam engine runs at 250 r.p.m and develops 30 kW. The pressure limits of operation are 10 bar. Cut-off is at 40% of the stroke. The L/D ratio is 1.25 and the diagram factor is 0.75. Assume saturated steam at inlet, hyperbolic expansion and negligible effect of piston rod. Find: (i) Mean effective pressure,
(ii)Cylinder dimensions and (iii) Indicated thermal efficiency. (10)

15. a) Derive the energy balance equation obtained when two streams of fluid mix to form one common stream. (4)

b) Two vessels, A and B, each of volume 3 m^3 may be connected together by a tube of negligible volume. Vessel A contains air at 7 bar, 95°C while B contains air at 3.5 bar, 205°C. Find the change of entropy when A is connected to B. Assume the mixing to be complete and adiabatic. (Take R for air = 0.287 kJ/kgK) (6)

16. a) What is the condition for minimum work input in a reciprocating compressor? (4)

b) A single stage reciprocating compressor takes 1 m^3 of air per minute at 1.013 bar and 15°C and delivers it at 7 bar. Assuming that the law of compression is $pV^{1.35}$= constant, and the clearance is negligible, calculate the indicated power? (6)

17. A turbine is supplied with steam at a pressure of 32 bar and a temperature of 410°C. The steam then expands isentropically to a pressure of 0.08 bar. Find the dryness fraction at the end of expansion and thermal efficiency of the cycle.
If the steam is reheated at 5.5 bar to a temperature of 395°C and then expanded isentropically to a pressure of 0.08 bar, what will be the dryness fraction and thermal efficiency of the cycle? (10)

****