

S 9225

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2006.

Third Semester

Mechanical Engineering

ME 231 — APPLIED THERMODYNAMICS

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

Use of Approved steam tables Mollier chart, Refrigeration tables permitted.

PART A — (10 × 2 = 20 marks)

1. Define the term 'Steam nozzle'. What are the types of nozzle?
2. State the relationship between the velocity of steam and heat drop during any part of a steam nozzle.
3. In an air compressor what is meant by free air delivered?
4. What is meant by isothermal efficiency of reciprocating air compressor?
5. What is the name of the process of heat rejection in diesel cycle?
6. Name the gas power cycle for a gas turbine.
7. Mention the two components in a rankine cycle that work at maximum pressure and minimum pressure respectively.
8. What is the effect of regeneration on efficiency and specific work output of the steam plant?
9. Define refrigeration.
10. The work of compression in the case of superheated cycle is _____ than that of simple saturated cycle.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Steam is expanded in a set of nozzles from 10 bar and 200° C to 5 bar. What type of nozzle is it? Neglecting the initial velocity find minimum area of the nozzle required to allow a flow of 3 kg/s under the given conditions. Assume that expansion of steam to be isentropic. (8)
- (ii) Discuss why attainment of sonic velocity determines the maximum mass rate of flow through steam nozzle. (8)

Or

- (b) Steam enters a group of convergent-divergent nozzles at a pressure of 2.2 Mpa and with a temperature of 260° C. Equilibrium expansion takes place through nozzles to an exit pressure of 0.4 MPa. Up to the throat of the nozzles the flow can be considered as frictionless. From the throat to exit the isentropic efficiency of expansion is 85%. The rate of stem flow through the nozzles is 11 kg/s. Using mollier chart determine the velocities and areas of throat and exit.
12. (a) (i) Derive the equation for volumetric efficiency of Air compressor in terms of pressure ratio and clearance ratio. (6)
- (ii) A single stage, single acting compressor running at 1000 rpm delivers air at 25 bar. The suction conditions are 1.013 bar and 15°C, and the volume delivered measured at this suction conditions is 0.25 m³/min. The clearance volume is 3% of the swept volume and the stroke/bore ratio is 1.2 : 1. The index of compression is 1.3. Calculate :
- (1) The volumetric efficiency,
 - (2) The bore and stroke,
 - (3) The indicated power,
 - (4) The isothermal efficiency. (10)

Or

- (b) (i) Derive the condition for the minimum work done for two-stage air compressor with the perfect inter-cooling. (8)
- (ii) A two stage compressor with complete inter-cooling delivers 10 kg/min of air at 16 bar. The suction occurs at 1 bar and 15°C. The expansion and compression processes are reversible polytropic with index $n = 1.25$. Calculate the power required and isothermal efficiency. (8)

- (a) (i) Derive an expression for efficiency for Otto cycle in terms of compression ratio. (6)
- (ii) An air standard diesel cycle has a compression ratio of 18 and the heat transferred to the working fluid per cycle is 1800 kJ/kg. At the beginning of the compression process the pressure is 0.1 MPa and the temperature is 15°C. Determine
- (1) The pressure and temperature at each point in the cycle.
 - (2) The thermal efficiency.
 - (3) The mean effective pressure. (10)

Or

- (b) An air standard dual cycle has compression ratio of 16 and begins at 1 bar, 50°C. The heat transferred at constant pressure is 312 kJ/kg and it is equal to that at constant volume. Determine the temperature at all the cardinal points of the cycle and thermal efficiency. Take C_p and C_v for air as 1.005 and 0.718 kJ/kg K respectively.

14. (a) (i) With the help of neat schematic sketch and T-s plot explain the Rankine cycle with reheat. (6)
- (ii) In a Rankine cycle, the steam at inlet to turbine is saturated at a pressure of 35 bar and the exhaust pressure is 0.2 bar. Determine the turbine work and rankine efficiency neglecting the pump work. (10)

Or

- (b) In a regenerative steam cycle employing two feed water heaters, the steam is supplied to the turbine at 40 bar and 500°C and is exhausted to the condenser at 0.035 bar. The intermediate bleed pressures are 10 and 1.1 bar respectively. Calculate the amount of steam bled at each stage, the work output of the plant per kg of steam supplied to the turbine and the cycle efficiency.
15. (a) A refrigerator working on Bell-Coleman cycle operates between pressure limits of 1.05 bar and 8.5 bar. Air is drawn from cold chamber at 10°C, compressed and then it is cooled to 30°C before entering into the expansion cylinder. The expansion and compression follow the law $pv^{1.3} = \text{constant}$. Determine the theoretical COP of the system. Indicate the cycle on both p-V and T-s plots.

Or

- (b) (i) Explain Vapour compression Refrigeration cycle with the neat schematic sketch. (8)
- (ii) Describe aqua-ammonia absorption refrigeration system with a neat sketch. (8)
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