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C 3375

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2008.

Third Semester

Electrical and Electronics Engineering

ME 1211 — APPLIED THERMODYNAMICS

(Common to Electronics and Instrumentation Engineering and Instrumentation and Control Engineering)

(Regulation 2004)

Time : Three hours

Maximum : 100 marks

(Use of Steam tables, Refrigeration and Air-conditioning tables, HMT data book, Mollier chart, P-H chart are permitted in examination)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Write down the general steady flow energy equation.
 - (a) Steam Turbine
 - (b) Centrifugal Compressor.
2. Define Heat engine, Refrigerator.
3. What are the factors that impose limitations on the compression ratio used in otto cycle engine?
4. What are the disadvantages of a closed cycle gas turbine over open cycle gas turbine?
5. Determine the quality of steam in the following states
Pressure (P) = 6 bar and $h_g = 2520$ kJ/kg.
6. What are the different methods of compounding of steam turbine stages?

7. What are the advantages of multi-stage compression over a single stage compression for the same pressure ratio?
8. Sketch the T-S and p-h diagrams for the vapour compression cycles when the vapour after compression is dry saturated.
9. What is critical thickness of insulation?
10. Distinguish between a black body and gray body.

PART B — (5 × 16 = 80 marks)

11. (a) A system receives 200 kJ of heat at constant volume process and rejects 220 kJ at constant pressure during which 40 kJ of work is done on the system. The system is brought to its original state by adiabatic process. Calculate the adiabatic work. If the initial internal energy is 240 kJ, calculate the internal energy at all points.

Or

- (b) Two reversible heat engines A and B are arranged in series. A rejects heat directly to B. Engine A receives 200 kJ at a temperature of 421°C from the hot source while engine B is in communication with a cold sink at a temperature of 5°C. If the work output of A is twice that of B, find (i) Intermediate temperature between A and B (ii) efficiency of each engine. (iii) Heat rejected to the sink.
12. (a) Discuss the working of a two stroke cycle petrol engine with the help of neat sketches and list out the advantages and disadvantages of a two stroke cycle over a four stroke one.

Or

- (b) In a gas turbine plant, the intake temperature and pressure are 1 bar and 18°C respectively. The air is then compressed to a pressure of 4 bar by a compressor, whose isentropic efficiency is 80%. The temperature of the gas, whose properties may be assumed to resemble with those of air, is raised to 645°C in the combustion chamber where there is a pressure drop of 0.1 bar. Expansion to atmospheric pressure then occurs. If the thermal efficiency of the plant is to be 19%, what must be the isentropic efficiency of the turbine? The mass of fuel may be neglected, Take $\gamma = 1.4$.

13. (a) The steam is supplied to a three stage turbine at 30 bar and 350°C . The steam leaves the first stage at 7 bar, second stage at 1 bar and finally at 0.1 bar. If the each stage has an efficiency of 0.7, determine (i) Rankine efficiency (ii) The final condition of steam (iii) Reheat factor and (iv) Overall thermal efficiency.

Or

- (b) The velocity of steam, leaving the nozzles of an impulse turbine, is 1200 m/s and the nozzle angle is 20° . The blade velocity is 375 m/s and the blade velocity coefficient is 0.75. Assuming no loss due to shock at inlet, calculate for a mass flow of 0.5 kg/s and symmetrical blading: (i) blade inlet angle (ii) driving force on the wheel (iii) axial thrust on the wheel.
14. (a) Show that the cylinder clearance does not affect the theoretical work required to compress and deliver 1 kg of air, provided that the suction and delivery pressure remain same and indices of compression and expansion have the same value.

Or

- (b) An ammonia refrigerating machines fitted with an expansion valve works between the temperature limits of -10°C and 30°C . The vapour is 95% dry at the end of isentropic compression and the fluid leaving the condenser is at 30°C . Assuming actual C.O.P as 60% of the theoretical, calculate the kilograms of ice produced per kW hour at 0°C from water at 10°C . Latent heat of ice is 335 kJ/kg.
15. (a) (i) Air at 30°C is flowing across a tube with a velocity of 25 m/s. The tube could be either a square with a side of 5 cm or a circular cylinder of diameter 5 cm. compare the rate of heat transfer in each case if the tube surface temperature is 124°C . (10)
- (ii) Derive an expression for heat conduction through a plane wall. (6)

Or

- (b) (i) A small polished sphere of 20 cm in diameter and at 700 K is located in the room. The temperature in the room is 27°C. Find the heat loss rate from the sphere to room initially if the emissivity of the polished sphere is 0.1. If the surface of the sphere is oxidized having 0.8 emissivity, find the change in heat loss. (7)
- (ii) Water flows through a long 2.2 cm diameter copper tube at an average velocity of 2 m/s. The tube wall is maintained at a constant temperature of 95°C whereas the water gets heated from 15°C to 60°C while passing through the tube. Find the average heat transfer coefficient. (9)
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