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B.E./B.Tech DEGREE EXAMINATION, NOVEMBER/DECEMBER 2005

Third Semester

Electrical and Electronics Engineering

ME 1211 — APPLIED THERMODYNAMICS

(Common to Electronics and Instrumentation Engg. and Instrumentation and Control Engg.)

(Regulations 2004)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

Use of approved thermodynamic charts and tables are permitted.

PART A — (10 × 2 = 20 marks)

1. Define thermodynamic system and surroundings.

2. What is a perpetual motion machine of the second kind?

3. Why should the optimum pressure ratio be maintained in gas turbine cycles?

4. What are sensible heat and latent heat?

5. Define cut-off ratio.

6. What does compounding of steam turbine mean?

7. Define free air delivered.

8. Define specific humidity.

9. What is meant by critical thickness of insulation?

10. What is critical Reynolds number? What is its value for internal flows?

PART B — (5 × 16 = 80 marks)

11. (i) What is meant by governing of steam turbines? Explain any one method of governing with a sketch. (10)

(ii) Dry saturated steam at 10 bar expands in a turbine to 0.1 bar. Calculate ideal Rankine cycle efficiency. (6)

12. (a) (i) Define the terms thermodynamic equilibrium, properties, cycle and work done. (8)

(ii) Air in a closed stationary system expands in a reversible adiabatic process from 0.5 Mpa, 15°C to 0.2 Mpa. Find the final temperature, and per kg of air, the change in enthalpy, the heat transferred and the work done. (8)

Or

(b) (i) State and prove Carnot theorem. (6)

(ii) A reversible power cycle is used to drive a reversible heat pump cycle. The power cycle takes in Q_1 heat unit at T_1 and rejects Q_2 at T_2. The heat pump abstracts Q_4 from the sink at T_4 and discharges Q_3 at T_3. Develop an expression for the ratio Q_3/Q_1 in terms of the four temperatures. What must be the relationship of the temperatures T_1, T_2, T_3 and T_4 for Q_3/Q_1 to exceed a value of unity? (10)

13. (a) (i) Explain the working principle of four stroke S.I engine with the help of neat sketches. (10)

(ii) Write a note on abnormal combustion. (6)

Or

(b) (i) Derive the expression of optimum pressure ratio for maximum net work output in an ideal Brayton cycle. What is the corresponding cycle efficiency? (10)

(ii) What are the effects of reheat, intercooling and regeneration on Brayton cycle performance? Explain with the help of T-s diagram.(6)

14. (a) (i) Explain the construction and working principle of centrifugal compressors. (8)

(ii) A multistage air compressor is to be designed to elevate the pressure from 1 bar to 100 bar such that the stage pressure ratio will not exceed 4. Determine number of stages, exact stage pressure ratio and intermediate pressures. (8)

Or

(b) (i) Discuss the effect of sub-cooling and superheating on the performance of vapour compression refrigeration system with the help of T-s diagram. (6)

(ii) Explain the working of summer air-conditioning system with a neat sketch. (10)

15. (a) (i) A 1.2 m high and 2 m wide double-pane window consists of two 3 mm thick layers of glass (k=0.78 W/m K) separated by a 12 mm wide stagnant air gap (k=0.026 W/m K). Determine the steady rate of heat transfer through this double-paned window and the temperature of its inner surface for a day during which the room is maintained at 24°C, while the temperature of the outdoors is −5°C. Take the convection heat transfer coefficients on the inner and outer surfaces of the window to be $h_1 = 10 W/m^2$ K and $h_2 = 25 W/m^2$ K and disregard any heat transfer by radiation. (12)

(ii) Explain the effect of extended surfaces on heat transfer. When is the use of fins not justified? (4)

Or

(b) (i) What are radiation shape factor, black body and grey body? (6)

(ii) Water is heated while flowing through a 2 cm diameter tube at a velocity of 1.2 m/s. The entering temperature of the water is 40°C, and the tube wall is maintained at 85°C. Determine the length of the tube required to raise the temperature of water to 60°C. (10)