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Question Paper Code : 31038

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2013.

Fifth Semester

Mechanical Engineering

080120023 — THERMAL ENGINEERING

(Regulation 2008)

Time : Three hours Maximum : 100 marks

Approved Steam tables, Mollier Charts and Refrigeration Tables Permitted)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Mention the ranges of compression ratio for SI and CI engines.

2. What is relative efficiency?

3. Name the four stages of combustion in a CI engine.

4. What is the effect of supercharging on the power output of the IC engine?

5. Define critical pressure ratio for the steam nozzle.

6. Define diagram efficiency of a steam turbine.

7. What is isothermal efficiency with reference to reciprocating air compressor?

8. State the principle of working of screw compressors.

9. What is the effect of sub-cooling of the refrigerant on the performance of a vapour compression refrigeration system?

10. Name the different components of a summer air-conditioning system.

PART B — (5 × 16 = 80 marks)

11. (a) (i) State the four processes that constitute the Ericsson cycle and show the cycle on the T-s and p-v diagrams. (6)

(ii) A gas turbine works on an air standard Brayton cycle. The initial condition of the air is 25°C and 1 bar. The maximum pressure and temperature are limited to 3 bar and 650°C. Determine the cycle efficiency and work output, heat supplied and heat rejected per kg of air. (10)

Or

(b) (i) With suitable sketches, explain the differences between the actual and theoretical p-v diagrams of a four stroke Otto cycle engine. (6)

(ii) An air standard dual cycle has a compression ratio of 16. The compression begins at 1 bar and 50°C. The maximum pressure is 70 bar. The heat transferred to air at constant pressure is equal to that at constant volume. Estimate the pressures and temperatures at the cardinal points of the cycle and the cycle efficiency. (10)

12. (a) (i) Explain the various factors that affect the flame speed in a SI engine. (6)

(ii) List the various types of combustion chambers of a CI engine. Explain the principle of working of any one type of combustion chamber. (10)

Or

(b) (i) Schematically explain the use of heat balance test of an engine. (6)

(ii) A six cylinder, four stroke gasoline engine having a bore of 90 mm and stroke of 100 mm has a compression ratio 7. The relative efficiency is 55% when the indicated specific fuel consumption is 300 gm/kWh. Find the calorific value of the fuel and corresponding fuel consumption, given that the imep is 8.5 bar and speed is 2500 rpm. (10)

13. (a) (i) In a steam nozzle, the steam expands from 4 bar to 1 bar. The initial velocity is 60 m/s and the initial temperature is 200°C. Determine the exit velocity if the nozzle efficiency is 92%. (10)

(ii) Explain the principle of velocity compounding of a steam turbine using a suitable sketch. (6)

Or

(b) (i) Explain: Throttle governing of steam turbines. (6)

(ii) A simple Rankine cycle works between pressures 28 bar and 0.06 bar, the initial condition of steam being dry saturated. Represent the cycle on a T-s diagram and calculate the cycle efficiency, work ratio and specific steam consumption. (10)

14. (a) (i) What is overall volumetric efficiency of a reciprocating air compressor? What are parameters that affect the overall volumetric efficiency? (6)

(ii) A single stage single acting reciprocating air compressor delivers 14 m^3 of free air per minute from 1 bar to 7 bar. The speed of the compressor is 310 rpm. Assuming polytropic compression and expansion with n = 1.35 and clearance is 5% of the swept volume, find the diameter and stroke of the compressor. Take L = 1.5 D. Assume the temperature and pressure at suction are same as atmospheric air. (10)

Or

(b) (i) Explain the working of a vane type blower with a neat sketch. (10)

(ii) Compare between axial flow and centrifugal compressors. (6)

15. (a) (i) State any five desirable characteristics of refrigerant. (6)

(ii) A R-12 refrigerator producing a cooling effect of 20 kJ/s operates on a simple cycle with pressure limits of 1.5 bar and 9.5 bar. The vapour leaves the evaporator as dry-saturated and there is no under-cooling. Determine the power required by the machine. If the compressor operates at 300 rpm and has a clearance volume of 3% of stroke volume, determine the piston displacement of the compressor. For the compressor assume that the law of expansion is $pv^{1.13} = C$. (10)

Or

(b) (i) What are the different types of controls used in an air-conditioning system? Explain: the automatic humidity controls and the automatic temperature controls. (6)

(ii) Write notes on the following internal heat gains for air-conditioning load calculation.

(1) Heat load of occupants

(2) Electrical loads

(3) Product load

(4) Process load. (10)