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B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2007.

Fourth Semester

(Regulation 2004)

Mechanical Engineering

ME 1251 — THERMAL ENGINEERING

(Common to B.E. (Part-Time) Third Semester Regulation — 2005)

Time : Three hours   Maximum : 100 marks

(Use of Steam table/chart, Refrigerant Property tables and Psychrometric chart is permitted)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1.   Sketch the Diesel Cycle on P-v and T-s planes.

2.   List out any two assumptions for the analysis of thermodynamic air cycles.

3.   What is the function of camshaft and crankshaft?

4.   List out the effects of detonation.

5.   Define nozzle efficiency.

6.   Give the working principle of an impulse turbine.

7.   Define volumetric efficiency of an air compressor.

8.   What is free air delivered?

9.   A carnot refrigerator requires 1.3 kW per tonne of refrigeration to maintain a region at low temperature of − 38°C. Determine the COP of the refrigerator and the higher temperature of the cycle.

10. Define dew point temperature.

PART B — (5 × 16 = 80 marks)

11. (a) An engine working on Otto cycle has a volume of 0.45 m³, pressure 1 bar and temperature 30°C at the beginning of compression stroke. At the end of compression stroke, the pressure is 11 bar and 210 kJ of heat is added at constant volume. Determine

   (i) pressures, temperatures and volumes at salient points in the cycle

   (ii) efficiency.

Or

   (b) (i) Derive an expression for the air-standard efficiency of a Brayton cycle in terms of pressure ratio. (8)

   (ii) Prove that the pressure ratio for maximum work is a function of the limiting temperature ratio. (8)

12. (a) (i) Explain any four types of classification of Internal Combustion engines. (8)

   (ii) With a neat sketch explain any one type of ignition system. (8)

Or

   (b) Following data relates to 4 cylinder, A stroke petrol engine. Air/Fuel ratio by weight 16:1. Calorific value of the fuel = 45200 kJ/kg, mechanical efficiency = 82%. Air standard efficiency = 52%, relative efficiency = 70% volumetric efficiency = 78%, stroke/bone ratio = 1.25 suction conditions = 1 bar, 25°C. Speed = 2400 rpm power at brakes = 72 kW. Calculate

   (i) Compression ratio

   (ii) Indicated thermal efficiency

   (iii) Brake specific fuel consumption and

   (iv) Bore and stroke.

13. (a) (i) Derive an expression for the critical pressure ratio in terms of the index of expansion. (8)

   (ii) Dry saturated steam enters a steam nozzle at a pressure of 15 bar and is discharged at a pressure of 2.00 bar. If the dryness fraction of discharge steam is 0.96, what will be the final velocity of steam. Neglect initial velocity of steam. If 10% of heat drop is lost in friction, find the percentage reduction in the final velocity. (8)

Or

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(b) A 50% reaction turbine running at 400 rpm has the exit angle of the blades as 20° and the velocity of steam relative to the blades at the exit is 1.35 times the mean speed of the blade. The steam flow rate is 8.33 kg/s and at a particular stage the specific volume is 1.381 m³/Kg. Calculate for this stage.

(i) a suitable blade height, assuming the rotor mean diameter 12 times the blade height, and

(ii) the diagram work

14. (a) (i) Derive an expression for the minimum work required for a two-stage reciprocating air compressor with perfect intercooling and neglecting clearance. (8)

(ii) A two stage air compressor compresses air from 1 bar and 20°C to 42 bar. If the law of compression is $pv^{1.35} =$ constant and the intercooling is perfect. Find per kg of air

(1) the work done in compression

(2) the mass of cooling water necessary for abstracting the heat in the intercooler, if the temperature rise of the cooling water is 25°C. (8)

Or

(b) (i) With a neat sketch describe any one type of rotary compressor. (8)

(ii) A single stage single acting reciprocating air compressor delivers 14 m³ of free air per minute from 1 bar to 7 bar. The speed of compressor is 310 rpm. Assuming that compression and expansion follow the law $pv^{1.35} =$ constant and clearance is 5% of the swept volume, find the diameter and stroke of the compressor. Take stroke length is 1.5 times the bore diameter. (8)

15. (a) A refrigeration system of 10.5 tonnes capacity at an evaporator temperature of $- 12°C$ and a condenser temperature of 27°C is needed in a food storage locker. The refrigerant ammonia is sub cooled by 6°C before entering the expansion valve. The vapour is 0.95 dry as it leaves the evaporator coil. The compression in the compressor is of adiabatic type. Find

(i) Condition of vapour at the outlet of the compressor

(ii) Condition of vapour at the entrance of the evaporator

(iii) COP and

(iv) The power required.

Neglect valve throttling and clearance effect.

Or

(b)   A sling psychrometer in a laboratory test recorded the following readings.

Dry bulb temperature = 35°C

Wet bulb temperature = 25°C

Calculate the following :

(i)   specific humidity

(ii)   relative humidity

(iii)   vapour density in air

(iv)   dew point temperature and

(v)   enthalpy of mixture per kg of dry air

Take atmospheric pressure = 1.0132 bar.

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