Question Paper Code : 42385

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2010.

Fourth Semester

Mechanical Engineering

ME 1251 — THERMAL ENGINEERING

(Regulation 2004)

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

Time : Three hours | Maximum : 100 marks

(Use of Steam tables/charts and refrigeration table/chart is permitted)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. In what respects the working processes in an actual engine differ from a theoretical cycle.

2. What are quality governed engines?

3. List the relative merits and demerits of 2 stroke engines over 4 stroke engines.

4. State the function of a carburetor in a petrol engine.

5. What is the effect of friction on the flow through a steam nozzle?

6. Enumerate the energy losses in steam turbines.

7. Why intercooling is necessary in multi stage compression?

8. Compare rotary and reciprocating compressors.

9. List out the important industrial and commercial applications of refrigeration.

10. What are the components used in summer air conditioning system?

PART B — ($5 \times 16 = 80$ marks)

11. (a) An engine with 200 mm cylinder diameter and 300 mm stroke works on theoretical Diesel cycle. The initial pressure and temperature of air used are 1 bar and 27°C. The cut- off is 8% of the stroke. Determine the

(i) Pressures and temperatures at all salient points.

(ii) Theoretical air standard efficiency.

(iii) Mean effective pressure.

(iv) Power of the engine if the working cycles per minute are 380. Assume that compression ratio is 15 and working fluid is air.

Consider all conditions to be ideal. (16)

Or

(b) (i) Air enters the compressor of a gas turbine plant operating on Brayton cycle at 101.325 kPa, 27°C. The pressure ratio in the cycle is 6. Calculate the maximum temperature in the cycle and cycle efficiency. Assume $W_T = 2.5\ W_C$, where W_T and W_C are the turbine and the compressor work respectively. Take $\gamma = 1.4$. (8)

(ii) An engine working on Otto-cycle in which the salient points are 1, 2, 3 and 4 has upper and lower temperature limits T_3 and T_1. If the maximum work per kg of air is to be done, then show that the intermediate temperature is given by

$$T_2 = T_4 = \sqrt{T_1}\sqrt{T_3}$$

If an engine works on otto-cycle between temperature limits 1430 K and 300 K, find the maximum theoretical power developed by the engine assuming the circulation of air per minute is 0.4 kg. (8)

12. (a) Following data relate to 4 cylinder four-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/bore ratio = 1.25, suction conditions = 1 bar and 25°C, speed = 2400 rpm and power at brakes = 72 kW. Calculate the :

(i) Compression ratio.

(ii) Indicated thermal efficiency.

(iii) Brake specific fuel consumption.

(iv) Bore and stroke. (16)

Or

(b) (i) Explain the phenomena of knocking in S.I. engine. (8)

(ii) Explain why cooling is necessary in an I.C. engine with a neat sketch. Describe the working of water cooling system used for multi-cylinder engine. (8)

13. (a) In an installation 5.2 kg/s of steam at 30 bar and 350°C is supplied to a group of six nozzles in a wheel diameter maintained at 4 bar. Determine :

(i) The dimensions of the nozzles of rectangular cross-sectional flow area with aspect ratio 3:1. The expansion may be considered metastable and friction is neglected.

(ii) Degree of undercooling and supersaturation.

(iii) Loss in available heat drop due to irreversibility.

(iv) Increase in entropy.

(v) Ratio of mass flow rate with metastable expansion to that if expansion is in thermal equilibrium. (16)

Or

(b) The following data relate to a stage of a reaction turbine :

Mean rotor diameter = 1.5 m; speed ratio = 0.72; blade outlet angle = 20°; rotor speed = 3000 rpm.

(i) Determine the diagram efficiency.

(ii) Determine the percentage increase in diagram efficiency and rotor speed if the rotor is designed to run at the best theoretical speed, the exit angle being 20°. (16)

14. (a) A two stage double acting air compressor operating at 200 rpm takes air in at 1.013 bar and 27°C. The diameter and stroke of L.P. cylinder are 35 cm and 38 cm respectively. The stroke of H.P. cylinder is same as L.P. cylinder and clearance of both the cylinders is 4% of the stroke. The L.P. cylinder discharges air at a pressure 4.052 bar. The air passes through the intercooler so that it enters the H.P. cylinder at 27°C and 3.85 bar. Finally, the air is discharged from the compressor at 15.4 bar. The compression and re-expansion in both cylinders follow the same law.

$pv^{1.3}$ = constant

Determine the

(i) Brake power required to run the compressor if mechanical η is 80%.

(ii) The diameter of H.P. cylinder.

(iii) Heat rejected in intercooler. (16)

Or

(b) Define volumetric efficiency of a compressor and explain why it is less than unity. A single-stage, double-acting air compressor delivers 15 cu.m of air per minute measured at 1.013 bar and temperature 27°C and delivers at 7 bar. The conditions at the end of the suction stroke are pressure 0.98 bar and temperature 40°C. The clearance volume is 4% of the swept volume and the stroke /bore ratio is 1.3/1, compressor runs at 300 rpm. Calculate the volumetric efficiency, cylinder dimensions, indicated power and isothermal efficiency of the compressor. Take the index of compression and expansion as 1.3 and $R_{air} = 0.287$ kJ/kgK. (16)

15. (a) (i) An ammonia ice plant operates between condenser temperature of 35°C and an evaporator temperature of –15°C. It produces 5 tons of ice per day from water at 25°C to ice at –5°C. The NH_3 enters the compressor as dry-saturated vapour and leaves the condenser as saturated liquid. Determine :

(1) The capacity of the refrigerating plant.

(2) Mass flow of the refrigerant.

(3) Discharge temperature of NH_3 from the compressor.

(4) Power of the compressor motor if the isentropic efficiency of the compressor is 85% and mechanical efficiency of the compressor is 90%.

(5) Relative efficiency.

Take latent heat of ice = 335 kJ/kg

Specific heat of ice = 1.94 kJ/kg K

Specific heat of water = 4.2 kJ/kg K

Use the following properties of NH_3 (8)

Saturation Temp. °C	Enthalpy kJ/kg		Entropy kJ/kg K		Specific heat kJ/kg K	
	h_f	h_g	s_f	s_g	Liquid C_{pf}	Vapour C_{pg}
–15	112.3	1426	0.457	5.549	–	–
35	347.5	1471	1.282	4.930	4.6	2.8

(ii) Draw a neat sketch of ammonia absorption refrigeration system and explain its working principle. (8)

Or

(b) (i) 40 m^3 of air per minute at 31°C DBT and 18.5°C WBT is passed over the cooling coil whose surface temperature is 4.4°C. The coil cooling capacity is 3.56 tons of refrigeration under the given condition of air. Determine the DBT and WBT of the air leaving the cooling coil. (8)

(ii) Explain with a neat diagram the working of a central system air-conditioning system. (8)