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Question Paper Code : 80659

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2016.

Fourth Semester

Mechanical Engineering

ME 6404 — THERMAL ENGINEERING

(Regulations 2013)

Time : Three hours Maximum : 100 marks

(Use of approved Thermodynamics Tables, Mollier diagram, Psychrometric chart and Refrigerant property tables permitted in the examinations)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What are the assumptions made in air standard cycles?

2. Write any four major difference between Otto cycle and diesel cycle.

3. What is the antifreeze solutions used in water cooling systems?

4. What is meant by motoring test?

5. What is the effect of super saturation in the nozzles?

6. Define stage efficiency.

7. Write the difference between centrifugal and axial compressors?

8. What are the merits of multistage compression?

9. Name any four commonly used refrigerants?

10. What is meant by ERSHF?

PART B — (5 × 16 = 80 marks)

11. (a) The swept volume of a diesel engine working on dual cycle is 0.0053 m^3 and clearance volume is 0.00035 m^3. The maximum pressure is 65 bar, Fuel injection ends at 5 per cent of the stroke. The temperature and pressure at the start of the compression are 80°C and 0.9 bar, Determine the air standard efficiency of the cycle. Take for air = 1.4. (16)

Or

(b) In a gas turbine plant working on the Brayton cycle the air at the inlet is at 27°C, 0.1 MPa. The pressure ratio is 6.25 and the maximum temperature is 800°C, The turbine and compressor efficiencies are each 80%. Find

(i) the compressor work per kg of air

(ii) the turbine work per kg of air

(iii) the heat supplied per kg of air

(iv) the cycle efficiency, and

(v) the turbine exhaust temperature. (16)

12. (a) (i) Explain the pressure lubrication system with a neat sketch. (8)

(ii) Explain the bosch fuel injector with a neat sketch. (8)

Or

(b) Air consumption for a four stroke petrol engine is measured by means of a circular orifice of diameter 3.5 cm. The coefficient of discharge for the orifice is 0.6 and the pressure across the orifice is 14 cm of water. The barometer reads 760 mm of Hg. The temperature of air in the room is 24°C. The piston displacement volume is 1800 cm^3. The compression ratio is 6.5. The fuel consumption is 0.13 kg/min and calorific value is 44,000 kJ/kg. The brake power developed at 2500 rpm is 28 kw. Determine

(i) Air fuel ratio

(ii) Volumetric efficiency on the basis of air alone

(iii) Brake mean effective pressure

(iv) Relative efficiency on brake thermal efficiency basis. (16)

13. (a) A convergent divergent nozzle required to discharge 2 kg of steam per second. The nozzle is supplied with steam at 7 bar and 180°C and discharge takes place against a back pressure of 1 bar. The expansion up to throat is isentropic and the frictional resistance between the throat and the exit is equivalent to 63 kJ/kg of steam. Take approach velocity of 75 m/s and throat pressure 4 bar, estimate

(i) suitable areas for the throat and the exit, and

(ii) overall efficiency of the nozzle based on the enthalpy drop between the actual inlet pressure and the temperature and the exit pressure. (16)

Or

(b) In a stage of impulse reaction turbine operating with 50% degree of reaction, the blades are identical in shape. The outlet angle of the moving blade is 19° and the absolute discharge velocity of steam is 100 m/s in the direction 70° to the motion of the blades. If the rate of flow through the turbine is 15000 kg/hr, calculate the power developed by the turbine. (16)

14. (a) The free air delivery of a single cylinder, single stage reciprocating air compressor is 2.5 m^3/min. The ambient air is at STP condition. The delivery pressure is at 7 bar. The clearance volume is 5 percent of stroke volume. Both compression and expansion are according to the law $PV^{1.25}$ = constant. Stroke length is 20% more than that of the bore. Compressor runs at 150 rpm. Determine the mass of air per second, indicated power, indicated mean effective pressure, bore and stroke of cylinder. (16)

Or

(b) Explain the construction and working principle of centrifugal compressor and axial flow compressor with neat sketches. (16)

15. (a) A food storage locker requires a refrigeration capacity of 50 kW. It works between a condenser temperature of 35°C and an evaporator temperature of –10°C. The refrigerant is ammonia. It is sub-cooled by 5°C before entering the expansion valve by the dry saturated vapour leaving the evaporator. Assuming a single cylinder, single-acting compressor operating at 1000 r.p.m. with stroke equal to 1.2 times the bore. Determine :

(i) The power required, and

(ii) The cylinder dimensions. (16)

Or

(b) (i) Explain centralized air-conditioning system with a neat sketch. (8)

(ii) 100 m^3 of air per minute at 15°C DBT 80% RH is heated until its temperature is 22°C. Calculate heat added to air per minute, RH of the heated air and wet bulb temperature of the heated air. (8)