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Question Paper Code : 27364

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2015.

Fourth Semester

Mechanical Engineering

ME 6404 — THERMAL ENGINEERING

(Regulations 2013)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is the need for compounding in steam turbines?

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

3. What is meant by perfect inter-cooling?

4. List out the factors limit the delivery pressure in a reciprocating compressor

5. Distinguish summer and winter air conditioning.

6. How does humidity affect the human comfort?

7. Write the important requirements of fuel injection system.

8. State the purpose of thermostat in an engine cooling system.

9. When compression ratio is kept constant, what is the effect of cut-off ratio on the efficiency of diesel cycle?

10. Differentiate any four major differences between Otto and diesel cycle.

PART B — ($5 \times 16 = 80$ marks)

11. (a) Dry saturated steam at a pressure of 8 bar enters a convergent divergent nozzle and leaves it at a pressure of 1.5 bar. if the flow is isentropic and if the corresponding expansion index is 1.133, find the ratio of cross-sectional area at exit and throat for maximum discharge.

Or

(b) The steam at 4.9 bar and 160°C is supplied to a single-stage impulse turbine at a mass flow rate of 30 kg/min, from where it is exhausted to a condenser at a pressure of 19.6 kPa. The blade speed is 300 m/s. The nozzles are inclined as 25° to the plane of wheel and the outlet blade angle is 35°.

Neglecting friction losses, determine (i) theoretical power developed by the turbine. (ii) diagram efficiency, and (iii) stage efficiency.

12. (a) Air enters the compressor of an air- craft cooling system at 100 kPa. and 283 K. Air is now compressed to 2.5 bar with an isentropic efficiency of 72%. After being cooled to 320 K at constant pressure in a heat exchanger; the air then expands in a turbine to 1 bar with an isentropic efficiency of 75%. The cooling load of the system is 3 tonnes of refrigeration. After absorbing heat at constant pressure, the air re-enters the compressor; which is driven by the turbine. Find the COP of the refrigerator, driving power required and air mass flow rate.

Or

(b) An air conditioning plant is required to supply 50 m^3 of air per minute at a DBT of 22°C and 50% RH. The atmospheric condition is 32°C with 65% R.H. Determine the mass of moisture removed and capacity of cooling coil, if the required effect is obtained by dehumidification and sensible cooling process. Also calculate sensible heat factor.

13. (a) A four-cylinder, four-stroke oil engine 10 cm in diameter and 15 cm in stroke develops a torque of 185 Nm at 2000 rpm. The oil consumption is 14.5 lit/hr The specific gravity of the oil is 0.82 and calorific value of oil is 42,000 kJ/kg. If the imep taken from the indicated diagram is 6.7 bar find,

(i) mechanical efficiency,

(ii) Brake thermal efficiency,

(iii) Brake mean effective pressure

(iv) Specific fuel consumption in litres on brake power basis.

Or

(b) Write a note on lubrication system for an I.C. Engine in detail with relevant sketches of various types.

14. (a) A single acting air compressor takes in atmospheric air (atm condition 101.325 kPa, 27° C) and delivers it at 1.4 MPa. The compressor runs at 300 rpm and has cylinder diameter of 160 mm and stroke 200 mm, clearance volume is 4% of stroke volume. If the pressure and temperature of the air at the end of suction stroke are 100kPa and 47° C, and law of compression and expansion is $pv^{1.2} = c$, determine;

(i) mass of the air delivered per minute.

(ii) volumetric efficiency.

(iii) driving power required, if $\eta_m = 0.85$.

Or

(b) A three-stage air compressor with perfect intercooling takes 15 m^3 of air per minute at 95 kPa and 27° C, and delivers the air at 3.5 MPa. If compression process is polytropic ($pv^{1.3} = c$), determine:

(i) power required if mechanical efficiency is 90%.

(ii) heat rejected in the intercoolers per minute.

(iii) isothermal efficiency.

(iv) heat rejected through cylinder walls per minute.

15. (a) Fuel supplied to an S1 engine has a calorific value 42000 kJ /kg. The pressure in the cylinder at 30% and 70% of the compression stroke are 1.3 bar and 2.6 bar respectively. Assuming that the compression follows the law $pV^{1.3}$ = constant. Find the compression ratio. If the relative efficiency of the engine compared with the air-standard efficiency is 50%. Calculate the fuel consumption in kg/kWh.

Or

(b) An air-standard Dual cycle has a compression ratio of 10. The pressure and temperature at the beginning of compression are 1 bar and 27°C. The maximum pressure reached is 42 bar and the maximum temperature is 1500 °C. Determine (i) the temperature at the end of constant volume heat addition (ii) cut-off ratio (iii) work done per kg of air and (iv) the cycle efficiency. Assume Cp = 1.004 kJ/kg K and Cv = 0.717 kJ/kg K for air.
