Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 80913

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2024.

Fourth/Sixth Semester

Mechanical Engineering

ME 8493 – THERMAL ENGINEERING – I

(Common to : Mechanical Engineering (Sandwich))

(Regulations 2017)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. An ideal diesel engine has a diameter = 150 mm and stroke = 200 mm. The clearance volume is 10% of the swept volume. Determine the compression ratio.

2. A steam power plant is supplied with dry saturated steam at a pressure of 12 bar and exhausts into a condenser at 0.1 bar. Calculate the Rankine efficiency by using steam tables.

3. Write the classification of air compressors.

4. What are the advantages of multistage air compressor?

5. Mention any four factors that cause "detonation" in I.C. Engines.

6. Write the functions of the following I.C. Engine components : (a) Connecting rod (b) Crankshaft

7. Differentiate between air and water cooling systems used in I.C. Engines.

8. What are the objectives of supercharging the I.C. Engines?

9. Gas turbine power plants may operate on either an open or closed basis. Differentiate between the two.

10. List any two characteristics of Stirling engine.

PART B — (5 × 13 = 65 marks)

11. (a) A hot air engine works on Brayton cycle with initial and final pressures of air as 3 bar and 1 bar respectively. If the temperature before isentropic compression and isentropic expansion are 298 K and 923 K, determine the heat supplied per kg of air and the heat rejected per kg of air. Also, find the work done per kg of air and efficiency of the engine. Take $C_p = 1$ kJ/kg K and $C_v = 0.715$ kJ/kg K

Or

(b) In a single–heater regenerative cycle, the steam enters the turbine at 30 bar, 400°C and the exhaust pressure is 0.10 bar. The feed water heater is a direct contact type which operates at 5 bar. Determine : (i) The efficiency and the steam rate of the cycle (ii) The increase in mean temperature of heat addition (iii) Efficiency and steam rate as compared to the Rankine cycle (without regeneration). Pump work may be neglected.

12. (a) Compare reciprocating air compressor with rotary air compressors.

Or

(b) A two-stage single acting reciprocating compressor takes in air at the rate of 0.2 m^3/s. The intake pressure and temperature of air are 0.1 MPa and 160°C. The air is compressed to a final pressure of 0.7 MPa. The intermediate pressure is ideal and inter cooling is perfect. The compression index in both the stages is 1.25 and the compressor runs at 600 rpm. Neglecting clearance, determine the intermediate pressure, the total volume of each cylinder and the power required to drive the compressor. Take $C_p = 1.005$ kJ/kg K and $R = 287$ J/Kg K

13. (a) Discuss the theoretical valve timing diagrams for four stroke and two stroke cycle engines with neat diagrams.

Or

(b) Write a detailed comparison between petrol engines and Diesel Engines.

14. (a) An I.C. engine uses 6 kg of fuel having calorific value of 44000 kJ/kg in one hour. The I.P. developed is 18 kW. The temperature of 11.5 kg of cooling water was found to rise through 25°C per minute. The temperature of 4.2 kg of exhaust gas with specific heat 1 kJ/kg K was found to raise through 22°C. Draw the heat balance sheet for the engine.

Or

(b) Write detailed notes on (i) Ignition systems of petrol engines (ii) Fuel injection system for diesel engines. (7+6)

15. (a) Air enters the compressor of an ideal air–standard Brayton cycle at 100 kPa, 300 K, with a volumetric flow rate of 5 m^3/s. The compressor pressure ratio is 10. The turbine inlet temperature is 1400 K. Determine (i) the thermal efficiency of the cycle (ii) The back work ratio (iii) The net power developed, in kW.

Or

(b) A gas turbine is supplied with gas at 5 bar and 1000 K and expands it adiabatically to 1 bar. The mean specific heat at constant pressure and constant volume are 1.0425 kJ/kg K and 0.7662 kJ/kg K respectively. (i) Draw the temperature–entropy diagram to represent the processes of the simple gas turbine system. (ii) Calculate the power developed in kW per kg of gas per second and the exhaust gas temperature.

PART C — (1 × 15 = 15 marks)

16. (a) For a two–stage compressor with fixed inlet state and exit pressure, conduct a cold air–standard analysis to express in terms of known property values, the intercooler pressure required for the minimum total compressor work per unit of mass flowing. Assume steady–state operation and the following idealizations: Each compression process is isentropic. There is no pressure drop through the intercooler. The temperature at the inlet to the second compressor is greater than, or equal to, that at the inlet to the first compressor. Kinetic and potential energy effects are negligible.

Or

(b) With the help of P–v and T–s diagram compare the cold air standard Otto, diesel and dual combustion cycles for same maximum pressure and maximum temperature.