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Question Paper Code : 30920

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 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 — ($10 \times 2 = 20$ marks)

1. What is the difference between steam power cycle and gas power cycle?

2. List the methods that improve the thermal efficiency of the Rankine cycle.

3. Mention the functions of perfect intercooler in a multistage compressor.

4. Write the difference between positive and dynamic displacement compressor.

5. Draw the port timing diagram for a petrol engine.

6. What is meant by (a) Stoichiometric mixture and (b) Lean mixture?

7. State the advantages of MPFI system.

8. What is supercharging of IC engine? Mention its purpose.

9. List the materials typically used for the production of compressor parts for aircraft engines.

10. Mention the processes of a closed cycle gas turbine in p-V and T-s plots.

PART B — (5 × 13 = 65 marks)

11. (a) Derive air-standard efficiency for Otto cycle with p-V and T-s diagram.

Or

(b) The compression and expansion ratios of an oil engine working on air standard dual cycle are 9 and 5, respectively. The initial pressure and temperature are 1 bar and 30°C, respectively. The heat liberated at constant pressure is twice the heat liberated at constant volume. The expansion and compression follow the law $pV^{1.25}$ = constant. Determine

(i) pressure and temperature at all salient points

(ii) the mean effective pressure of the cycle

(iii) thermal efficiency of the cycle. Take cylinder bore = 250 mm and stroke = 400 mm.

12. (a) A two stage reciprocating air compressor has air being admitted at 1 bar, 27°C and delivered at 30 bar, 150°C with inter-stage pressure of 6 bar and inter-cooling up to 35°C. Compressor delivers at the rate of 2 kg/s. Clearance volumes of LP and HP cylinders are 5% and 7% of stroke volume respectively. The index of compression and expansion are same throughout. Determine the swept volume of both cylinders in m^3/min, amount of cooling required in intercooler and total power required.

Or

(b) A single acting reciprocating compressor with cylinder of 15 cm diameter and 18 cm stroke has a clearance volume of 4% of swept volume. It takes in air at 1 bar, 25°C and delivers at 8 bar while running at 1200 rpm. The actual power input is 18 kW. Estimate

(i) the power required to drive the unit

(ii) the isothermal efficiency and

(iii) the mechanical efficiency when the mass flow rate in 4 kg/min

13. (a) Discuss the process of combustion in CI engine and mention factors affecting knocking.

Or

(b) Explain the working principle of a 4-stroke SI engine with the help of p-V and T-s diagrams.

14. (a) With suitable sketches, discuss in detail about various components of CRDI.

Or

(b) Explain the working principle of battery ignition system with a neat sketch.

15. (a) Air at 15°C enters a gas turbine plant working at a pressure ratio of 15 with 1250°C turbine inlet temperature. Assume polytrophic efficiency of compressor and turbine as 0.91, Cp for air and gases as 1.005 and 1.128 respectively. $\gamma =$ 1.4 for both air and gases. Calorific value of fuel = 42000 kJ/kg, calculate, overall efficiency, specific work output, fuel air ratio and specific fuel consumption.

Or

(b) Derive an expression to determine the isentropic efficiency of an open cycle gas turbine and discuss the various methods of improving the efficiency.

PART C — ($1 \times 15 = 15$ marks)

16. (a) On a cold air-standard basis, derive an expression for the thermal efficiency of the Atkinson cycle (which consists of various processes in the following order : isentropic compression, constant volume heat addition, isentropic expansion, and constant pressure compression) in terms of the volume ratio during the isentropic compression, the pressure ratio for the constant volume process, and the specific heat ratio. Compare and discuss the thermal efficiencies of the cold air-standard Atkinson and Otto cycles, each having the same compression ratio and maximum temperature.

Or

(b) Prove that the work done in a two-stage reciprocating air compressor with perfect intercooler is given by $W = 2nP_1V_1/(n-1)\left[(P_3/P_1)^{n-1/2n} - 1\right]$.