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Question Paper Code : 70898

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2023.

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. A Carnot engine working between 400°C and 40°C produces 130 kJ of work. Determine the engine thermal efficiency.

2. The efficiency of an Otto cycle is 60% and the ratio of specific heats is 1.5. What is the compression ratio?

3. List any two effects of inter cooling in a multistage reciprocating compressor.

4. Differentiate between reciprocating and rotary air compressors.

5. How the internal combustion engines are classified?

6. Write any four factors that causes detonation.

7. Differentiate between the two types of solid fuel injection system used in I. C. engines.

8. Mention any four objectives of supercharging the engines.

9. Differentiate between a closed cycle gas turbine and an open cycle gas turbine.

10. List the methods of improving the efficiency and specific output of a simple gas turbine.

PART B — (5 × 13 = 65 marks)

11. (a) In a gas turbine plant, air is compressed through a pressure ratio of 6:1 from 15°C. It is then heated to the maximum permissible temperature of 750°C and expanded in two stages each of expansion ratio $\sqrt{6}$, the air being reheated between the stages to 750°C. A heat exchanger allows the heating of the compressed gases through 75 per cent of the maximum range possible. Calculate: (i) The cycle efficiency (ii) The work ratio (iii) The work per kg of air. The isentropic efficiencies of the compressor and turbine are 0.8 and 0.85 respectively.

Or

(b) Explain with the help of neat diagram a 'Regenerative Cycle', Derive also an expression for its thermal efficiency.

12. (a) A two- stage single acting reciprocating air compressor draws in air at a pressure of 1 bar and 17°C and compresses it to a pressure of 60 bar. After compression in the L.P. cylinder, the air is cooled at constant pressure of 8 bar to a temperature of 37°C. The low pressure cylinder has a diameter of 150mm and both the cylinders have 200 mm stroke. If the law of compression is $pv^{135} = C$, find the power of the compressor, when it runs at 260 rpm. Take R as 287 J/kg K.

Or

(b) A single acting reciprocating air compressor has cylinder diameter and stroke of 200 mm and 300mm respectively, The compressor sucks air at 1 bar and 27°C delivers at 8 bar while running at 100 rpm. Find: (i) Indicated power of the compressor; (ii) Mass of air delivered by the compressor per minute and (iii) Temperature of the air delivered by the compressor. The compression follows the law $pv^{1.25} = C$. Take R as 287 J/kg K.

13. (a) Compare and contrast petrol and diesel engines.

Or

(b) Describe with neat sketches, the valve timing diagram for a four stroke cycle petrol engine.

14. (a) With the aid of neat diagrams, describe the two types of cooling system used for IC. Engines.

Or

(b) With the aid of neat diagrams, describe the two types of lubrication systems used for I.C. Engines.

15. (a) In a gas turbine plant, the air is compressed in a single stage compressor from 1 bar to 9 bar and from an initial temperature of 300 K. The same air is then heated to a temperature of 800 K and then expanded in the turbine. The air is then reheated to a temperature of 800 K and then expanded in the second turbine. Find the maximum power that can be obtained from the installation, if the mass of air circulated per second is 2 kg. Take C_p = 1 kJ/kg K.

Or

(b) A gas turbine plant consists of two stage compressor with perfect intercooler and a single stage turbine. If the plant works between the temperature, pressure limits of 300 K & 1000 K and 1 bar & 16 bar. Find the net power of the plant per Kg of air. Take specific heat at constant pressure as 1 kJ/kg K.

PART C — (1 × 15 = 15 marks)

16. (a) 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.

Or

(b) A steam power plant operates on ideal Rankine cycle using re-heater and regenerative feed water heaters. It has one open feed heater. Steam is supplied at 150 bar and 600°C. The condenser pressure is 0.1 bar. Some steam is extracted from the turbine at 40 bar for closed feed water heater and remaining steam is reduced at 40 bar to 600°C. Extracted steam is completely condensed in this closed feed water heater and is pumped to 150 bar before mixing with the feed water heater. Steam for the open feed water heater is bled from L.P. turbine at 5 bar. Determine: (i) Fraction of steam extracted from the turbines at each bled heater and (ii) Thermal efficiency of the system. Draw the line diagram of the components and represent the cycle on T-s diagram.