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Question Paper Code : 50876

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 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. Define air standard cycle efficiency of an Otto Cycle.

2. Name the factors that affect the air standard efficiency of diesel cycle.

3. Indicate the application of reciprocating compressors in industry.

4. Define clearance ratio.

5. Write any two major differences between 'SI engine' and 'CI engine'.

6. List the merits and demerits of four stroke engines.

7. What are the functions of lubrication system?

8. Give the difference between battery ignition and magneto ignition system.

9. State the assumptions made for deriving an expression for thermal efficiency of a gas turbine plant.

10. Draw the line diagram of a closed cycle gas turbine.

PART B — (5 × 13 = 65 marks)

11. (a) In an Otto cycle, air at 1bar and 290K is compressed isentropically until the pressure is 15 bar. The heat is added at constant volume until the pressure rises to 40 bar. Calculate the air standard efficiency and mean effective pressure for the cycle. Take $C_v = 0.717$ KJ/Kg K and $R_{univ} = 8.314$ KJ/Kg K.

Or

(b) The compression ratio of an air standard dual cycle is 12 and the maximum pressure of the cycle is limited to 70 bar. The pressure and temperature of the cycle at the beginning of compression process are respectively 1 bar and 300K. Calculate the thermal efficiency and Mean Effective Pressure. Assume cylinder bore = 250mm, Stroke length = 300mm, $C_p = 1.005$ KJ/Kg K, $C_v = 0.718$ KJ/Kg K.

12. (a) Derive an expression for the volumetric efficiency of reciprocating air compressors.

Or

(b) A single stage, single acting reciprocating air compressor is required to handle $30m^3$ of free air per hour measured at 1 bar. The delivery pressure is 6.5 bar and the speed is 450 r.p.m. Assuming volumetric efficiency of 75%, isothermal efficiency of 76% and mechanical efficiency of 80%, find the indicated mean effective pressure and the power required to drive the compressor.

13. (a) The following details were noted in a test on a four cylinder, four stroke engine, diameter = 100mm; stroke = 120mm; speed of the engine = 1600 rpm; fuel consumption = 0.2 kg/min; fuel calorific value = 44,000 kJ/kg; difference in the tensions on either side of the brake pulley = 40 kgf; brake drum circumference is 300cm. If the mechanical efficiency is 80%, calculate the Brake thermal efficiency, Indicated thermal efficiency, Indicated mean effective pressure and Brake specific fuel consumption.

Or

(b) Explain with neat sketches the phenomena of knocking in SI engines.

14. (a) Discuss with neat sketches the magneto ignition system.

Or

(b) Explain the various cooling systems in IC engines.

15. (a) In a closed cycle gas turbine, there is a two stage compressor and a two stage turbine. All the components are mounted on the same shaft. The pressure and temperature at the inlet of the first stage compressor are 1.5 bar and 20°C. The maximum cycle temperature and pressure are limited to 750 °C and 6 bar. A perfect intercooler is used between the two stages of the compressor and a reheated is used between the two turbines at 3 bar pressure. Gases are heated in the reheated to 750 °C before entering into the L.P turbine. Assuming the compressor and turbine efficiencies as 0.82. calculate,

(i) The efficiency of the cycle without regenerator. (6)

(ii) The efficiency of the cycle with a regenerator whose effectiveness is 0.70. The working fluid used in the cycle is air : for air : specific heat ratio = 1.4 and $C_p = 1.005$ kJ/kg K. (7)

Or

(b) Explain in detail about gas turbine fuels and gas turbine materials.

PART C — (1 × 15 = 15 marks)

16. (a) A two stage, single acting air compressor compresses air to 20 bar. The air enters the L.P. cylinder at 1 bar and 27°C and leaves it at 4.7 bar. Then the air enters the H.P. cylinder at 4.5 bar and 27°C. The size of the L.P cylinder is 400mm diameter and 500mm stroke. The clearance volume in both cylinders is 4% of the respective stroke volume. The compressor runs at 200rpm. Taking index of compression and expansion in the two cylinders as 1.3, estimate (i) The indicated power required to run the compressor; and (ii) The heat rejected in the intercooler per minute.

Or

(b) Derive expressions for efficiency and mean effective pressure of Brayton Cycle showing also $p-v$ and $T-s$ diagrams.

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