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

Question Paper Code : 30257

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2023.

Fourth Semester

Mechanical Engineering

ME 3451 – THERMAL ENGINEERING

(Common to: Mechanical Engineering (Sandwich))

(Regulations 2021)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Discuss the effect of cut-off ratio on diesel cycle in thermal efficiency values.

2. List out all cold air assumption of air standard cycles?

3. Define metastable state and degree of super saturation in steam nozzles.

4. What is the significance of the critical pressure ratio on discharge through the steam nozzle?

5. Compare the open cycle gas turbine and closed cycle gas turbine

6. List out the methods of improving the performance of gas turbine power plant.

7. What do understand by stoichiometric, rich and lean mixture?

8. Represent the various stages of combustion of CI engine in pressure and crank angle diagram.

9. Battery coil ignition system is preferred in most of the automobiles – justify this statement.

10. How do you avoid the overheating, and over cooling of the internal combustion engines?

PART B — (5 × 13 = 65 marks)

11. (a) For the same compression ratio, prove that the efficiency of the Otto cycle is greater than that of the diesel cycle.

Or

(b) In an air standard diesel cycle with a compression ratio of 14, the condition of air at the start of the compression stroke are 1 bar and 300 K. After addition of heat at constant pressure, the temperature rises to 2775 K. Determine the thermal efficiency of the cycle, network done per kg of air.

12. (a) Calculate the critical pressure ratio and throat area per unit mass flow rate of steam, expanding through a convergent-divergent steam nozzle from 10 bar, dry saturated down to atmospheric pressure of 1 bar. Assume that the inlet velocity is negligible and that the expansion is isentropic.

Or

(b) A nozzle is to be designed to expand steam at the rate of 0.1 kg/sec from 500 kPa, 210°C to 100 kPa. Neglect the inlet velocity of steam. For a nozzle efficiency of 0.9, determine the exit area of the nozzle.

13. (a) In a gas turbine power plant, air enters the compressor at 15°C and it is compressed through a pressure ratio of 4 with isentropic efficiency of 85%. The air-fuel ratio is 80 and the calorific value of the fuel is 42,000 kJ/kg. The turbine inlet temperature is 1000 K and the isentropic efficiency of the turbine is 82%. Find the overall plant efficiency.

Or

(b) Explain the concept of advanced techniques adapted in gas turbine power plant with neat line schematic diagram. Also represent the cycle in all P-v, T-s and h-s diagrams. Give merits of the advance techniques.

14. (a) Define the detonation. Give its effects on Spark Ignition Engines.

Or

(b) Explain the working principle of simple carburetor with neat sketch. Give its limitations.

15. (a) A full load test was conducted on a two stroke engine and the following results were obtained:

Speed of engine = 500 rpm; Brake load = 500 N; Air /fuel ratio 30; oil consumption = 5kg/hr; Room temperature = 25°C; Atmospheric pressure = 1 bar; diameter of cylinder = 22cm; stroke length 28cm; Brake diameter = 1.6m. Calculate the volumetric efficiency and brake specific fuel consumption.

Or

(b) The following results refer to at test on a four stroke petrol engine:

The diameter of the cylinder is 30 cm and stroke length of the piston is 45 cm. The Engine runs at the speed of 1000 rpm. The brake specific fuel consumption is 0.35 kg/kWh. The calorific value of the fuel is 43,900 kJ/kg. The indicated mean effective pressure is 540 kPa. Calculate the following:

(i) Indicated thermal efficiency

(ii) Brake thermal efficiency

(iii) Mechanical efficiency

PART C — (1 × 15 = 15 marks)

16. (a) Two engines are operated in ideal Otto and diesel cycles for which the following information are available:

Maximum temperature = 1227°C

Exhaust temperature = 447°C

Ambient condition = 1.013 bar and 35°C

Air consumption = 2 kg/min

Estimate the following:

(i) Compression ratio

(ii) Air standard efficiency

(iii) Power output

Or

(b) An ideal regenerative steam cycle operates with the steam entering the turbine at 30 bar and 500°C and is exhausted at 0.1 bar. A feed water heater is used which operates at 5 bar. Calculate the following:

(i) The thermal efficiency

(ii) Steam rate of the cycle

(iii) Increase in average temperature of heat addition

(iv) Compare the values of thermal efficiency and steam rate with ideal Rankine cycle

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