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Question Paper Code : 40830

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2021.

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. How does diesel efficiency change with increase in cut off ratio for the same compression ratio?

2. How does regenerative Rankine cycle differ from reheat Rankine cycle?

3. Define isothermal efficiency of the compressor.

4. What are the general applications of the rotary compressors?

5. How does power produced by 2 stroke engine compare with that of 4 stroke engine? List conditions under which your answer is valid.

6. What are the significant effects of rich mixture on the heat released during combustion and product composition?

7. What are the advantages of Magneto ignition system?

8. What type of cooling is used in motor cycle engine?

9. What is work ratio? How does it vary with compression ratio?

10. What is the purpose for using inter cooler?

PART B — (5 × 13 = 65 marks)

11. (a) (i) Derive an expression for the efficiency of the diesel cycle. (5)

(ii) In a standard Otto cycle, the compression ratio is 7 and the compression begins at 1 bar and 313 K. The heat added is 2510 kJ/kg. Find the maximum pressure and temperature of cycle; work done per kg of air, cycle efficiency and mean effective pressure. (8)

Or

(b) Steam at 50 bar 400°C expands in a Rankine cycle to 0.34 bar. If perfect reheating is done at 10 bar pressure, for a mass flow rate of 150 kg/sec of steam, determine

(i) power developed (5)

(ii) thermal efficiency. (5)

(iii) specific steam consumption. (3)

12. (a) A single-stage single-acting air compressor delivers 0.6 kg of air per minute at 6 bar. The temperature and pressure at the end of suction stroke are 30°C and 1 bar. The bore and stroke of the compressor are 100mm and 150mm respectively. The clearance is 3% of the swept volume. Assuming the index of compression and expansion to be 1.3, find

(i) volumetric efficiency of the compressor (5)

(ii) power required if the mechanical efficiency is 85%, and (5)

(iii) speed of the compressor (r.p.m) (3)

Or

(b) (i) Explain the working principle centrifugal and roots compressor. With suitable sketch. (8)

(ii) Comparison between rotary compressor with reciprocating compressor. (5)

13. (a) (i) Explain the working of a 4 stroke petrol engine. (8)

(ii) Describe the valve timing diagram of a 4 stroke diesel engine. (5)

Or

(b) (i) Describe the desirable qualities and properties of fuels for IC engines. (8)

(ii) Explain the methods of knocking control in petrol engines. (5)

14. (a) (i) Explain the working of CRDI fuel injection and compare the same with MPFI system. (8)

(ii) Describe the need of heat balance tests. (5)

Or

(b) (i) Describe the working of the battery ignition system and its merits and demerits. (8)

(ii) Explain the working of force feed lubrication system. (5)

15. (a) (i) Compare closed cycle gas turbine cycle with that of the open cycle gas turbine cycle. (8)

(ii) In an air standard gas turbine Baryton cycle, air enters the compressor at 300K and 1 bar. The pressure ratio is 8 and the maximum allowable temperature is 1300K. Determine the turbine work, the compressor work per kg and efficiency of the cycle. (5)

Or

(b) In a constant pressure open cycle gas turbine air enters at 1 bar and 20°C and leaves the compressor at 5 bar. Using the following data: temperature of gases entering the turbine = 680°C, pressure loss in the combustion chamber = 0.1 bar, compressor efficiency = 85%, turbine efficiency = 80%, combustion efficiency =85%, specific heat ratio = 1.4 and Cp = 1.024 kJ/kgK for air and gas, find

(i) The quantity of air circulation. (5)

(ii) Heat supplied per kg of air circulation (5)

(iii) The thermal efficiency of the cycle. (3)

Mass of the fuel may be neglected.

PART C — (1 × 15 = 15 marks)

16. (a) 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.

Find:

(i) the efficiency and the steam rate of the cycle. (5)

(ii) The increase in mean temperature of heat addition efficiency and steam rate as compared to the Rankine cycle (without regeneration). (10)

Or

(b) A 4500 kW gas turbine generating set operates with two compressor stages; the overall pressure ratio is 9: 1. A high pressure turbine is used to drive the compressors and a low pressure turbine drives the generator. The temperature of the gases at entry the high pressure turbine is 625°C and the gases are reheated to 625°C after expansion in the first turbine.

The exhaust gases leaving the low-pressure turbine are passed through a heat exchanger to heat air leaving the high pressure stage compressor. The compressors have equal pressure ratios and intercooling is complete between the stages. The air inlet temperature to the unit is 20°C. The isentropic efficiency of each compressor stage is 0.8, and the isentropic efficiency of 95% can be assumed for both the power shaft and compressor turbine shaft. Neglecting all pressure losses and changes in kinetic energy calculate:

(i) The thermal efficiency; (5)

(ii) Work ratio of the plant; (5)

(iii) The mass flow in kg/s (5)

Neglect the mass of the fuel and assume the following:

For air: Cp = 1.055 kJ/kg K and γ =1.4

For gases in the combustion chamber and in turbines and head exchanger, Cp= 1.15 kJ/kg-K and γ =1.333.

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