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Question Paper Code : 41377

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2024.

Fourth Semester

Mechanical Engineering

ME 3451 — THERMAL ENGINEERING

(Common to Mechanical Engineering (Sandwich))

(Regulations 2021)

(Use of Steam Table is Permitted)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. List the assumptions of the Otto cycle.
2. State the meaning of thermal efficiency in thermodynamic cycles.
3. Identify the purpose of a steam nozzle in power plants.
4. Define the term "metastable flow" in steam nozzles.
5. State the differences between impulse and reaction turbines.
6. State the concept of governing in steam turbines.
7. Identify the role of the connecting rod in an IC engine.
8. List two desirable properties of fuels for internal combustion engines.
9. State the purpose of a heat balance test in IC engines.
10. State the purpose of an ignition system in IC engines.

PART B — (5 × 13 = 65 marks)

11. (a) Explain the working of the Dual cycle with the help of a p-v and T-S diagram. Derive an expression for its efficiency.

Or

(b) Compare the Otto and Diesel cycles in terms of efficiency, compression ratio and applications. Illustrate with relevant diagrams.

12. (a) (i) Explain the concept of nozzle efficiency and its role in determining the exit velocity of steam. (6)

(ii) Analyze the effect of supersaturation in steam nozzles on efficiency and performance. (7)

Or

(b) Analyze the variation of mass flow rate with respect to pressure ratio in a convergent-divergent nozzle. Explain the conditions for choking.

13. (a) (i) A Parson reaction turbine running at 400 rpm with 50% reaction develops 75 kW per kg of the steam. The exit angle of the blade is 20° and the steam velocity is 1.4 times the blade velocity. Determine

(1) Blade velocity,

(2) Blade inlet angle. (3+3)

(ii) In a Parson reaction turbine, the angles of receiving tips are 35° and of discharging tips, 20°. The blade speed is 100 m/s. Calculate the tangential force, power developed, diagram efficiency, and axial thrust is the turbine, if its steam consumption is 1 kg/min. (7)

Or

(b) Air enters the compressor of a gas turbine plant operating on air-standard cycle at 100 kPa and 300 K with a volumetric flow rate of 5 m^3/s. The compressor pressure ratio is 10. The turbine inlet temperature is 1400 K. The turbine and compressor's is entropic efficiency is 80%. Calculate

(i) The thermal efficiency of the cycle. (7)

(ii) The back work ratio. (3)

(iii) the net power developed in kW. (3)

14. (a) (i) Discuss the phenomenon of knocking in SI and CI engines. (8)

(ii) Compare the factors affecting knocking in both engines and explain how it is controlled. (5)

Or

(b) (i) Explain the influence of compression ratio, air-fuel ratio and ignition timing on the performance of internal combustion engines. (9)

(ii) Discuss the significance of scavenging in two-stroke engines and compare different scavenging methods. (4)

15. (a) (i) A four-cylinder, two-stroke cycle petrol engine develops 30 kW at 2500 rpm. The mean effective pressure on each piston is 8 bar and mechanical efficiency is 80%. Calculate the diameter and stroke of each cylinder, if the stroke to bore ratio is 1.5. Also calculate the fuel consumption of the engine, if the brake thermal efficiency is 28%. The calorific value of the fuel is 43900 kJ/kg. (8)

(ii) The following results were obtained from a test on a single-cylinder, four-stroke Diesel engine. Diameter of the cylinder is 30 cm, stroke of the piston is 45 cm, indicated mean effective pressure is 540 kPa and engine speed is 240 rpm. Calculate the indicated power of the engine. (5)

Or

(b) Discuss in detail the working principles, advantages and limitations of Multipoint Fuel Injection (MPFI) and Common Rail Direct Injection (CRDI) systems used in modern IC engines.

PART C — (1 × 15 = 15 marks)

16. (a) Design a regenerative Rankine cycle for a thermal power plant with two feed water heaters. Perform an energy analysis to calculate the cycle efficiency and the mass fraction of steam extracted for regeneration. Discuss the impact of regeneration on plant performance.

Or

(b) Evaluate the role of modern hybrid engines combining internal combustion and electric systems in reducing fuel consumption and emissions. Develop a conceptual system diagram and explain the key technological challenges in implementing such systems.

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