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Reg No.: \_\_\_\_\_

Name: \_\_\_\_\_

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S5 (R, S) / S3 (PT) (R, S) Examination December 2023 (2019 Scheme)



Course Code: MET 303

Course Name: THERMAL ENGINEERING

Max. Marks: 100

Duration: 3 Hours

*Use of steam tables, refrigeration tables, and psychrometric chart are permitted*

**PART A**

*(Answer all questions; each question carries 3 marks)*

Marks

- |    |  |   |
|----|--|---|
| 1  | Draw the T-S diagram of a reheat cycle. Mention two advantages of the reheat cycle                                   | 3 |
| 2  | What is a binary vapour power cycle? Give one example.   | 3 |
| 3  | Differentiate between impulse and reaction steam turbines.   | 3 |
| 4  | Explain velocity compounding of steam turbines.  | 3 |
| 5  | What is air standard cycle and why does the fuel air cycle differ from the air standard cycle? List any two reasons. | 3 |
| 6  | Explain the procedure for conducting a retardation test.   | 3 |
| 7  | Define stoichiometric ratio, equivalence ratio and excess air.   | 3 |
| 8  | Enumerate the difference between Petrol knock and diesel knock.  | 3 |
| 9  | With help of a figure explain air refrigeration cycle.   | 3 |
| 10 | Define DBT, WBT and DPT.   | 3 |

**PART B**

*(Answer one full question from each module, each question carries 14 marks)*

**Module -1**

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|----|--|----|
| 11 | a) 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 (a) the thermal efficiency, (b) specific steam consumption and (c) average temperature of heat addition. Compare these to an ideal Rankine cycle operates between same conditions. | 14 |
| 12 | a) With the help of a figure explain the working of a Velox boiler and mention its merits and demerits over other high pressure boilers.   | 9  |
|    | b) Derive the expression for critical pressure ratio of flow of steam through nozzle.  | 5  |

**Module -2**

- 13 a) In an impulse turbine, the mean diameter of the blades is 1.05 m and the speed is 3000 rpm. The nozzle angle is  $18^\circ$ , speed ratio is 0.42, and the friction factor is 0.84. The outlet blade angle is to be made  $3^\circ$  less than the inlet angle. The steam flow is 10 kg/s. Draw the velocity diagrams for the blades and calculate (a) the tangential thrust, (b) the axial thrust, (c) the resultant thrust, (d) the power developed, and (e) the blade efficiency. 14
- 14 a) With the help of figures explain throttle governing, nozzle governing and by-pass governing. 9
- b) Explain degree of reaction of a steam turbine and derive an expression for it 5

**Module -3**

- 15 a) Explain the concept of stratified charge engines and methods for charge stratification. Mention its advantages. 9
- b) A four-cylinder gasoline engine works on four strokes develops a brake power of 20.9 kW. A morse test was conducted on the engine and brake power obtained when each cylinder made inoperative by short circuiting the spark plug are 14.9, 14.3, 14.8 and 14.5 kW respectively. Find the indicated power, friction power and mechanical efficiency when all cylinders are firing? 5
- 16 a) The following observations were made during a trial of a single cylinder 4 stroke diesel engine. Cylinder diameter = 20 cm, Stroke = 40 cm, mean effective pressure 6 bar, torque = 407 Nm, Speed = 250 rpm, fuel consumption = 4 kg/h, Calorific value of the fuel = 43 MJ/kg, cooling water flow rate = 4.5 kg/min, Air used per kg of fuel = 30 kg, rise in cooling water temperature =  $45^\circ\text{C}$ , Temperature of exhaust gas =  $420^\circ\text{C}$ , room temperature =  $20^\circ\text{C}$ , specific heat of exhaust gas = 1 kJ/kg K and specific heat of water = 4.18 kJ/kgK. Find mechanical efficiency, brake thermal efficiency, specific fuel consumption and prepare the heat balance sheet in KJ/hr. 14

**Module -4**

- 17 a) With help of a p- $\theta$  diagram explain stages of CI engine combustion. 7
- b) Discuss major pollutants coming from SI engines. How does the catalytic converter help to reduce emissions? 7
- 18 a) What are the requirements of SI engine combustion chamber? With help of figure explain different types of SI engine combustion chamber designs. 10

- b) How is the Octane number of a fuel determined? 4

**Module -5**

- 19 a) A food storage locker requires a refrigeration system of 42 kW capacity at an evaporator temperature of  $-5^{\circ}\text{C}$  and a condenser temperature of  $40^{\circ}\text{C}$ . The refrigerant, R-12, is sub-cooled by  $5^{\circ}\text{C}$  before entering the expansion valve, and the vapour is superheated by  $6^{\circ}\text{C}$  before leaving the evaporator coil. The compression of the refrigerant is reversible adiabatic. A two-cylinder vertical single acting compressor with stroke equal to 1.5 times the bore is to be used operating at 960 rpm. Determine (a) the refrigerating effect/kg, (b) the mass of refrigerant to be circulated per minute, (c) the theoretical piston displacement per minute, (d) the theoretical power, (e) the COP, (f) the heat removed through condenser/kg and (g) the theoretical bore and stroke of compressor. 14
- 20 a) The atmospheric air at  $30^{\circ}\text{C}$  DBT and 70% RH enters a cooling coil at the rate of  $220\text{ m}^3/\text{min}$ . The coil DPT =  $15^{\circ}\text{C}$  and its Bypass Factor = 0.15. Determine (a) the temperature of air leaving the cooling coil, (b) the capacity of the cooling coil in TR, (c) the amount of water vapour removed per minute, and (d) sensible heat factor for the process. 9
- b) Air refrigeration used for food storage provides 30 Ton of Refrigeration. The temperature of air entering the compressor is  $10^{\circ}\text{C}$  and temperature at exit of cooler is  $30^{\circ}\text{C}$ . Calculate: (a) COP of the cycle, and (b) Power required per ton of refrigeration by the compressor. The quantity of air circulated in the system is  $3600\text{ kg/h}$ . The compression and expansion processes follow the law  $pv^{1.3} = \text{const.}$  and  $\gamma = 1.4$ ,  $c_p = 1.005\text{ kJ/kg.K}$  for air. 5

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