CBCS SCHEME

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15ME43

Fourth Semester B.E. Degree Examination, Dec.2023/Jan.2024
Applied Thermodynamics

Time: 3 hrs. Max. Marks: 80

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Compare the otto, diesel and dual cycles on P-V diagram and T-S diagrams, when heat is supplied to each cycle is same. **(08 Marks)**

b. Derive air standard efficiency expression for dual combustion cycle. **(08 Marks)**

OR

2 a. With a schematic diagram, explain a closed cycle gas turbine. **(04 Marks)**

b. With the help of neat diagram, explain a Rocket engine. **(04 Marks)**

c. The air enters the compressor of an open cycle constant pressure gas turbine at a pressure of 1 bar and temperature 20°C. The pressure of the air after the compression is 4 bar. The isentropic efficiencies of the compressor and turbine are 80% and 85% respectively. The air fuel ratio is 90 : 1. If flow rate of air is 3 kg/sec. Find (i) Power developed (ii) Thermal efficiency of the cycle.
Assume C_P = 1.0 kJ/kgK and γ = 1.4 for air and gases. Take calorific value of the fuel as 41800 KJ/kg. **(08 Marks)**

Module-2

3 a. With a schematic diagram, explain the working of regenerative Rankine cycle. Show the process on T-S and H-S diagram. **(08 Marks)**

b. In a steam power plant operating on ideal Rankine cycle steam enters the turbine at 20 bar with an enthalpy of 3248 kJ/kg and an entropy of 7.127 kJ/kgK. The condenser pressure is 0.1 bar. Find the cycle efficiency and specific steam consumption in kg/kWh. Do not neglect pump work. **(08 Marks)**

OR

4 a. What are the advantages and disadvantages of binary vapour power cycle? **(06 Marks)**

b. In a reheat cycle, the initial steam pressure and the maximum temperature are 150 bar and 550°C, If the condenser pressure is 0.1 bar and the moisture at the condenser inlet is 5% and assuming ideal processes, determine:
i) Reheat pressure
ii) Cycle efficiency
iii) Steam rate, steal is reheated to 550°c. **(10 Marks)**

Module-3

5 a. With neat sketch, explain the Orsat's apparatus used for exhaust gas analysis. **(06 Marks)**

b. The products of combustion of an unknown hydrocarbon C_xH_y have the following composition as measured by an Orsat apparatus: CO_2 = 8.0%, CO = 0.9%, O_2 = 8.8% and rest is N_2. Determine:
i) Composition of the fuel
ii) The air-fuel ratio
iii) Percentage of excess air
iv) Dew point temperature of the products if the total pressure is 1.0 bar. **(10 Marks)**

OR

6 a. Explain the principle of conducting Morse test on IC engines for determining frictional power. **(04 Marks)**

b. List the factors affecting the detonation. **(02 Marks)**

c. A 4-cylinder 2-stroke petrol engine has a bore of 57 mm and stroke of 90 mm. Its rated speed is 2800 rpm and is tested at this speed against a brake, which has a torque arm of 0.356 m. The net brake load is 155 N and the fuel consumption is 6.74 lit/h. The specific gravity of the petrol is 0.735 and it has a calorific value of 44200 kJ/kg. A Morse test is carried out and the cylinders are cut-out in order 1, 2, 3, 4 with corresponding brake loads 111, 106.5, 104.2 and 111.3 N respectively. Calculate for this speed :

i) The engine torque
ii) Brake mean effective pressure
iii) Brake thermal efficiency
iv) BSFC
v) Mechanical efficiency
vi) Indicated thermal efficiency. **(10 Marks)**

Module-4

7 a. With the help of a neat sketch, explain a simple vapour absorption cycle. **(05 Marks)**

b. Explain the various factors affecting the performance of a vapour compression system. **(04 Marks)**

c. A vapour compression refrigerator uses methyl chloride (R-40) and operates between temperature limits of $-10^{\circ}C$ and $45^{\circ}C$. At the entry to the compressor, the refrigerant is dry and after compression it acquires a temperature of $60^{\circ}C$. Find the C.O.P of the refrigerator. **(07 Marks)**

OR

8 a. Define the following terms:

i) Dry bulb temperature (DBT).
ii) Wet bulb temperature (WBT)
iii) Specific humidity.
iv) Relative humidity. **(08 Marks)**

b. Atmospheric air at 101.325 KPa has $30^{\circ}C$ DBT and $15^{\circ}C$ DPT. Without using the psychromatic chart, using the property values from the tables. Calculate

i) Partial pressure of air and water vapour.
ii) Specific humidity
iii) Relative humidity.
iv) Vapour density and enthalpy of moist air. **(08 Marks)**

Module-5

9 a. Show that for perfect intercooling, stage pressure ratio remains the same in multistage air compressor and hence prove that $Z = \left(\frac{p_{x+1}}{p_1}\right)^{1/x}$ where z = stage pressure ratio, p_1 = initial pressure, x = number of stages. **(09 Marks)**

b. Steam expands from 17 bar and 284°C to 0.7 bar in a convergent-divergent nozzle. Assuming that the expansion is frictionless and the steam discharged is 0.25 kg/s, calculate the diameter of the nozzle, (i) at a point where the pressure is 9.5 bar, (ii) at exit, using H-S chart. **(07 Marks)**

OR

10 a. Briefly explain the different types of flows in a steam nozzle. **(09 Marks)**

b. Determine the size of the cylinder of a double acting air compressor of 45kW in which air is taken at 1 atmosphere and compressed to 16 atmospheric pressure according to the law $PV^{1.25} = C$. Assume speed of the crank as 300 rpm, piston speed = 180 m/min. **(07 Marks)**