CBCS Scheme

USN | | | | | | | | | | 15ME43

Fourth Semester B.E. Degree Examination, Dec.2017/Jan.2018
Applied Thermodynamics

Time: 3 hrs. Max. Marks: 80

Note: 1. *Answer FIVE full questions, choosing one full question from each module.*
2. *Use thermodynamic data hand book and steam tables is permitted.*

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. List out the factors affecting the efficiency of the Rankine cycle. **(04 Marks)**

b. Compare the Rankine and the Carnot cycles of steam power plants. **(04 Marks)**

c. In a steam power cycle, the steam supply is at 15 bar and dry saturated. The condenser pressure is 0.4 bar. Calculate Carnot and Rankine efficiency of the cycle neglect the pump work. **(08 Marks)**

OR

4 a. What do you mean by Regenerative cycle? With help of neat diagram, explain the working of a regenerative Rankine cycle and derive the efficiency of the cycle. **(08 Marks)**

b. Consider a regenerative vapour power cycle with open feed water heater. Steam enters the turbine at 9 MPa and 350°C and expands to 0.9 MPa where some of the steam is extracted and passed to the open feed water heater operating at 0.9 MPa. The remaining steam expands through the remaining part of the turbine to the condenser pressure of 0.01 MPa. Saturated liquid exits the open feed water heater at 0.9 MPa. If the net power output of the cycle is 120 MW. Determine

(i) Thermal efficiency (ii) Mass flow rate of steam entering the turbine. **(08 Marks)**

Module-3

5 a. Explain the following terms with reference to a combustion process:

(i) Enthalpy of formation (ii) Adiabatic flame temperature

(iii) Enthalpy of combustion (iv) Heat of reaction **(08 Marks)**

b. Methane is burned with atmospheric air. The analysis of the products on a dry basis is as follows:

CO_2 = 10%, O_2 = 2.37%, CO = 0.53%, N_2 = 87.10%

(i) Determine the combustion equation.

(ii) Calculate the air fuel ratio on mass basis.

(iii) Percent theoretical air. **(08 Marks)**

OR

6 a. Explain the combustion phenomenon in C.I. engine. **(08 Marks)**

b. A single cylinder 4 stroke diesel engine gave the following results while running on full load. Area of indicator card = 300 mm^2, Spring constant = 1 bar/mm,
Length of the diagram = 40 mm, Speed of the engine = 450 rpm, Load on the brake = 370 N,
Spring balance reading = 50 N, Diameter of the brake drum = 1.2 m,
Diameter of the cylinder = 160 mm, Stroke of the piston = 200 m,
C.V of the fuel = 41800 KJ/kg.
Calculate (i) IMEP
(ii) BP and brake mean effective pressure
(iii) BSFC (Brake Specific Fuel Consumption)
(iv) Brake thermal and indicated thermal efficiency. **(08 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. Obtain expression for volumetric efficiency of a single stage air compressor in terms of pressure ratio, clearance and 'n' the polytropic index. **(06 Marks)**

b. What are disadvantages of a single stage air compressor? **(02 Marks)**

c. A two stage air compressor with perfect intercooling takes in air at 1 bar $27^{\circ}C$. The law of compression in both the stages is $PV^{1.3}$ = constant. The compressed air is delivered at 9 bar. Calculate for unit mass flow rate of air the minimum workdone and the heat rejected to the intercooler. Compare the values if the compression is carried out in single stage compressor with after cooler. **(08 Marks)**

OR

10 a. Mention the types of nozzles. Explain any one. **(04 Marks)**

b. Derive an expression for steam velocity coming out from a nozzle. **(04 Marks)**

c. Dry saturated steam at a pressure of 11 bar enters a convergent-divergent nozzle and leaves at a pressure of 2 bar. If the flow is adiabatic and frictionless, determine
(i) The exit velocity of steam.
(ii) Ratio of cross section at exit and that at throat. **(08 Marks)**
Assume the index of adiabatic expansion is 1.135.

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