CBCS SCHEME

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21ME34

Third Semester B.E. Degree Examination, June/July 2023
Thermodynamics

Time: 3 hrs. Max. Marks: 100

Note: 1. ***Answer any FIVE full questions, choosing ONE full question from each module.***
2. ***Use of Thermodynamic Data Hand book is permitted.***

Module-1

1 a. Explain different types of temperature scales. **(04 Marks)**

b. Derive an expression for PdV work for an isentropic process. **(08 Marks)**

A thermo couple with test junction at 1°C on a gas thermo meter scale and reference junction at ice point gives the emf as $e = (0.3t - 4\times10^{-4}t)$mV. The millimeter is calibrated at ice and steam points. What will be the reading on this thermometer when gas thermometer reads 80°C? **(08 Marks)**

OR

2 a. Obtain the expression for displacement work,
(i) Isothermal process
(ii) Polytropic process.
(iii) Isobaric process
(iv) Isochronic process. **(10 Marks)**

b. A piston-cylinder arrangement contains a fluid system which passes through a complete cycle of four process. During a cycle, the sum of all heat transfer is −170kJ. The system completes 100 cycles per minute. Complete the following table and compute the net rate of work in K.

Process	Q KJ/min	W KJ/min	ΔE KJ/min
AB	0	2170	-
BC	21000	0	-
CD	2100	-	36600
DA	-	-	-

(10 Marks)

Module-2

3 a. Give Kelvin Plank and Clausius statements of second law of thermodynamics. **(04 Marks)**

b. Show that entropy is a property of system. **(06 Marks)**

c. A heat engine working on a Carnot cycle absorbs heat from three thermal reservoirs at 1000 K, 800 K and 600 K respectively. The engine does 10 kW of net work and rejects 400 kJ/min of heat to the sink at 300 K if the heat supplies by the reservoir at 1000 K is 60% of heat supplied by the reservoir at 600 K. Find the quantities of heat supplies by each reservoirs. **(10 Marks)**

OR

4 a. State and prove Clausius inequality. **(08 Marks)**

b. State and Carnot's theorem. **(02 Marks)**

c. Heat is transferred by conduction from a reservoir at 500°K to a reservoir at 300°K at the rate of 100 kJ/min. Evaluate $\oint \frac{\delta Q}{T}$. What will be $\oint \frac{\delta Q}{T}$ if reversible heat engine operates between these two reservoirs? How much work would be have been done by the engine. **(10 Marks)**

Module-3

5 a. Write Maxwell equations and explain the terms involved. **(06 Marks)**

b. Define : (i) Sub cooled liquid (ii) Tripple point (iii) Critical point. **(06 Marks)**

c. Super heated steam from initial condition of 5 bar and 300°C is expanded isentropically to a pressure of 0.5 bar. Calculate (i) Final condition of steam after expansion (ii) Change in enthalpy / kg of steam (iii) Change in internal energy / kg of steam. **(08 Marks)**

OR

6 a. With a neat sketch, explain working of a combined separating and throttling calorimeter. **(10 Marks)**

b. Steam at 10 bar and dry state is cooled under constant pressure until it becomes 0.85 dry. Using steam tables find the work done, change in enthalpy, heat transfer and change in entropy. **(10 Marks)**

Module-4

7 a. Define :

(i) Mole fraction.
(ii) Mass fraction.
(iii) Dalton's law.
(iv) Amagat's law of additives **(10 Marks)**

b. A mixture of gases contain 1 kg of CO_2 and 1.5 kg of N. The pressures and temperature of the mixture are 3.5 bar and 27°C. Calculate

(i) Mole fraction of each constituent.
(ii) Partial pressure.
(iii) Partial value.
(iv) Volume of mixture.
(v) Density of mixture **(10 Marks)**

OR

8 a. Derive an expression of air standard efficiency of diesel cycle with neat PV and TS diagrams. **(10 Marks)**

b. An engine with 200 mm cylinder and 300 mm stoke length works on diesel cycle. The initial pressure and temperature of air are 0.1 MPa and 27°C. The cut off is 8% of stoke volume and compression ratio is 15. Calculate

(i) Pressure and temperature of salient points.
(ii) Air standard efficiency. **(10 Marks)**

Module-5

9 a. Draw a neat PV and TS diagram of air standard dual cycle and derive an expression for air standard efficiency interms of compression ratio, explosion ratio and cut off ratio under what conditions the dual cycle becomes otto cycle and diesel cycle. **(10 Marks)**

b. An air standard diesel cycle has compression ratio 16. The temperature before compressor is $27^{\circ}C$ and the temperature after expansion is $627^{\circ}C$. Compute

(i) Cut off ratio.
(ii) The net work output per unit mass of air.
(iii) Thermal efficiency.
(iv) Mean effective pressure in bar. **(10 Marks)**

OR

10 a. Explain any two methods of improving the efficiency of an open cycle gas turbine plant. **(10 Marks)**

b. In an open cycle gas turbine plant air enters the compressor at 1 bar and $27^{\circ}C$. The pressure of after compression is 4 bar. The isentropic efficiency of the turbine and compressor are 85%, 80% and air fuel ratio is 80%. The calorific value of fuel used is 42000 kJ/kg and mass flow rate is 2.5 kg/s. Calculate the power output from the plant and the cycle efficiency. Assume that C_P and γ to be same for both air and products of combustion. **(10 Marks)**

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