CBCS SCHEME

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BMR304

Third Semester B.E./B.Tech. Degree Examination, June/July 2024
Thermodynamics

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. M : Marks , L: Bloom's level , C: Course outcomes.
3. Thermodynamics Data Hand book / Steam table are permitted.
4. Missing data may be assumed suitably by giving proper reason.

		Module – 1	M	L	C
Q.1	a.	State Zeroth law of Thermodynamics and briefly explain its significance.	5	L1	CO1
	b.	Write the thermodynamics definition of work with a suitable example, explain how it is more general than the definition of work in mechanics.	5	L1	CO2
	c.	A platinum wire is used as a resistance thermometer. The wire resistance was found to be 10 Ω and 16 Ω at ice point and steam point respectively, and 30 Ω at sulphur boiling point of 444.6°C. Find the resistance of the wire at 750°C, if the resistance varies with temperature by the relation, $R = R_0(1+\alpha t+\beta t^2)$.	10	L3	CO1
		OR			
Q.2	a.	Prove that the internal energy is a property of the system.	5	L3	CO1
	b.	Derive an expression for displacement work for an adiabatic process.	7	L2	CO1
	c.	A sphere of diameter 1 m contains a gas at a pressure of 1 atm. The sphere is heated, because of which the diameter of the sphere increase to 1.1 m. During the heating process the pressure of the gas is directly proportional to the diameter of the sphere determine the work done.	8	L2	CO1
		Module – 2			
Q.3	a.	State first law of thermodynamics for cyclic and non cyclic processes.	6	L1	CO2
	b.	Write down the expression for SFEE with usual notation.	6	L2	CO2
	c.	Air enters an adiabatic nozzle at 400°C with a velocity of 50 ms^{-1} the inlet area is 240 cm^2, the temperature of air at the exit is 80°C. Give that the specific volume of air at the inlet and exit are 0.2 m^3/kg and 1.02 m^3/kg respectively, find the area of cross section of the nozzle at the exit. Assume that the enthalpy of air is a function of temperature only and take C_p = 1.005 KJ/kgK.	8	L2	CO2
		OR			
Q.4	a.	What are the limitations of First law of thermodynamics?	5	L1	CO2
	b.	State and explain Kelvin-Planck and Clausius statements of second law of thermodynamics.	8	L2	CO2
	c.	A domestic food freezer maintains a temperature of −15°C. The ambient temperature is 30°C. If the heat leaks into the freezer at the rate of 1.75 KJ/S. What is the minimum power necessary to pump this heat continuously?	7	L2	CO2

		Module – 3			
Q.5	**a.**	Show that Entropy is a property of a system.	**5**	**L1**	**CO3**
	b.	Explain principle of increase of entropy of universe.	**7**	**L2**	**CO3**
	c.	A volume of 0.05 m^3 of a perfect gas for which R = 0.297 KJ/kgK is compressed reversibly in a cylinder according to the law, $PV^n = C$ and then cooled at constant pressure. The initial temperature is 27°C and the final pressure is 8.5 times the initial pressure. The final volume is 0.007 m^3. Determine the following : (i) The final temperature after compression (ii) The final temperature (iii) The net heat transfer per kg (iv) The net change in specific entropy.	**8**	**L2**	**CO2**
		OR			
Q.6	**a.**	Define the following with respect to steam formation : (i) Sub-cooled liquid. (ii) Dryness fraction (iii) Latent heat of vaporization (iv) Degree of super heat.	**4**	**L2**	**CO3**
	b.	Describe with neat sketch working of separating and throttling calorimeter.	**8**	**L2**	**CO2**
	c.	Determine the dryness fraction of the steam sample which is tested in a separating and throttling calorimeter and the following data were obtained? (i) Pressure of steam sample = 15 bar (ii) Pressure of steam at exit = 1 bar (iii) Temperature of steam at exit = 150°C (iv) Water collected from separating calorimeter = 0.2 kg/min (v) Discharge collected at exit = 10 kg/min	**8**	**L3**	**CO3**
		Module – 4			
Q.7	**a.**	With neat sketch, explain the Orsat's apparatus using for exhaust gas analysis.	**10**	**L2**	**CO4**
	b.	A SI engine uses Octane (C_8H_{18}) as the fuel and the exhaust gas analysis give the following composition : CO_2 = 9.9%, CO = 7.2%, H_2 = 3.3%, CH_4 = 0.3% and N_2 = 79.3% by volume. Calculate A : F ratio.	**10**	**L2**	**CO4**
		OR			
Q.8	**a.**	With a neat schematic diagram and T-S diagrams, derive an expression for the thermal efficiency in a reheat vapour power cycle.	**10**	**L2**	**CO4**
	b.	A steam power plant operating on Rankine cycle gets steam at 40 bar and dry saturated. After doing work steam is exhausted at 0.3 bar. If the steam flow rate is 60 kg/s determine, (i) Pump work (ii) Turbine work (iii) Cycle efficiency (iv) Heat flow in the condenser.	**10**	**L2**	**CO4**
		Module – 5			
Q.9	**a.**	Derive an expression for air standard efficiency for diesel cycle with P-V and T-S diagram.	**10**	**L3**	**CO5**
	b.	An air standard Otto cycle has a compression ratio of 8. The temperature and pressure at the beginning of compression are 300 K and 102 KPa respectively. If the maximum cycle temperature is 1900 K, determine (i) The heat supplied 1 kg of air (ii) The net workdone/kg of air (iii) The thermal efficiency of the cycle, assuming $\gamma = 1.4$.	**10**	**L2**	**CO5**

		OR			
Q.10	**a.**	Explain with a neat sketch, the difference between open and closed cycle gas turbine.	**10**	**L2**	**CO5**
	b.	In an open cycle constant pressure gas turbine unit air enters compressor at 1 bar and 300 K. The pressure of air after compression is 4 bar, the isentropic efficiencies of compressor and turbine are 80% and 85% respectively. The air fuel ratio is 90 : 1. Calculate the power developed and thermal efficiency of the cycle if the flow rate of air is 3 kg/s. Take $C_P = 1.005$ KJ/kgK and $\gamma = 1.4$ for air and gases $C_V = 42000$ KJ/kg.	**10**	**L2**	**CO5**

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