CBCS SCHEME

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BME304

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

Basic 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. Used of thermodynamic data hand book is permitted.

		Module – 1	**M**	**L**	**C**
Q.1	**a.**	Explain Zeroth law of thermodynamics.	4	L2	CO1
	b.	Define heat and work in thermodynamics. Show that work is a path function.	8	L1	CO1
	c.	The temperature 'T' on thermometric scale is defined in terms of property 'P' by the relation T = a $\log_e P$ + b, where a and b are constants. The temperature at ice point and steam point are 0 and 100°C respectively. Instrument gives values of 'P' 1.86 and 6.81 at ice and stream point respectively. Evaluate temperature corresponding to a reading of P = 2.5.	8	L3	CO1
		OR			
Q.2	**a.**	Derive an expression for displacement work for : i) Isothermal process ii) Isentropic process.	10	L2	CO1
	b.	A cylinder contains $0.5m^3$ of gas at 1 bar and 90°C. The gas compressed to a volume of $0.125m^3$. The final pressure being 6 bar. Find : i) The mass of the gas ii) Value of 'n' iii) The heat transferred iv) Internal energy.	10	L3	CO1
		Module – 2			
Q.3	**a.**	State the first law of thermodynamics applied to cyclic process and non cyclic process.	6	L1	CO2
	b.	Show that internal energy is a property of system.	6	L2	CO2
	c.	A closed system undergoes a cycle. The energy transfer are as obtained : i) Complete the table ii) Determine rate of work in KW.	8	L3	CO2

Process	Q(kJ/min)	W(kJ/min)	DE(kJ/min)
AB	400	150	–
BC	200	–	300
CD	–200	–	–
DA	0	75	–

		OR			
Q.4	**a.**	Starting the assumptions, derive steady flow energy equation.	6	L2	CO2
	b.	A nozzle is a device for increasing the velocity of steadily flowing steam. Enthalpy of the fluid at inlet is 3000kJ/kg and velocity is 60m/s. Enthalpy at discharge end is 2762 kJ/kg. The nozzle is horizontal and there is negligible heat loss from it : i) Find velocity at exit of nozzle ii) If inlet area is $0.1m^2$ and specific volume is $0.187\ m^3/kg$, find mass flow rate. iii) If specific volume at exit is $0.498m^3/kg$ find diameter at exit of nozzle.	8	L3	CO2
	c.	The power capacity of a system is 3000KW for the following data determine the fluid flow rate in kg/hour. The heat rejection from fluid = 100 kJ/s Inlet velocity = 300 m/s Inlet pressure = 600 KPa Inlet internal energy = 2000 kJ/kg Inlet volume = $0.2\ m^3/kg$ Outlet velocity = 120 m/s Outlet pressure = 150 Kpa Outlet internal energy = 1500 kJ/kg Final volume = $1.2\ m^3/kg$ The fluid enters and leaves the system at same elevation.	6	L3	CO2
		Module – 3			
Q.5	**a.**	Give the Kelvin plank and Clausius statements of second law of thermodynamics and prove their equivalence.	10	L1	CO3
	b.	Explain PMMK – 1 and PMMK – 2.	4	L1	CO3
	c.	A series combination of two Carnot engines operate between temperature of 180°C and 20°C. Calculate the intermediate temperature, if engine produces : i) Equal amount of work ii) Engines having same efficiency.	6	L3	CO3
		OR			
Q.6	**a.**	State and prove Clausius inequality.	8	L1	CO3
	b.	Show that entropy is a property of a system.	6	L2	CO3
	c.	5 kg of copper block of 200°C is dropped to an insulated tank with 100kg of oil at 30°C. Find the increase in entropy of the universe. Take C_p(copper) = 0.4kJ/kg-k, C_p(oil) = 2.1kJ/kg-k .	6	L3	CO3

		Module – 4			
Q.7	**a.**	With T – S diagram briefly explain the available energy and unavailable energy.	**6**	**L1**	**CO4**
	b.	Obtain an expression for maximum work available in steady flow system.	**6**	**L2**	**CO4**
	c.	Define the following with respect to the pure substance : i) Latent heat of vapourisation ii) Sensible heat iii) Saturation temperature iv) Triple point v) Dryness fraction vi) Wet steam.	**8**	**L1**	**CO4**
		OR			
Q.8	**a.**	With a neat sketch explain the working of a separating and throttling calorimeter.	**10**	**L1**	**CO4**
	b.	In a test to find the quality of the steam in a pipe using a combined separating and throttling calorimeter, the following data was obtained : Pressure of steam in steam mains = 14 bar Pressure of steam after throttling = 1.19 bar Temperature after throttling = 120°C Water collected in separator = 0.45 kg Steam condensed after throttling = 6.75 kg Describe the condition of the steam in the mains. Take SP heat of superheated steam as 2.1 kJ/kg-k.	**10**	**L3**	**CO4**
		Module – 5			
Q.9	**a.**	Clearly distinguish between ideal and real gases.	**6**	**L1**	**CO5**
	b.	Explain briefly Dalton's law and Amagat's law.	**6**	**L1**	**CO5**
	c.	Derive an expression for specific heat at constant pressure and constant volume for mixture of gases.	**8**	**L2**	**CO5**
		OR			
Q.10	**a.**	Explain reduced properties and compressibility chart.	**6**	**L1**	**CO5**
	b.	Write Maxwell relations and explain the terms involved.	**6**	**L1**	**CO5**
	c.	Determine the pressure exerted by carbon-dioxide in a container of $1.5m^3$ capacity when it contains 5kg at 27°c using. i) Ideal gas equation ii) Vander walls equation Take $a = 364.3\ kN/m^4/kg\ mol^2$ $b = 0.0427\ m^3/kg\ mol$.	**8**	**L3**	**CO5**

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