CBCS SCHEME

USN | | | | | | | | | |

BME304

Third Semester B.E./B.Tech. Degree Examination, Dec.2023/Jan.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. Use of thermodynamic data handbook and steam tables is permitted.
4. Assume missing data suitably.

		Module – 1	M	L	C
Q.1	a.	State Zeroth law of thermodynamics and justify how it forms the basis for temperature measurement.	05	L1	CO1
	b.	Derive an expression for P-dV work for a process in which (i) PV = C (ii) $PV^n = C$ where C is a constant.	05	L2	CO1
	c.	The temperature scale by a certain thermometer is given by the relation $t = a \ln x + b$ where 'a' and 'b' are constants and x is the thermometric property of the fluid in the thermometer. If at ice and steam points the thermometric property is found to be 1.5 and 7.5 respectively. What will be the temperature corresponding to the thermometric property 3.5?	10	L3	CO1
		OR			
Q.2	a.	Show that thermodynamics definition for work is superior to mechanics definition.	05	L1	CO1
	b.	With a neat sketch, explain working principle of constant volume gas thermometer.	05	L2	CO1
	c.	A perfect gas is undergoing a process in which $T \alpha V^{2/5}$. Calculate the work done by the gas in going from state 1 in which the pressure is 100 bar and volume is 4 m^3 to the state 2 in which volume is 2 m^3. Also calculate the final pressure.	10	L4	CO1
		Module – 2			
Q.3	a.	State the first law of thermodynamics along with the mathematical expression for the following: (i) A closed system undergoing a cycle (ii) A closed system undergoing a change of state.	05	L1	CO2
	b.	With a neat sketch of steady flow device, write the steady flow energy equation with usual notations.	05	L1	CO2
	c.	A stationary mass of gas is compressed without friction from an initial state of 0.3 m^3 and 0.105 MPa to a final state of 0.15 m^3 and 0.105 MPa, the pressure remaining constant during the process. There is a transfer of 37.6 kJ of heat from the gas during the process. How much does the internal energy of the gas change?	10	L3	CO2
		OR			
Q.4	a.	Write the steady flow energy equation for (i) Boiler (ii) Centrifugal pump.	05	L1	CO2
	b.	Show that energy is a property of the system.	05	L2	CO2
	c.	In a certain steady flow process, 12 kg of fluid per minute enters at a pressure of 1.4 bar, density 25 kg/m^3, velocity 120 m/s and internal energy 920 kJ/kg. The fluid properties at exit are 5.6 bar, density 5 kg/m^3, velocity 180 m/s, and internal energy 720 kJ/kg. During the process, the fluid rejects 60 kJ/s of heat and rises through 60 m. Determine work done during the process in KW.	10	L4	CO2

		Module – 3			
Q.5	**a.**	Define thermal efficiency of a heat engine and COP of a refrigerator along with mathematical expressions for both. Write their schematic diagram.	**05**	**L1**	**CO3**
	b.	Define entropy and show that it is a property of the system.	**05**	**L2**	**CO3**
	c.	A reversible heat engine converts one-sixth of the heat input into work. When the temperature of the sink is reduced by 62°C, its efficiency is doubled. Find the temperature of the source and the sink.	**10**	**L4**	**CO3**
		OR			
Q.6	**a.**	State and prove Clausius theorem.	**05**	**L2**	**CO3**
	b.	Give the Kelvin-Plank and Clausius statements of the second law of thermodynamics.	**05**	**L1**	**CO3**
	c.	A lump of steel of mass 10 kg at 627°C is dropped in 100 kg of oil at 30°C. The specific heats of steel and oil are 0.5 kJ/kgK and 3.5 kJ/kgK respectively. Calculate the entropy change of steel, the oil and the universe.	**10**	**L3**	**CO3**
		Module – 4			
Q.7	**a.**	Define Available Energy (AE) and Unavailable Energy (UE). Show that unavailable energy is the product of lowest temperature of heat rejection and the change in entropy of the system during the process of supplying heat. Draw the necessary schematics and T-S diagrams.	**10**	**L4**	**CO4**
	b.	With a neat sketch, explain the working principle of separating and throttling calorimeter.	**10**	**L2**	**CO4**
		OR			
Q.8	**a.**	In a certain process, a vapor, while condensing at 420°C, transfers heat to water evaporating at 250°C. The resulting steam is used in a power cycle which rejects heat at 35°C. What is the fraction of the available energy in the heat transfer process from the vapour at 420°C that is lost due to the irreversible heat transfer at 250°C?	**10**	**L3**	**CO4**
	b.	Draw the phase equilibrium diagram for a pure substance on P-T coordinates and show the fusion curve, vaporization curve, sublimation curve, triple point and critical point.	**10**	**L2**	**CO4**
		Module – 5			
Q.9	**a.**	Write notes on: (i) Daltons law of partial pressure (ii) Amagots law of additive volumes (iii) Compressibility factor (iv) Law of corresponding states (v) Generalized compressibility chart	**10**	**L2**	**CO5**
	b.	One kg of ideal gas is heated from 50°C to 150°C. Determine: (i) Change in internal energy (ii) Change in enthalpy (iii) Change in flow energy (iv) $\overline{C}_V$ and $\overline{C}_p$ Take R = 280 kJ/kgK; $\gamma = 1.32$ for gas.	**10**	**L3**	**CO5**
		OR			
Q.10	**a.**	Derive: (i) Maxwell's equations (ii) The first and second Tds equations.	**10**	**L2**	**CO5**
	b.	Find the gas constant and apparent molar mass of a mixture of 2 kg O_2 and 3 kg N_2 given that the universal gas constant is 8314.3 J/kgK, molar mass of O_2 and N_2 are respectively 32 and 28.	**10**	**L3**	**CO5**

* * * * *