

BALLARI INSTITUTE OF TECHNOLOGY & MANAGEMENT

(Autonomous Institute under Visvesvaraya Technological University, Belagavi)

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Course Code

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Third Semester B.E. Degree Examinations, January 2025

BASIC THERMODYNAMICS

Duration: 3 hrs

Max. Marks: 100

Note: 1. Answer any FIVE full questions choosing ONE full Question from each Module.
2. Missing data, if any, may be suitably assumed

<u>Q. No</u>	<u>Question</u>	<u>Marks</u>	<u>(RBTL:CO:PI)</u>
<u>Module-1</u>			
1.	a. Define thermodynamics with example.	04	(1 : 1 : 1.6.1)
	b. Differentiate between (i) microscopic and macroscopic approach (ii) adiabatic and diathermic wall	08	(1 : 1 : 1.6.1)
	c. The temperature T on a thermometric scale is defined by $T = a \ln K + b$, where 'a' and 'b' are constants. The values of K are found to be 2.5 and 9.5 at 0°C and 100°C respectively. Calculate the temperature for the values of K = 4.5	08	(3 : 1 : 1.6.1)
(OR)			
2.	a. Define (i) Thermal equilibrium (ii) Mechanical equilibrium (iii) Chemical equilibrium.	06	(1 : 1 : 1.6.1)
	b. Classify the following systems (i) Tree (ii) Printer (iii) Baking of bread in an oven (iv) Fan (v) Thermo flask (vi) Boiler.	06	(1 : 1 : 1.6.1)
	c. Two Celsius thermometers A and B agree at ice point and steam point and related by the equation is $t_A = L + M t_B + N t_B^2$ where L, M, N are constants. When both the thermometers are immersed in a fluid A registers 26°C while B registers 25°C. Determine the reading of A when B reads 37.4°C	08	(3 : 1 : 1.7.1)
<u>Module-2</u>			
3.	a. Write similarities and dissimilarities between Work and Heat.	06	(1 : 2 : 1.6.1)
	b. Derive an expression for displacement work for following processes (i) Isobaric process (ii) Isothermal process	06	(2 : 2 : 1.6.1)
	c. A cylinder contains 1 kg of certain fluid at an initial pressure of 20 bar. The fluid is allowed to expand reversible behind a piston according to a law $PV^2 = C$ until the volume is doubled, the fluid is then cooled reversibly at const pressure until the piston regains its original positions, heat is then supply reversibly with the piston firmly locked in position until the pressure rises to original value. Calculate the net work done by the fluid for an initial volume of 0.05m ³ .	08	(3 : 2 : 1.7.1)
(OR)			
4.	a. Explain the first law for a closed system undergoing change of state.	04	(1 : 2 : 1.6.1)
	b. Define specific heat at constant pressure and constant volume also find their relationships for an ideal gas.	08	(1 : 2 : 1.6.1)

Note: (RBTL - Revised Bloom's Taxonomy Level: CO - Course Outcome: PI- Performance Indicator)

- c. A stationary mass of gas is compressed without friction from an initial state of 0.3 m^3 and 1.05 bar to a final state of 0.15 m^3 and 1.05 bar . There is a heat transfer of 37.6 kJ from the gas during a process? Find change in internal energy of a system. **08 (3 : 2 : 1.7.1)**

Module-3

5. a. State the Kelvin Planck and Clausius statement of second law of thermodynamics. **06 (1 : 3 : 1.6.1)**
 b. With a neat sketch, prove that $\text{COP}_{\text{HP}} = \text{COP}_{\text{Ref}} + 1$ **06 (2 : 3 : 1.6.1)**
 c. A reversible heat engine operates between two reservoirs at temperature of 600°C and 40°C . The engine drives a refrigerator which operates between reservoirs at temperature 40°C and -20°C . The heat transfer to the heat engine is 2000 kJ and network output of combined engine refrigerator plant is 360 kJ . Evaluate the heat transfer to the refrigerator and net heat transfer to the reservoir at 40°C . **08 (3 : 3 : 1.7.1)**

(OR)

6. a. State and prove Clausius of Inequality. **06 (1 : 3 : 1.6.1)**
 b. What do you mean by principle of increase of entropy? Derive the thermodynamic relations. **06 (1 : 3 : 1.6.1)**
 c. Find the entropy change of 5 kg of a perfect gas whose temperature varies from 150°C to 200°C during constant volume process. The specific heat varies linearly with absolute temperature and represented by the relation $C_v = 0.45 + 0.009T \text{ kJ/kgK}$. **08 (3 : 3 : 1.7.1)**

Module-4

7. a. Draw phase equilibrium diagram for water on P-T co-ordinates, explain triple point and critical point. **06 (1 : 4 : 1.6.1)**
 b. With a neat sketch explain throttling calorimeter to determine the dryness fraction of a steam. **06 (2 : 4 : 1.6.1)**
 c. Steam initially at 1.5 MPa and 300°C expands reversibly and adiabatically in a steam turbine to 40°C determine ideal work output of a turbine per kg of steam. **08 (3 : 4 : 1.7.1)**

(OR)

8. a. What do you mean by Irreversibility? What are the causes for Irreversibility? **08 (1 : 4 : 1.6.1)**
 b. Two kg of air at 5 bar , 80°C expands adiabatically in a closed system until its volume is doubled and its temperature becomes equal to that of the surroundings which is at 1 bar and 50°C . For this process determine (i) Maximum work (ii) Change in availability (iii) Irreversibility. **12 (3 : 4 : 1.7.1)**

Module-5

9. a. Define (i) Mass fraction (ii) Mole Fraction (iii) DBT (iv) WBT **08 (1 : 5 : 1.6.1)**
 b. A mixture of gases has the following volumetric composition: $\text{CO}_2=12\%$, $\text{O}_2=4\%$, $\text{N}_2=82\%$, $\text{CO}=2\%$. Calculate (i) The gravimetric composition (ii) Molecular weight of the mixture (iii) R for the mixture **12 (3 : 5 : 1.7.1)**

(OR)

10. a. Derive the Vander Waal's constants in terms of critical properties. **10 (2 : 5 : 1.6.1)**
 b. Determine the specific volume of hydrogen gas when its pressure is 60 bar and temperature is 100°K using (i) Compressibility chart (ii) Vander Waal's equation. **10 (3 : 5 : 1.7.1)**

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