*Basavarajeswari Group of Institutions*

# BALLARI INSTITUTE OF TECHNOLOGY & MANAGEMENT

(Autonomous Institute under Visvesvaraya Technological University, Belagavi)

| USN | | | | | | | | | | Course Code | 2 | 2 | M | E | 3 | 6 | 1 |
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Third Semester B.E. Degree Examinations, March/April 2024

## BASIC THERMODYNAMICS

**Duration: 3 hrs** **Max. Marks: 100**

***Note: 1. Answer any* FIVE *full questions choosing ONE full Question from each Module.***
***2. Thermodynamics Data Handbook is permitted***
***3. Missing data, if any, may be suitably assumed***

| *Q. No* | | *Question* | *Marks* | *(RBTL:CO:PI)* |
|---|---|---|---|---|
| | | **Module-1** | | |
| **1.** | **a.** | Define with an example (i) Open system (ii) Closed system (iii) Isolated system | **06** | (1 :1 : 1.6.1) |
| | **b.** | Differentiate between (i) Intensive and extensive properties (ii) Thermal and Mechanical equilibrium | **06** | (2 :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 found to be 1.83 and 6.78 at $0^oC$ and $100^oC$ respectively. Calculate the temperature for the values of K=2.42 | **08** | (3 :1 : 1.7.1) |
| | | **(OR)** | | |
| **2.** | **a.** | Differentiate between Microscopic and Macroscopic approach. | **06** | (2 :1 : 1.6.1) |
| | **b.** | Explain (i) Zeroth law of thermodynamics (ii) Constant volume gas thermometer | **06** | (2 :1 : 1.6.1) |
| | **c.** | The reading $T_A$ and $T_B$ of two Celsius thermometers A and B agree at the ice point and steam point, but else where they are related by the equation $T_A = L+mT_B+nT_B^2$ ,where L ,M and N are constants. When both the thermometer are immersed in a well stirred bath, A registers $51^oC$ whereas B registers $50^oC$.Determine the reading on B when A registers $25^oC$. | **08** | (3 :1 : 1.7.1) |
| | | **Module-2** | | |
| **3.** | **a.** | Write the similarities and dissimilarities between work and heat. | **06** | (1 :2 : 1.6.1) |
| | **b.** | With neat P-V diagram, derive an expression for work done in Polytropic process. | **06** | (3 :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 constant 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 0.05 $m^3$ | **08** | (3 :2 : 1.7.1) |
| | | **(OR)** | | |
| **4.** | **a.** | With neat sketch explain joule's paddle wheel experiment. | **06** | (2 :2 : 1.6.1) |
| | **b.** | Show that internal energy is the property of the system. | **06** | (2 :2 : 1.6.1) |

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

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| | **c.** | The work and heat transfer per degree temperature change for a system executes a steady non-flow process are given by $dw/dt = 200$ w-s/ $^oC$ and $= dQ/dt = 160$ J/ $^oC$. Determine the change in internal energy when the temperature increases from 55 $^oC$ to 95 $^oC$. | **08** | (3 :2 : 1.7.1) |

**Module-3**

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| **5.** | **a.** | Explain (i) **Kelvin Planck** statement of 2nd law of thermodynamics (ii) **Clausius** statement of 2nd law of thermodynamics | **06** | (2 :3 : 1.6.1) |
| | **b.** | State the limitations of 1st law of thermodynamics. Explain PMM II. | **06** | (2 :3 : 1.6.1) |
| | **c.** | An inventor claims that his engine has the following specification: Heating value of the fuel = 74,500 kJ/kg temperature limits 750°C and 25°C, Power developed 75 kW fuel burned is 0.065 kg/min state whether the claim is valid or not. | **08** | (3 :3 : 1.7.1) |

**(OR)**

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| **6.** | **a.** | With P-V diagram explain Clausius inequality. | **06** | (2 :3 : 1.6.1) |
| | **b.** | Explain the principle of measure of entropy. | **06** | (2 :3 : 1.6.1) |
| | **c.** | A lump of steel of mass 8 kg at 1000 K is dropped in 80 kg of oil at 300 K. Calculate the entropy change of steel the oil and the universe. Take specific heats of steel and oil as 0.5 KJ/kg K and 3.5 KJ /kg K respectively. | **08** | (3 :3 : 1.7.1) |

**Module-4**

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| **7.** | **a.** | Define (i) Pure substance (ii) Critical point (iii) Triple point | **06** | (1 :4 : 1.6.1) |
| | **b.** | With a neat sketch explain combined and separating Throttling calorimeter. | **06** | (2 :4 : 1.6.1) |
| | **c.** | Steam is initially at 1.5 MPa, 300 $^oC$ expands reversibly and adiabatically in a steam turbine to 40 $^oC$. Determine the ideal work output of the turbine per kg of steam. | **08** | (3 :4 : 1.7.1) |

**(OR)**

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| **8.** | **a.** | Explain briefly available and unavailable energy. | **06** | (2 :4 : 1.6.1) |
| | **b.** | Explain the concept of second law efficiency. | **06** | (2 :4 : 1.6.1) |
| | **c.** | 2.5 kg steam at 10 bar and 400 °C is cooled at constant pressure in a heat exchanger until it becomes saturated vapour. Find the available and unavailable parts of the energy from this steam. Assume the surroundings are at 27 °C. | **08** | (2 :4 : 1.7.1) |

**Module-5**

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| **9.** | **a.** | State and explain (i) Dalton law of additive pressure (ii) Amagat's law of additive volume | **06** | (2 :5 : 1.6.1) |
| | **b.** | Define (i) Mass fraction (ii) Mole fraction (iii) DBT | **06** | (1 :5 : 1.6.1) |
| | **c.** | A gas mixture contains 3 mole $O_2$, 5 mole of $N_2$ and 2 mole of $CO_2$. Determine (i) Mole fraction (ii) Mass fraction of each component (iii) Apparent molecular weight of mixture (iv) Apparent gas constant | **08** | (3 :5 : 1.7.1) |

**(OR)**

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| **10** | **a.** | Write a note on (i) Reduce properties (ii) Compressibility chart | **06** | (2 :5 : 1.6.1) |
| | **b.** | Differentiate between Ideal and Real gas | **06** | (2 :5 : 1.6.1) |
| | **c.** | Determine the pressure exerted by oxygen in a container of 2 $m^3$ capacity when it contains 5 kg at 27°C using (i) ideal gas equation and (ii) Van der Waals equation. | **08** | (3 :5 : 1.7.1) |

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