

**BALLARI INSTITUTE OF TECHNOLOGY & MANAGEMENT**

(Autonomous Institute under Visvesvaraya Technological University, Belagavi)

USN 

|  |  |  |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|--|--|

Course Code 

|   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|
| 2 | 2 | M | E | 4 | 6 | 1 |
|---|---|---|---|---|---|---|

Fourth Semester B.E. Degree Examinations, July 2026

**APPLIED THERMODYNAMICS**

Duration: 3 hrs

Max. Marks: 100

**Note:** 1. Answer any FIVE full questions choosing ONE full Question from each Module.

2. Use of Thermodynamic Data Handbook is permitted

3. Missing data, if any, may be suitably assumed

| <u>Q. No</u>           | <u>Question</u>                                                                                                                                                                                                                                                                                                                                            | <u>Marks</u> | <u>(RBTL:CO: PI)</u> |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|----------------------|
| <b><u>Module-1</u></b> |                                                                                                                                                                                                                                                                                                                                                            |              |                      |
| 1.                     | a. Derive expression for mean effective pressure in an air standard Otto cycle.                                                                                                                                                                                                                                                                            | 10           | (2 :1: 1.6.1)        |
|                        | b. Compression ratio of an air standard dual cycle is 8 air enters at 100 kPa and 300 K. The temperature of air at the end of constant pressure heat addition is 1300 K. The net heat transfer to the cycle is 480 kJ/kg. Determine (i) Heat added during constant volume (ii) Air standard efficiency of a cycle (iii) m.e.p                              | 10           | (3 :1: 1.7.1)        |
| <b>(OR)</b>            |                                                                                                                                                                                                                                                                                                                                                            |              |                      |
| 2.                     | a. What do you understand by heat balance sheet? Enumerate the importance of the same.                                                                                                                                                                                                                                                                     | 08           | (2 :1: 1.6.1)        |
|                        | b. A 4 - cylinder petrol engine has a rated output of 52 kW at 2000 RPM. A Morse test is carried out and the brake torque readings are 177, 170, 168 and 174 N-m respectively. For normal running at this speed, the BSFC is 0.25 kg/kW-hr and CV of fuel used is 42500 kJ/kg. Calculate (i) Mechanical efficiency (ii) Brake thermal efficiency           | 12           | (3 :1: 1.7.1)        |
| <b><u>Module-2</u></b> |                                                                                                                                                                                                                                                                                                                                                            |              |                      |
| 3.                     | a. Derive the expression for work ratio in terms of maximum and minimum temperature and pressure ratio for a simple gas turbine with p-v and T-s diagram.                                                                                                                                                                                                  | 10           | (2 :2: 1.6.1)        |
|                        | b. A gas turbine plant works between the temperature limits 300 K and 1000 K and a pressure of air rises from 1 bar to 16 bar. The compression is carried out in two stages with perfect inter cooling in between calculate the net power and thermal efficiency of the plant per Kg of air circulation (take $C_p = 1 \text{ kJ/kgK}$ , $\gamma = 1.4$ ). | 10           | (3 :2: 1.7.1)        |
| <b>(OR)</b>            |                                                                                                                                                                                                                                                                                                                                                            |              |                      |
| 4.                     | a. With a neat sketch explain rocket propulsion.                                                                                                                                                                                                                                                                                                           | 08           | (2 :2: 1.6.1)        |
|                        | b. In a regenerative gas turbine cycle air enters the compressor at 1 bar and 30°C pressure ratio is 6 isentropic efficiency of compressor and turbine are 80 % each, The maximum temperature in the cycle is 900°C if the regenerative efficiency is 0.75 find the percentage increase in the cycle efficiency due to regenerator.                        | 12           | (3 :2: 1.7.1)        |
| <b><u>Module-3</u></b> |                                                                                                                                                                                                                                                                                                                                                            |              |                      |
| 5.                     | a. What are the draw backs of Carnot vapor power cycle? With a neat sketch derive the expression for efficiency of Rankin cycle.                                                                                                                                                                                                                           | 10           | (2 :3: 1.6.1)        |

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

- b. In a single Regenerative vapour power cycle steam enters the Turbine at 30 bar and 400°C and exhaust pressure is 0.1 bar the feed water heater is direct contact type which operates at 5 bar determine (i) Cycle efficiency (ii) Increase in efficiency and steam flow rate as compared to the Rankin cycle without regeneration. Pump work may be neglected. **10 (3 :3: 1.7.1)**
- (OR)**
6. a. With the help of block diagram and T-S diagram explain the working of regenerative Rankin cycle for single feed water heater and derive the efficiency of the cycle. **10 (2 :3: 1.6.1)**
- b. A reheat cycle has the 1<sup>st</sup> stage supply conditions of 70 bar and 500°C reheat is at 3 bar and to same temperature (i) If the efficiency of first Turbine is 80 % how much energy is added per kg of steam in reheat coils (ii) If second Turbine has same efficiency what is thermal efficiency if the condenser pressure is 0.03 bar. **10 (3 :3: 1.7.1)**
- Module-4**
7. a. Explain the properties of a refrigerants. **06 (1 :4: 1.6.1)**
- b. Define (i) Refrigeration Effect (ii) Capacity of Refrigerator **04 (2 :4: 1.6.1)**
- c. A Refrigerator plant is required to produce 2.5 tons of ice /day at -4°C from water to 20°C. If the temperature range of compressor is between 25°C and -6°C calculate the power required to drive the compressor. Assume latent heat of ice 335 kJ/kg. Take  $C_{pice} = 2.1$  kJ/kg. **10 (3 :4: 1.7.1)**
- (OR)**
8. a. With a neat sketches, explain summer air conditioning and winter air conditioning. **10 (2:4: 1.6.1)**
- b. It is required to design an air conditioning plant for an office room with the following conditions. **10 (3 :4: 1.7.1)**
- Outdoor conditions: 14°C DBT and 10°C WBT  
 Required conditions: 20°C DBT and 60 % RH  
 Amount of air circulation = 0.3 m<sup>3</sup>/min/person  
 Seating capacity of the office is 60  
 Required condition is achieved first by heating and then by adiabatic humidifying. Determine (i) Heating capacity of coil in kW and surface temperature required if the by-pass factor of the coil is 0.4 (ii) The capacity of humidifier
- Module-5**
9. a. Derive the expression for volumetric efficiency in terms clearance ratio and pressure ratio. **10 (2 :5: 1.6.1)**
- b. A two stage air compressor delivers 1 m<sup>3</sup> of air per minute at a pressure of 14 bar the suction pressure and temperature are 1 bar and 20°C the index for compression in both the stages is 1.25 and the intermediate pressure is optimum calculate (i) Power required for the compression (ii) Heat carried away by the intercooler. **10 (3 :5: 1.7.1)**
- (OR)**
10. a. With a neat sketch, explain different types of Nozzles. What is the significance of critical pressure ratio? **10 (2 :5: 1.6.1)**
- b. Steam approaches a nozzle with a velocity of 250 m/s, 3.5 bar and dryness fraction 0.95. If the back pressure is 2 bar, assuming flow to be isentropic find the final condition of steam and drop in enthalpy. Also find exit velocity and area of nozzle if flow rate is 2700 kg/hr **10 (3 :5: 1.7.1)**

\*\* \*\* \*