QP Code:ME2T06-1 **(Pages: 3)**

Reg No : ..... Name : .....

MAR ATHANASIUS COLLEGE OF ENGINEERING, KOTHAMANGALAM

(Govt. Aided Autonomous Institution)

Fourth Semester B.Tech. Degree Examination, May, 2026

Course Code: B24ME2T06

Course Name: ENGINEERING THERMODYNAMICS

Max. Marks: 100 Duration:3 Hours

PART - A: 30 Marks (10 Qns x 3 Marks)

Answer all questions

1. What is the concept of continuum? How would you use this idea to define density? Describe with neat diagrams.
2. What is a thermocouple? What is its engineering application
3. State and explain the first law of thermodynamics for a closed system undergoing a cyclic process with the help of neat sketches.
4. Why does free expansion have zero work transfer?
5. What do you understand by the entropy principle?
6. Give the Kelvin-Planck and Clausius statements of second law of thermodynamics.
7. Define dryness fraction. Draw the *p-v-T* surface of a substance that contracts on freezing.
8. Show that the internal energy of an ideal gas is a function of temperature.
9. Explain the working principle of the Ideal Brayton Cycle
10. Briefly explain the effect of boiler pressure on Rankine cycle efficiency.

PART - B: 70 Marks (5 Qns x 14 Marks)

Answer any One full question from each module.

Module 1

11. a) Define the following terms associated with a thermodynamic system: (i) Properties, (ii) State, (iii) Path, (iv) Process, (v) Cycle, (vi) Intensive property (give at least one example), (vii) Extensive property (give at least one example). (8 Marks)

b) List any 6 applications of thermodynamics. Explain any two in detail. (6 Marks)

OR

12. a) (i) What do you mean by thermodynamic equilibrium of a system?

(ii) Consider a system whose temperature is 18°C. Express this temperature in R, K, and °F. (7 Marks)

b) (i) The temperature t on a thermometric scale is defined in terms of a property K by the relation t=alnK+b, where a and b are constants. The values of K are found to be 1.83 and 6.78 at the ice point and the steam point, the temperatures of which are assigned the numbers 0 and 100, respectively. Determine the temperature corresponding to a reading of K equal to 2.42 on the thermometer.

(ii) What is the working principle of a constant volume gas thermometer? Explain with neat sketches. (7 Marks)

Module 2

13. a) Define the specific heats at constant volume and constant pressure. Show $Q_v=\Delta u$ and $Q_p=\Delta h_p$. (7 Marks)

b) Air flows steadily at the rate of 0.5 kg/s through an air compressor, entering with a velocity 7 m/s , pressure 100 kPa , and specific volume 0.95 m^3/kg . The corresponding values at the exit are 5 m/s , 700 kPa , and 0.19 m^3/kg respectively. The internal energy of the air leaving is 90 kJ/kg greater than that of the air entering. Cooling water in the compressor jackets absorbs heat from the air at the rate of 58 kW . (a) Compute the rate of shaft work input to the air in kW. (b) Find the ratio of the inlet pipe diameter to outlet pipe diameter. (7 Marks)

OR

14. a) Derive steady flow energy equation. (6 Marks)

b) A turbo compressor delivers 2.33 m^3/s at 0.276 MPa , 43°C which is heated at this pressure to 430°C and finally expanded in a turbine which delivers 1860 kW . During the expansion, there is a heat transfer of 0.09 MJ/s to the surroundings. Calculate the turbine exhaust temperature if changes in kinetic and potential energy are negligible. (8 Marks)

Module 3

15. a) State and prove Clausius inequality. (8 Marks)

b) What is meant by (i) exergy (ii) dead state (iii) Unavailability. (6 Marks)

OR

16. a) Explain at least three different causes of irreversibility associated with a process. (6 Marks)

b) State and prove Carnot's theorem. (8 Marks)

Module 4

17. a) What are saturation states? Express the saturation states on h-s , T-h and T-s diagrams. (5 Marks)

b) A vessel of volume 0.04 m^3 contains a mixture of saturated water and saturated steam at a temperature of 250 °C . The mass of the liquid present is 9 kg . Find the pressure, mass, specific volume, enthalpy, entropy, and internal energy of the mixture. (9 Marks)

OR

18. a) What are reduced properties? State the law of corresponding states? (6 Marks)

b) Explain Van der Waals equation of state. How does it differ from the Ideal gas equation of state? (8 Marks)

Module 5

19. Derive Maxwell relations from relevant equations of the form $dz = Mdx + Ndy$. Also derive Clausius-Clapeyron equation from Maxwell relation. (14 Marks)

OR

20. a) Comment on the physical significance of Clausius-Clapeyron equation. (7 Marks)

b) Define Gibbs and Helmholtz function. Give its significance on chemical reaction. (7 Marks)

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