

**Indian Maritime University**  
**(A Central University, Govt of India)**  
**End Semester Examinations – December 2023**  
**Programme Name: B. Tech (Marine Engineering)**  
**Semester: II**  
**Subject Code: UG11T4205**  
**Subject Name: BASIC THERMODYNAMICS**

---

Date: 17.11.2023

Max Marks: 70

Duration: 03 Hrs

Pass Marks: 35

---

General Instructions

- (i) All Sections (A, B & C) are to be attempted.
- (ii) Options, if any, are specified in respective section.
- (iii) Usage of Steam and Thermodynamic Property Tables permitted

**Section A**

**Ten MCQs/Fill in the Blanks of 01 Mark each – Choose the correct answer as applicable.**

1. If the value of  $n$  is zero in the equation  $PV^n = C$ , then the process is called
  - (a) Constant volume process
  - (b) Constant pressure process
  - (c) Adiabatic process
  - (d) Isothermal process
2. Irreversibility of the process is equal to
  - (a)  $W_{\max} - W$
  - (b)  $W - W_{\max}$
  - (c)  $W_{\max}$
  - (d)  $W$
3. In a steady flow process, across the control volume mass and energy flow
  - (a) Varies continuously
  - (b) Remain constant
  - (c) Depends on control surface

- (d) Depends on type of process
4. Kelvin Planck law deals with
- (a) Conversion of work into heat
  - (b) Conversion of heat into work
  - (c) Conservation of work
  - (d) Conservation of heat
5. The internal energy of an ideal gas is function of
- (a) pressure only
  - (b) absolute temperature only
  - (c) pressure and volume
  - (d) pressure, volume and temperature
6. Which among the following is an extensive property?
- (a) Temperature
  - (b) Specific Enthalpy
  - (c) Pressure
  - (d) Entropy
7. If there is transfer of heat or shaft work during the flow-through confined passage problem; which equation will be applicable for such problems?
- (a) Bernoulli's Equation
  - (b) Euler's Equation
  - (c) Steady Flow Energy Equation
  - (d) Laplace Equation
8. The value of  $\oint dQ/T$  for an reversible cycle is
- (a) Equal to zero
  - (b) Greater than zero
  - (c) Less than zero
  - (d) Unity
9. For a given temperature  $T_1$  and  $T_2$ , as the difference  $T_1$  and  $T_2$  increases, the COP of a Carnot Heat Pump

- (a) Increases
  - (b) First increases, then decreases
  - (c) Does not change
  - (d) Decreases
10. During throttling process:
- (a) internal energy does not change
  - (b) pressure does not change
  - (c) enthalpy does not change
  - (d) volume does not change

### Section B

#### **Five Questions of 02 Marks each**

- 11. Write Vander Waals Equation of state and mention meaning of each term involved in it.
- 12. Define exergy and dead state
- 13. What is the difference between Critical Point and Triple Point?
- 14. Define point function and path function
- 15. Define the specific heats at Constant Pressure and Constant Volume

### Section C

#### **Seven Questions of 10 Marks each of which any 05 questions to be answered.**

- 16. a) A cyclic heat engine operates between a source temperature of  $1000^{\circ}\text{C}$  and a sink temperature of  $40^{\circ}\text{C}$ . Find the least rate of heat rejection per kW net output of engine. (6 marks)
- b) State Kelvin Planck and Clausius Statement of second law of thermodynamics (4 marks)
- 17. Derive the equation for pdV-Work in adiabatic process?
- 18. a) A heat engine receives heat from a source at  $1200\text{ K}$  at a rate of  $500\text{ kJ/s}$  and rejects waste heat to a medium at  $300\text{ K}$ . The power output of heat engine is  $180\text{ kW}$ . Determine the reversible power & the irreversibility rate for this process. (7 marks)

b) Describe Second-Law efficiency? (3 marks)

19. A vessel of volume  $0.03 \text{ m}^3$  contains a mixture of saturated water and saturated steam at a temperature of  $250^\circ\text{C}$ . The mass of the liquid present is  $10 \text{ kg}$ . Calculate the mass, the specific volume, the enthalpy, the entropy, and the internal energy.

At  $250^\circ\text{C}$ , take

$$p_{\text{sat}} = 3.973 \text{ MPa}$$

$$v_f = 0.0012512 \text{ m}^3/\text{kg}, v_g = 0.05013 \text{ m}^3/\text{kg}$$

$$h_f = 1085.36 \text{ kJ/kg}, h_{f,g} = 1716.2 \text{ kJ/kg}$$

$$s_f = 2.7927 \text{ kJ/kgK}, s_{f,g} = 3.2802 \text{ kJ/kgK}$$

(10 Marks)

20. a) Explain an adiabatic process (03 marks)  
b) What is Dryness Fraction? Does it have any meaning in the superheated vapour region? (03 marks)  
c) Explain the difference between Heat Engine and Heat Pump? (04 marks)

21. Two Carnot Engines A and B are connected in series between two thermal reservoirs. Engine A receives  $1600 \text{ kJ}$  of heat from the high temperature reservoir maintained at  $1200 \text{ K}$  and rejects heat to the Carnot engine B. Engine B takes in heat rejected by engine A and rejects heat to the low temperature reservoir maintained at  $200 \text{ K}$ . If engines A and B have equal thermal efficiencies, determine

- a. the heat rejected by engine B  
b. temperature at which heat is rejected by engine A  
c. Calculate the work done by engine A and B.

(10 Marks)

22. (a) In a gas turbine unit, the gases flow through the turbine is  $15 \text{ kg/s}$  and the power developed by the turbine is  $12000 \text{ kW}$ . The enthalpies of gases at the inlet and outlet are  $1260 \text{ kJ/kg}$  and  $400 \text{ kJ/kg}$  respectively, and the velocity of gases at the inlet and outlet are  $50 \text{ m/s}$  and  $110 \text{ m/s}$  respectively. Calculate:

(i) The rate at which heat is rejected to the turbine, and

(ii) The area of the inlet pipe given that the specific volume of the gases at the inlet is  $0.45 \text{ m}^3/\text{kg}$ . (4+2 marks)

(b) Derive steady flow energy Equation. Explain each term involved in it.

(4 marks)