

**Indian Maritime University**  
**(A Central University, Govt of India)**

**End Semester Examinations – December 2023**

**Programme Name: B. Tech (Marine Engineering)**

**Semester: II**

**Subject Code: UC11T4205**

**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) Remains constant
  - (c) Depends on control surface
4. (d) Depends on type of process  
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  $\oint \delta Q/T$  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°C and a sink temperature of 40°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 K at a rate of 500 kJ/s and rejects waste heat to a medium at 300 K. The power output of heat engine is 180 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 m<sup>3</sup> contains a mixture of saturated water and saturated steam at a temperature of 250°C. The mass of the liquid present is 10 kg. Calculate the mass, the specific volume, the enthalpy, the entropy, and the internal energy.  
At 250 °C, take

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

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

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

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

20. a) Explain an adiabatic process (03 marks) (10 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 kJ of heat from the high temperature reservoir maintained at 1200 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 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 kg/s and the power developed by the turbine is 12000 kW. The enthalpies of gases at the inlet and outlet are 1260 kJ/kg and 400 kJ/kg respectively, and the velocity of gases at the inlet and outlet are 50 m/s and 110 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 m<sup>3</sup>/kg. (4+2 marks)
- (b) Derive steady flow energy Equation. Explain each term involved in it. (4 marks)