

**Indian Maritime University**  
**(A Central University, Govt of India)**  
**Supplementary Examinations – September/October 2024**  
**Programme Name: B Tech (Marine Engineering)**  
**Semester: II**  
**Subject Code: UG11T4205**

Date: 19.09.2024	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

4. A Carnot cycle has following processes
  - (a) 4 reversible isotherms
  - (b) 4 reversible adiabatics
  - (c) 2 reversible isochoric and 2 reversible adiabatics
  - (d) 2 reversible isochoric and 2 reversible isobars
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. Consider The general energy equation for a closed system is
  - (a)  $Q = \Delta KE + \Delta PE - \Delta U + W$
  - (b)  $Q = \Delta KE + \Delta PE - \Delta U - W$
  - (c)  $Q = -\Delta KE - \Delta PE + \Delta U + W$
  - (d)  $Q = \Delta KE + \Delta PE + \Delta U + W$
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. Write 1st and 2nd T-ds relationships.
14. Define point function and path function
15. Define Heat Engine's Thermal Efficiency.

**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 Plank and Clausius Statement of second law of thermodynamics (4 marks)
17. Derive the equation for p dV-Work in adiabatic process? (10 Marks)
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  
 $p_{sat} = 3.973 \text{ MPa}$   
 $v_f = 0.0012512 \text{ m}^3/\text{kg}$ ,  $v_g = 0.05013 \text{ m}^3/\text{kg}$   
 $h_f = 1085.36 \text{ kJ/kg}$ ,  $h_g = 1716.2 \text{ kJ/kg}$   
 $s_f = 2.7927 \text{ kJ/kgK}$ ,  $s_g = 3.2802 \text{ kJ/kgK}$

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 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) Define specific heat  $c_p$  &  $c_v$ . Derive relation  $c_p = c_v + R$  using enthalpy.  
 (b) Steam at 0.4 MPa, 300°C, enters an adiabatic nozzle with a low velocity and leaves at 0.2 MPa with a quality of 90%. Sketch the diagram of the adiabatic nozzle & find the exit velocity. In m/s. Consider  $h_g@300^\circ\text{C} \& 0.4 \text{ MPa} = 3067.1 \text{ kJ/kg}$ ,  $h_f@0.2 \text{ MPa} = 220.16 \text{ kJ/kg}$  &  $h_g@0.2 \text{ MPa} = 2201.6 \text{ kJ/kg}$ . (4 + 6 marks)