

KATHMANDU UNIVERSITY
End Semester Examination [C]
November/December, 2023

Marks Scored:

Level : B.E./B.Tech.

Course : MEEG 207

Year : II

Semester : II

Exam Roll No. :

Time: 30 mins.

F. M. : 20

Registration No.:

Date 30 NOV 2023

SECTION "A"

[20 Q. × 1 = 20 marks]

Choose and encircle the most appropriate option.

- A closed thermodynamic system is one in which
 - there is no energy or mass transfer across the boundary
 - there is no mass transfer, but energy transfer exists
 - there is no energy transfer, but mass transfer exists
 - both energy and mass transfer take place across the boundary, but the mass transfer is controlled by valves
- Hot coffee stored in a well-insulated thermos flask is an example of
 - Isolated system
 - Closed system
 - Open system
 - Non-flow diabatic system
- Which one is the open thermodynamic system?
 - ice cream freezer
 - centrifugal pump
 - pressure cooker
 - storage battery
- The atmospheric pressures at the top and the bottom of a building are read by a barometer to be 96.0 and 98.0 kPa. If the density of air is 1.0 kg/m³, the height of the building is
 - 17 m
 - 20 m
 - 170 m
 - 204 m
- Two blocks which are at different states are brought into contact with each other and allowed to reach a final state of thermal equilibrium. The final temperature attained is specified by the
 - Zeroth law of thermodynamics
 - First law of thermodynamics
 - Second law of thermodynamics
 - Third law of thermodynamics
- Heat and work are
 - intensive properties
 - extensive properties
 - point function
 - path function
- The quality of a two-phase liquid–vapor mixture of H₂O at 40°C with a specific volume of 10 m³/kg is
 - 0
 - 0.486
 - 0.512
 - 1
- A 3-m³ rigid vessel contains steam at 2 MPa and 500°C. The mass of the steam is
 - 13 kg
 - 17 kg
 - 22 kg
 - 28 kg

9. A 3-m³ rigid tank contains nitrogen gas at 500 kPa and 300 K. Now heat is transferred to the nitrogen in the tank and the pressure of nitrogen rises to 800 kPa. The work done during this process is
 a. 500 kJ b. 1500 kJ c. 0 kJ d. 900 kJ
10. A 0.5-m³ cylinder contains nitrogen gas at 600 kPa and 300 K. Now the gas is compressed isothermally to a volume of 0.2 m³. The work done on the gas during this compression process is
 a. 82 kJ b. 180 kJ c. 240 kJ d. 275 kJ
11. Joule's law states that the specific internal energy of a gas depends only on
 a. the pressure of the gas b. the volume of the gas
 c. the temperature of the gas d. none of the above.
12. Heat transfer takes place according to
 a. Zeroth Law of Thermodynamics b. First Law of Thermodynamics
 c. Second Law of Thermodynamics d. Third Law of Thermodynamics
13. A heat engine is supplied with 250 KJ/s of heat at a constant fixed temperature of 227°C. The heat is rejected at 27°C. The cycle is reversible, if the amount of heat rejected is
 a. 273 KJ/s b. 200 KJ/s c. 180 KJ/s d. 150 KJ/s
14. An Otto cycle with air as the working fluid has a compression ratio of 10.4. Under cold-air-standard conditions, the thermal efficiency of this cycle is
 a. 10 percent b. 39 percent c. 61 percent d. 79 percent
15. A refrigerator removes heat from a refrigerated space at 0°C at a rate of 1.5 kJ/s and rejects it to an environment at 20°C. The minimum required power input is
 a. 102 W b. 110 W c. 140 W d. 150 W
16. Increase in entropy of a system represents
 a. increase in availability of energy b. increase in temperature
 c. decrease in pressure d. degradation of energy
17. Which of the following refers to stored energy?
 a. heat b. work c. internal energy d. none of these
18. In an ideal Brayton cycle, air is compressed from 95 kPa and 25°C to 1100 kPa. Under cold air standard conditions, the thermal efficiency of this cycle is
 a. 45% b. 50% c. 62% d. 73%
19. Thermodynamic work is the product of
 a. two intensive properties
 b. two extensive properties
 c. an intensive property and change in an extensive property
 d. an extensive property and change in an intensive property
20. A fluid flowing along a pipe line undergoes a throttling process from 10 bar to 1 bar in passing through a partially open valve. Before throttling, the specific volume of the fluid is 0.5 m³ /kg and after throttling is 2.0 m³ /kg. What is the Change in specific internal energy during the throttling process?
 a. 0 b. 100 kJ/kg c. 200 kJ/kg d. 300 kJ/kg

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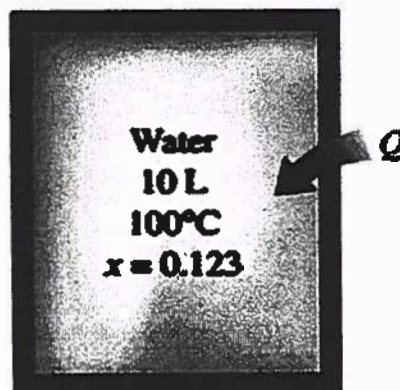
Level : B.E./B.Tech.
Year : II
Time : 2 hrs. 30 mins.

Course : MEEG 207
Semester : II
F. M. : 55

SECTION "B"

Attempt ALL the questions. Assume suitable data if necessary. Steam tables are allowed.

1. a. Describe thermodynamic system along with its various types. [3]
b. State and Explain Zeroth law of thermodynamics. [3]
2. a. What is total energy? Identify the different forms of energy that constitute the total energy. [2]
b. Define critical point, quality or dryness fraction of steam, saturation temperature and saturation pressure. [3]
3. a. Draw and explain T-v diagram of water. [3]
b. Steam initially at 0.3 MPa, 250°C is cooled at constant volume. [5]
At what temperature will the steam become saturated vapor?
What is the quality at 80°C?
What is the heat transferred per kg of steam in cooling from 250°C to 80°C?
4. a. What is the thermodynamic definition of work? State the sign convention used in thermodynamics for energy transfer by work for a closed system. [2]
b. A rigid 10-L vessel initially contains a mixture of liquid water and vapor at 100°C with 12.3 percent quality. The mixture is then heated until its temperature is 150°C. Calculate the heat transfer required for this process. [5]



- c. Steam enters a converging-diverging nozzle operating at steady state with $p_1 = 40$ bar, $T_1 = 400^\circ\text{C}$, and a velocity of 10 m/s. The steam flows through the nozzle with negligible heat transfer and no significant change in potential energy. At the exit, $p_2 = 15$ bar, and the velocity is 665 m/s. The mass flow rate is 2 kg/s. Determine the exit area of the nozzle, in m^2 . [5]

5. a. State and explain the Clausius statement of the second law of thermodynamics. [3]
- b. The entropy of a hot baked potato decreases as it cools. Is this a violation of the increase of entropy principle? Explain. [3]
- c. A heat engine receives a heat-transfer rate of 1 MW at a high temperature of 550°C and rejects energy to the ambient surroundings at 300 K. Work is produced at a rate of 450 kW. We would like to know how much energy is discarded to the ambient surroundings and the engine efficiency and compare both of these to a Carnot heat engine operating between the same two reservoirs. [4]
6. a. Explain a vapour compression refrigeration cycle using T-S and P-h diagrams. [3]
- b. What is the difference between spark-ignition and compression-ignition engines? [3]

OR

- Derive an expression for air standard efficiency of Brayton cycle. [3]
- c. In a Rankine cycle steam leaves the boiler and enters the turbine at 4 MPa, 400°C. The condenser pressure is 10 kPa. Determine the cycle efficiency. [4]
7. Write short notes on (*ANY TWO*): [4]
- a. Displacement work
- b. Joule's law
- c. Isentropic efficiency of turbines and compressors