DR. BABASAHEB AMBEDKAR TECHNOLOGICAL UNIVERSITY, LONERE

Bachelor of Technology (Mechanical Engineering) SEMESTER - 3 Winter 2025 (Regular)

Course :Bachelor of Technology (Mechanical Engineering) Branch : Engineering and Technology

Semester : SEMESTER - 3

Subject Code & Name: 25AF1612PC303 - THERMODYNAMICS

Time : 3 Hours] **[Total Marks : 60**

Instructions to the Students:

1.Each question carries 12 marks.

2.Question No. 1 will be compulsory and include objective-type questions.

3.Candidates are required to attempt any four questions from Question No. 2 to Question No.6

4.Use of non-programmable scientific calculators is allowed.

5.Assume suitable data wherever necessary and mention it clearly.

Q1. Objective type questions. (Compulsory Question) 12

1 During a quasi-static process, the system:
a) is far from equilibrium at all times
b) passes through a sequence of equilibrium states
c) Exchanges heat only
d) Cannot do work

2 The zeroth law of thermodynamics is mainly used to:
a) Measure energy
b) Establish temperature scales
c) Measure work
d) Calculate heat transfer

3 If 100 kJ of work is done on a system and 60 kJ of heat is lost, what is the net change in internal energy?
a) +160 kJ
b) +40 kJ
c) -40 kJ
d) -160 kJ

4 In a nozzle, which energy component is usually neglected?
a) Kinetic energy
b) Potential energy
c) Enthalpy
d) Internal energy

5 Entropy of a system decreases when:
a) Work is done irreversibly on the system
b) Heat is added reversibly
c) A spontaneous process occurs
d) Heat is transferred reversibly from low to high temperature

6 The Carnot cycle consists of:
a) Two adiabatic and two isothermal processes
b) Two isobaric and two isochoric processes
c) Two adiabatic and two isobaric processes
d) Two isothermal and two isobaric processes

7 Clausius inequality is valid for:
a) Reversible processes only
b) Irreversible processes only
c) Both reversible and irreversible processes
d) Adiabatic processes only

8 A gas follows the process PV^n=Constant with n=1. This process is:
a) Isothermal
b) Isobaric
c) Isochoric
d) Adiabatic

9 For an ideal gas, which of the following is true for internal energy?
a) Depends on pressure and volume only
b) Depends on temperature only
c) Depends on enthalpy only
d) Depends on volume only

10 Dryness fraction of 0.75 indicates:
a) 75% of mass is liquid
b) 25% of mass is vapor
c) 75% of mass is vapor
d) Saturated liquid

11 In a Mollier diagram (h-s), the slope of the line indicates:
a) Pressure
b) Temperature
c) Saturation fraction
d) Work done

12 Universal gas constant R has a value of:
a) 0.287 kJ/kg·K
b) 8.314 kJ/kmol·K
c) 287 J/kg.K
d) 4.18 kJ/kg·K

Q2. Solve the following.

A) Differentiate between the following with suitable examples: 6
a) Control Mass and Control Volume
b) Microscopic approach and Macroscopic approach
c) Path function and Point function

B) Explain quasi-static process and justify why work and heat are path functions while properties are point functions. 6

Q3. Solve the following.

A) State and explain the First Law of Thermodynamics for a closed system. Derive the expression for a system undergoing a cycle. 6

B) Air enters a nozzle at 300 kPa, 500 K, with a velocity of 50 m/s, and leaves at 100 kPa with a velocity of 350 m/s. The mass flow rate is 0.4 kg/s. Neglect heat transfer. Calculate the change in enthalpy of air across the nozzle. 6

Q4. Solve Any Two of the following.

A) Explain the equivalence of Kelvin-Planck and Clausius statements using a schematic heat engine and refrigerator arrangement. 6

B) Two reversible heat engines M and N are arranged in series. Engine M receives 250 kJ from a source at 450°C and rejects heat to engine N. Engine N then rejects heat to a cold sink at 27°C. If the work output of engine M is twice that of engine N, find: 6
a) The intermediate temperature between the two engines
b) The efficiency of each engine
c) The heat rejected to the cold sink

C) State the entropy principal and explain the entropy balance with proper illustration. Also define the concept of entropy generation. 6

Q5. Solve Any Two of the following.

A) Derive the expression for maximum available work (availability) for a closed system. 6

B) Air in a closed system expands reversibly from 0.2 m^3 to 0.8 m^3 along $PV^{1.35}$=constant. The initial pressure = 150 kPa, temperature = 80°C. Calculate: 6
a) Final pressure and temperature
b) Work done
c) Change in entropy

C) A mass of 1 kg of air initially at 4 bar and 120°C undergoes a cycle consisting of constant pressure expansion until the volume triples, constant volume cooling, reversible adiabatic compression to the initial state. Determine net work done in the cycle. 6

Q6. Solve Any Two of the following.

A) Draw and explain a T-S diagram representing the heating of ice at -10°C to water at 100°C and further to steam at 250°C. Include all phase change lines and indicate the sensible and latent heat portions. 6

B) The pressure of steam in a boiler is 1.5 MPa. The specific volume of the steam is 0.1 m^3/kg. Find: 6
a) Enthalpy
b) Entropy
c) Determine if the steam is saturated or superheated

C) Explain dryness fraction with its significance in turbine performance and describe any one method of its measurement. 6

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