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3E1413

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B. Tech. (Sem.III) (Main/Back) Examination, January - 2009
(3ME3) Engineering Thermodynamics (Mechanical Engg.)
(3PI3) Engineering Thermodynamics (Prod. & Indus. Engg.)
(3AE3) Engineering Thermodynamics (Automobile Engg.)

Time : 3 Hours] [Total Marks : 80

[Min. Passing Marks : 24

Attempt five questions in all. Schematic diagrams must be shown wherever necessary. Any data you feel missing may suitably be assumed and stated clearly.

Use of following supporting material is permitted during examination. *(Mentioned in form No. 205)*

1. STEAM TABLE 2. MOLLIER CHART

1 (a) Define the following thermodynamic terms with suitable examples :
   (i) System
   (ii) Properties
   (iii) Process
   (iv) Cycle.

2+2+2+2

(b) What is temperature scale ? How is temperature scale established ? Explain standard fixed point in thermometry.

3+3+2

OR

1 What is a pure substance ? Draw phase equilibrium diagram of water on P-V coordinates and define the different saturation states, critical point and triple point.

2+4+6+2+2

2 Air enters a heat exchanger at 15°C temperature, 30 m/s velocity and is heated to 800°C. It then enters a turbine with 30 m/s velocity and expands until the temperature falls to 650°C. On

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leaving the turbine, the air is taken at a velocity of 60 m/s to a nozzle where it expands until the temperature has fallen to 500°C. If mass flow rate is 2 kg/s, Calculate :

(a) Heat transfer rate in heat exchanger

(b) Power developed by the turbine

(c) Exit velocity from the nozzle.

Assume $C_p = 1.005\ kJ/kg-K$

5+5+6

OR

2 (a) Prove that maximum work obtainable from two finite heat reservoirs is given by

$$W_{max} = C_p\left(\sqrt{T_1} - \sqrt{T_2}\right)^2$$

where $C_p \rightarrow$ Heat capacities of reservoirs

$T_1 \rightarrow$ Higher temperature

$T_2 \rightarrow$ Lower temperature.

8

(b) Determine entropy change of the universe, when 1 kg of ice at –5°C is exposed to the atmosphere which is at 20°C.

Assume $C_{p_{ice}} = 2.093\ kJ/kg-K$, $C_{p_{water}} = 4.187 \dfrac{kJ}{kg-K}$ and latent heat of fusion is 333.3 kJ/kg.

8

3 What is available and unavailable energy ? Show that there is decrease in available energy when heat is transferred through a finite temperature difference. Explain the concept of quality of energy.

2+2+8+4

OR

3 (a) Derive first and second Tds equation.

8

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(b) Prove that $C_p - C_v = -T\left(\frac{\partial V}{\partial T}\right)_p^2 \left(\frac{\partial P}{\partial V}\right)_T$ .....

What are important facts which can be deduced from the expression ?

6+2

4 In an air standard diesel cycle, the compression ratio is '16' and at the beginning of isentropic compression, the temperature is 15°C and the pressure is 0.1 MPa. Heat is added until the temperature at the end of the constant pressure process is 1480°C. Calculate :

(a) Cut off ratio
(b) Heat supplied per kg of air
(c) Cycle efficiency
(d) Mean effective pressure.

4×4

OR

4 (a) Draw Atkinson cycle on P-V and T-S diagram and derive an expression for cycle efficiency.

3+7

(b) Explain the working of two stroke petrol engine.

6

5 Steam at 0.8 MPa, 250°C and with 1 kg/s flow rate, mixes with another stream of steam at 0.8 MPa, 0.95 dry. Total flow rate is 2.3 kg/s, calculate final temperature and entropy of the steam. If the steam is now expanded in a nozzle isentropically to a pressure of 0.4 MPa, determine the final velocity at exit.

8+8

OR

5 In a single heater regenerative cycle, steam inlet to turbine is 30 bar, 400°C. Exhaust pressure is 0.10 bar. Feed water heater works at 5 bar. Find the cycle efficiency, steam rate and increase in mean temperature of heat addition.

5+5+6

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(b) Prove that $C_p - C_v = $ [illegible]

What are important facts which can be deduced from the expression ?

6+5

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(b) Heat supplied per kg of air
(c) Cycle efficiency
(d) Mean effective pressure

4×4

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