CBCS SCHEME

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18AE/AS32

Third Semester B.E. Degree Examination, Jan./Feb. 2023
Aerothermodynamics

Time: 3 hrs. Max. Marks: 100

Note: *1. Answer any FIVE full questions, choosing ONE full question from each module.*
2. Use of thermodynamics data hand book is permitted.

Module-1

1 a. What is thermodynamic system? Explain the types of thermodynamic systems. **(05 Marks)**

b. What is Quasi – Static Process? Explain with a neat diagram. **(05 Marks)**

c. A thermometric property X(length of mercury column) is equal to 7.5cm and 52.5cm at ice point and steam point respectively. If a temperature scale is defined by equation $T = a + bx^2$, where t = 32 and 212 at ice point and steam point, find 't' on this scale, when the temperature is 100° on the Fahrenheit scale. **(10 Marks)**

OR

2 a. What are the difference between work and heat? **(05 Marks)**

b. Prove that work is a path function. **(05 Marks)**

c. In a two part process, a gas expands from $0.1m^3$ to $0.2m^3$ at a constant pressure of 150KPa, followed by an expansion from $0.2m^3$ to $0.4m^3$ with linearly increasing pressure from 150KPa, followed by an expansion from $0.2m^3$ to 0.4m with linearly increasing pressure from 150KPa to 300KPa. Sketch the process on P-V diagram and find the total work done. **(10 Marks)**

Module-2

3 a. Explain Joules experiment with a neat sketch. **(10 Marks)**

b. Prove that internal energy is a property of the system. **(10 Marks)**

OR

4 a. Write the steady flow energy equation for an open system and explain the terms involved in it. Simplify SFEE for the following systems. i) Steam turbine ii) Nozzle. **(10 Marks)**

b. A gas Flowing through a compressor enters at 100KPa, 16°C, 392 kJ/kg and leaves at 0.6MPa, 245°C, 535kJ/kg. There is no heat transfer. Determine :
i) Work supplied neglecting kinetic energy and potential energy
ii) Work supplied, if the velocities at inlet and exit are 80m/s and 60m/s. **(10 Marks)**

Module-3

5 a. State Kelvin plank and Clausius statements of second law of thermodynamics and show that they are equivalent. **(08 Marks)**

b. A reversible refrigerator operates between 35°C and –15°C. If heat rejected to 35°C is 15KW, determine the rate at which heat is leaking into refrigerator. **(08 Marks)**

c. Represent schematically and give performance equation for :
i) Heat engine
ii) Refrigerator
iii) Heat pump
Prove that $(COP)_{HE} = (COP)_R + 1$. **(04 Marks)**

OR

6 a. Define Clausius inequality and entropy of a system. Show that for an irreversible process, $ds \geq \frac{\delta Q}{T}$. **(10 Marks)**

b. Prove that entropy is a property of the system. **(05 Marks)**

c. One kg of water at 273K is heated to 373K by first bringing it in contact with reservoir at 323K and then reservoir at 373K. What is the change in entropy of the universe? **(05 Marks)**

Module-4

7 a. Define :
i) Critical point
ii) Triple point
iii) Dryness fraction
iv) Pure substance
v) Latent heat. **(10 Marks)**

b. Derive Vander Waal's constants interms of critical properties. **(10 Marks)**

OR

8 a. A rigid vessel of volume $0.3m^3$ contains 10kg of air at 300K. Determine the pressure that would be exerted by air on the vessel, using :
i) Perfect gas equation
ii) Vander Waal's equation.
Take for air, R = 287.1J/kg.K, Molecular weight = 28.97, Vander Waal's constants, $a = 135.8kN\ m^4/(kg.mol)^2$, $b = 0.0365m^3/kg.mol$. **(10 Marks)**

b. $0.1m^3$ of air at 5MPa, 356° contained in a cylinder expands reversibly and isothermally to 0.25MPa. Calculate for air :
i) Work transfer
ii) Heat transfer
iii) Change in entropy
Assuming that air behaves as an ideal gas with R = 287J/kg.K. **(10 Marks)**

Module-5

9 a. With the help of a schematic diagram and T – S diagram, explain the working of a regenerative vapour power cycle and derive an expression for its overall efficiency. **(10 Marks)**

b. With the help of a P – V and T – S diagram, formulate an expression for the air standard efficiency of an Otto cycle. **(10 Marks)**

OR

10 a. Sketch the flow diagram and corresponding T – S diagram of a reheat vapour cycle and derive an expression for reheat cycle efficiency. **(10 Marks)**

b. Steam enters the turbine of a steam power plant, operating on Rankine cycle, at 10 bar, 300°C. The condenser pressure is 0.1 bar. Steam leaving the turbine is 90% dry. Calculate the adiabatic efficiency of the turbine and also the cycle efficiency neglecting pump work. **(10 Marks)**

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