CBCS SCHEME

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21ME34

Third Semester B.E. Degree Examination, Dec.2023/Jan.2024
Thermodynamics

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. Steam tables may be permitted.

Module-1

1 a. What is meant by thermometric property? Elucidate with a neat sketch of thermocouple type and vapor pressure thermometers. **(10 Marks)**

b. Define a thermodynamic system. Differentiate between open system, closed system and an isolated system. **(06 Marks)**

c. Explain the following terms : i) State ii) Process iii) Cycle. **(04 Marks)**

OR

2 a. A fluid is contained in a cylinder by a spring loaded, friction less piston so that the pressure in the fluid is a linear function of the volume (p = a + bv). The internal energy of the fluid is given by the following equation: U = 42 + 3.6pV, where U is in kJ, P in kPa and V in cubic metre. If the fluid changes from an initial state of 190kPa, 0.035m^3 to a final state of 420 kPa, 0.07m^3, with no work other than that done on the piston. Find the direction and magnitude of the work and heat transfer. **(10 Marks)**

b. State and explicate the Steady Flow Energy Equations (S.F.E.E) with engineering applications. **(06 Marks)**

c. In an internal combustion engine, during the compression stroke the heat rejected to the cooling water is 50kJ/kg and the work input is 100kJ/kg. Calculate the change in internal energy of the working fluid stating whether it is a gain or loss. **(04 Marks)**

Module-2

3 a. Describe the working of a carnot cycle with a P-V diagram. **(10 Marks)**

b. Enumerate the Clausius inequality with a layout diagram. **(06 Marks)**

c. Define heat engine, refrigerator and heat pump. **(04 Marks)**

OR

4 a. A reversible heat engine operates between two reservoirs at temperature 727°C and 27°C, the engine drives a reversible refrigerator which working between reservoirs at temperature of 27°C and -20°C. The heat absorbed by engine is 2600kJ and the net work output of combined engine refrigerator plant is 500kJ. Determine the heat transfer to the refrigerant and the net heat transfer to the reservoir at 27°C. **(10 Marks)**

b. Define:
i) PMM I
ii) PMM II
iii) Thermal Energy Reservoirs (TET)
iv) Available energy and unavailable energy. **(06 Marks)**

c. What do you mean by the term 'Entropy'? Prove that entropy is a property of a system. **(04 Marks)**

Module-3

5 a. Derive the Maxwell's relations and explain their importance in thermodynamics. **(10 Marks)**

b. Brief about the Clausius-Clapeyron equation for evaporation of liquids. **(06 Marks)**

c. Explicate the Joule Kelvin effect and its significance in engineering applications. **(04 Marks)**

OR

6 a. With a neat sketch, expound the flue gas analysis apparatus. (Orsat apparatus). **(10 Marks)**

b. Dry exhaust gases from an oil engine have the following composition by volume carbon dioxide 8.85%, carbon monoxide 1.2%, oxygen 6.8% and nitrogen 83.15%. The fuel oil has a percentage composition of mass as carbon 82%, hydrogen 14% and oxygen 2%. Determine : i) Mass of carbon per kg of flue gas ii) Air fuel ratio. **(06 Marks)**

c. Define compressibility factor, compressibility chart and its applications. **(04 Marks)**

Module-4

7 a. A vessel having a capacity of $0.05m^3$ contains a mixture of saturated water and saturated steam at a temperature of 245°C. The mass of liquid present is 10kg.
Find the following:
i) The pressure
ii) The mass
iii) The specific volume
iv) The specific enthalpy
v) The specific entropy
vi) The specific internal energy. **(10 Marks)**

b. What amount of heat would be required to produce 4.4kg of steam at a pressure of 6 bar and temperature of 250°C from water at 30°C? Take specific heat for super heated steam as 2.2kJ/kg K. **(06 Marks)**

c. Brief about
i) Triple point and critical point
ii) Mollier chart. **(04 Marks)**

OR

8 a. A steam turbine is fed with steam having an enthalpy of 3100kJ/kg. It moves out of the turbine with an enthalpy of 2100kJ/kg. Feed heating is done at a pressure of 3.2 bar with steam enthalpy of 2500kJ/kg. The condensate from a condenser with an enthalpy of 125kJ/kg enters into the feed heater. The quantity of bled steam is 11200 kg/h. Find the power developed by turbine. Assume that the water leaving the feed heater is saturated liquid at 3.2 bar and the heater is direct mixing type neglect pump work. **(10 Marks)**

b. In a steam power cycle, the steam supply is at 15 bar and dry saturated. The condenser pressure is 0.4 bar. Calculate the carnot and ranking efficiencies of the cycle. Neglect pump work. **(06 Marks)**

c. State the advantages of regenerative cycle and reheat cycle over the simple ranking cycle. **(04 Marks)**

Module-5

9 a. Derive the Otto cycle with P-V diagram and compare with diesel and duel cycle efficiency and compression ratio. **(10 Marks)**

b. The minimum pressure and temperature in an Otto cycle are 100kPa and 27°C. The amount of heat added to the air per cycle is 1500kJ/kg.

i) Determine the pressures and temperatures at all points of the air standard otto cycle.

ii) Also calculate the specific work and thermal efficiency of the cycle for a compression ratio of 8:1.

Take for air : $C_V = 0.72$kJ/kg K, and $\gamma = 1.4$. **(06 Marks)**

c. Brief about the Ericsson cycle with applications. **(04 Marks)**

OR

10 a. Explicate briefly about the Brayton cycle. Derive expression for optimum pressure ratio. **(10 Marks)**

b. In a gas turbine power plant, the air enters the compressor at 1.0 bar and 20°C. The pressure of air leaving the compressor is 3.5 bar and the temperature at turbine inlet is 600°C. Determine per kg of air:

i) Efficiency of the cycle

ii) Heat supplied to air

iii) Work available at the shaft. **(06 Marks)**

c. What are the methods for improvement of thermal efficiency of Brayton cycle and explain any one method. **(04 Marks)**

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