CBCS SCHEME

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21ME34

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

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. State zero[th] law of thermodynamics. Explain its significance. **(06 Marks)**

b. What are the similarities and dissimilarities between work transfer and heat transfer? **(06 Marks)**

c. A cylinder contains 1 kg of a certain fluid at an initial pressure of 20 bar. The fluid is allowed to expand reversibly behind a piston according to a law PV^2 = constant until the volume is doubled. The fluid is then cooled reversibly at constant pressure until the piston regains its original position heat is then supplied reversibly with the piston firmly locked in position until the pressure rises to the original value of 20 bar. Calculate the net work done by the fluid for an initial volume of 0.05 m^3 and draw a neat PV diagram. **(08 Marks)**

OR

2 a. Define Heat and Work from thermodynamic point of view. **(06 Marks)**

b. A temperature scale of certain thermometer is given by the relation $t = a\ln p + b$ where a and b are constants and p is the thermometric property of the fluid in the thermometer. If at the ice point and steam point the thermometric properties are found to be 1.5 and 7.5 respectively. What will be the temperature corresponding to the thermometric property of 3.5 on Celsius scale. **(06 Marks)**

c. Apply steady flow energy equation to each of the following:
(i) Nozzle (ii) Boiler (iii) Turbine (iv) Pump **(08 Marks)**

Module-2

3 a. Prove that Kelvin-Plank statement and Clausius statements of second law of thermodynamic are equivalent. **(10 Marks)**

b. Two reversible heat engines A and B are arranged in series, A rejecting heat to B through the intermediate reservoir. Engine A receives 2000 kJ at a temperature of 421°C from a heat source, while engine B is in communication with a cold sink at a temperature of 4.4°C. If work output of A is twice that of B. Find :
(i) The intermediate temperature between A and B
(ii) Efficiency of each engine
(iii) The heat rejected to the cold sink **(10 Marks)**

OR

4 a. State and explain the Carnot cycle with PV and TS diagram. **(06 Marks)**

b. Obtain a relation between COP's of a refrigerator and heat pump. **(04 Marks)**

c. Define entropy. State and prove Clausius inequality. **(10 Marks)**

Module-3

5 a. Explain the following:
(i) Generalized compressibility chart
(ii) Law of corresponding states
(iii) Compressibility factor **(10 Marks)**

b. One kg of CO_2 has a volume of 1 m^3 at 100°C. compute the pressure by:
(i) Vander Waal's equation (ii) Perfect gas equation **(10 Marks)**

OR

6 a. Explain the following terms with reference to a combustion process:
(i) Enthalpy of formation (ii) Adiabatic flame temperature
(iii) Enthalpy of combustion (iv) Heat of reaction **(08 Marks)**

b. Methane is burned with atmospheric air. The analysis of the products on a dry basis is as follows: $CO_2 = 10\%$, $O_2 = 2.37\%$, $CO = 0.53\%$, $N_2 = 87.10\%$
(i) Determine the combustion equation
(ii) Calculate the air-fuel ratio
(iii) Percentage theoretical air **(08 Marks)**

c. Write Maxwell relations and explain the terms involved. **(04 Marks)**

Module-4

7 a. Explain P-T diagram for water. **(06 Marks)**

b. Explain the working of a practical regenerative Rankine cycle and derive the efficiency of the cycle. **(08 Marks)**

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

OR

8 a. Explain reheat vapour cycle and derive an expression for the reheat cycle efficiency, state the advantages. **(10 Marks)**

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

Module-5

9 a. Derive the expression for the air standard efficiency of a diesel cycle. State the assumptions made. **(10 Marks)**

b. Explain the different methods of improving the efficiency of Brayton cycle. **(10 Marks)**

OR

10 a. Air enters the compressor of a gas turbine plant operating on Brayton cycle at 101.325 kPa, 27°C. The pressure ratio in the cycle is 6. Calculate the max temperature in the cycle and the cycle efficiency. Assume $W_T = 2.5\ W_C$, where W_T = turbine work, W_C = compressor work. Take Y = 1.4. **(10 Marks)**

b. Derive the expression for M.E.P of Otto cycle. **(10 Marks)**

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