Total No. of Questions : 8]

SEAT No. :

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S.E. (Mechanical Sandwich) (Automobile & Mechanical Engg.)

ENGINEERING THERMODYNAMICS

(2019 Pattern) (Semester- III) (202043)

Time : 2½ Hours] *[Max. Marks : 70*

Instructions to the candidates:

1) ***Answer Q.1 or Q.2, Q.3 or Q.4, Q.5 or Q.6, Q.7 or Q.8.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right side indicate full marks.***
4) ***Assume suitable data if necessary.***
5) ***Use of electronic calculator is allowed.***
6) ***Use of steam table is allowed.***

Q1) a) Define: **[4]**

i) Dead State

ii) Exergy

b) The metal block of 5 kg in mass with specific heat 0.4 kJ/kgK at temperature 450 K is thrown in a water tank at temperature 20°C. Calculate the change in entropy of the universe. **[8]**

c) State and prove the Principle of Increase of Entropy. **[5]**

OR

Q2) a) Show that entropy is property of the system. **[5]**

b) A heat engine receives 600 kJ of heat from a high temperature reservoir at a temperature of 1000K during a cycle. It converts 150 kJ of this heat into net work and rejects the remaining 450 kJ heat to a low temperature sink at 300 K temperature. Determine if this heat engine violates the second law of Thermodynamics on the basis of **[8]**

i) Clausius Inequality

ii) Carnot Theorem

c) Define: **[4]**

i) Available Energy

ii) Unavailable Energy

P.T.O.

Q3) a) Define dryness fraction. Draw neat sketch of throttling calorimeter and derive the formula for dryness fraction measurement by throttling calorimeter. **[6]**

b) Rankine cycle working between a boiler pressure of 30 bar and condenser pressure of 0.5 bar. The mass leaving the boiler and entering the turbine having a dryness fraction of 0.85 determine the following. **[8]**

i) Rankine cycle efficiency

ii) Turbine work

iii) Pump work

Pb	h_f (kJ/kg)	h_{fg} (kJ/kg)	h_g (kJ/kg)	S_f (kJ/kgK)	S_{fg} (kJ/kgK)	S_g (kJ/kgK)
30 bar	1008.3	1794	2802.3	2.646	3.538	6.184
Pc	h_f (kJ/kg)	h_{fg} (kJ/kg)	h_g (kJ/kg)	S_f (kJ/kgK)	S_{fg} (kJ/kgK)	S_g (kJ/kgK)
0.5 bar	340.6	2305.4	2646	1.091	6.504	7.595

c) Explain Rankine vapour power cycle with the help of T-S diagram. **[4]**

OR

Q4) a) 2 kg of steam is at 8 bar pressure and 0.85 dry. Determine **[6]**

i) Total enthalpy of steam

ii) Total volume of the steam

iii) Total entropy of steam.

This steam is further heated at the same pressure till it becomes completely dry saturated. Estimate a total change in enthalpy to the steam during the process.

b) A throttling calorimeter is used to measure dryness fraction of the steam in the steam mains which has steam flowing at a pressure of 8 bar. The steam after passing through the calorimeter is at 1 bar pressure and 115 deg centigrade temperatures. Calculate the dryness fraction of the steam in the mains. Take specific heat of superheated steam as 2.1 kJ/kg K. **[8]**

c) Write difference between Carnot and Rankine cycle. **[4]**

Q5) a) Define the following terms. **[4]**

i) Mass fraction

ii) Mole fraction

b) Explain Boy's Gas Calorimeter with a neat schematic diagram. **[5]**

c) Determine the Air-Fuel ratio and the theoretical mass of air required for complete combustion of a fuel containing 85% of Carbon, 8% of Hydrogen, 3% of Oxygen, 1% of Sulpher and remaining ash by mass. If 40% of excess air is used, what volume of air at 27deg centigrade and 1.05 bar pressure, does this represent per kg of fuel. **[8]**

OR

Q6) a) Define: **[4]**

i) Stoichiometric Air

ii) Stoichiometric Mixture

b) Write a note on 'Orsat Apparatus' used for volumetric analysis of Dry Exhaust Gases. **[5]**

c) Coal with following mass analysis is burnt with 100% excess air. C=74%, H_2=4.3%, S=2.7%, N2=1.5%, H_2O=5.5%, O_2=5%, Ash =7%. Find the moles of gaseous product if 100 kg of fuel are burnt. **[8]**

Q7) a) Give the function and location of the following (Any two)? **[4]**

i) Super heater

ii) Air pre heater

iii) Fusible plug

b) A water tube boiler produces 6000 kg/hour of steam at a pressure of 10.5 bar and consumes coal at a rate of 10.83 kg/min. The steam produced has a temperature of 250°C. The calorific value of fuel is 30500 kJ/kg. The water initially enters into the economizer and has temperature of 49°C at the economizer outlet. Determine **[8]**

i) Boiler Efficiency

ii) Equivalent Evaporation

c) Derive the formula for: **[6]**

i) Equivalent Evaporation

ii) Boiler efficiency

OR

Q8) a) Define steam generator. Write down classification of boiler. **[4]**

b) The following results obtained from boiler trial: **[8]**

i) Feed water per hour = 700 kg at 27°C

ii) Steam pressure = 8 bar of dryness 0.97

iii) Coal consumption = 100 kg/hr

iv) C.V. of coal = 25000kJ/kg

v) Unburnt coal collected = 7.5 kg/hr

vi) Flue gas formed per kg of fuel = 17.3 kg at 327°C (Cp of flue gas = 1.025 kJ/kgK)

vii) Room temperature = 16°C

Draw heat balance sheet kJ/min basis & Boiler Efficiency.

c) Explain the boiler heat balance sheet with formulas used. **[6]**