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Applied Thermodynamics
(1050)

P. Pages : 3

Time : Three Hours **Max. Marks : 100**

Instructions to Candidates :
1. Do not write anything on question paper except Seat No.
2. Answer sheet should be written with blue ink only. Graph or diagram should be drawn with the same pen being used for writing paper or black HB pencil.
3. Students should note, no supplement will be provided.
4. All questions are compulsory.
5. Attempt **any two** sub questions from each unit.
6. Use of steam table, Mollier chart, non programmable calculator is allowed.
7. Neat diagrams must be drawn wherever necessary.
8. Assume suitable data, if necessary.

UNIT - I

1. a) Explain Orsat apparatus with neat sketch. **10**

b) Define : **10**
 i) Enthalpy of Formation.
 ii) Enthalpy of combustion.
 iii) H.C.V.
 iv) L.C.V.
 v) Excess Air

c) A petrol contains 15% Hydrogen and 85% carbon, 50% excess air is supplied to ensure complete combustion. Determine the percentage analysis of dry products of combustion by mass. **10**

UNIT – II

2. a) Explain the construction and working of Loeffler Boiler with neat sketch. Also give the advantages & disadvantages. **10**

b) Prove that the draught produced, in mm of water by a chimney is given by $h = 353H\left[\frac{1}{Ta} - \frac{m+1}{m}\frac{1}{Tg}\right]$ **10**

c) A steam generator evaporates 18000 kg/h of steam at 12.5 bar and a quality of 0.97 dry from feed water at 105ºC, when coal is fired at 2040 kg/h. If the higher calorific value of coal is 27400 kJ/kg, find : **10**
i) The heat rate of boiler in kJ/h.
ii) The equivalent evaporation.
iii) The thermal efficiency.

UNIT – III

3. a) Explain carnot cycle with the help of PV & TS diagram. Discuss the limitations of carnot cycle. **10**

b) In a Rankine cycle, the steam at inlet to turbine is saturated at a pressure of 35 bar and the exhaust pressure is 0.2 bar. **10**
Determine :
i) The pump work
ii) The Turbine Work
iii) The Rankine efficiency.
iv) The condenser heat flow.
v) The dryness at the end of expansion.
Assume flow rate of 9.5 kg/s.

c) The steam is supplied to a turbine at a pressure of 32 bar and a temperature of 410ºC. The steam is then expands isentropically to a pressure of 0.08 bar. Find the dryness fraction of steam at the end of expansion and thermal efficiency of the cycle. **10**

If the steam is reheated at 5.5 bar to a temperature of 395ºC and then expands isentropically to 0.08 bar, what will be the dryness fraction and thermal efficiency of the cycle.

UNIT – IV

4. a) Discuss the effect of friction on the flow through a steam nozzle. Explain with the help of hs diagram. **10**

b) A convergent divergent nozzle is required to discharge 2kg of steam per second. The nozzle is supplied with the steam at 7 bar and 180°C and discharge takes place against the back pressure of 1 bar. The expansion upto throat is isentropic and the frictional resistance between throat and exit is equivalent to 63 kJ/kg of steam. The approach velocity to the nozzle is 75 m/s and throat pressure is 4 bar. Estimate : **10**

i) Suitable areas of throat and exit.

ii) Overall efficiency of the nozzle based on enthalpy drop between inlet pressure and temperature and exit pressure.

c) Discuss the effect of back pressure on mass flow rate when the flow is through convergent nozzle. Also state when the nozzle is said to be chocked. **10**

UNIT – V

5. a) Define : **10**

i) Mechanical Efficiency

ii) Adiabatic Efficiency.

iii) Isothermal Efficiency.

iv) Volumetric Efficiency.

v) FAD

b) Prove that the minimum work required per cycle with perfect intercooling is given by **10**

$$W = \frac{Sn}{n-1} P_1 V_1 \left[\left(\frac{P_{S+1}}{P_1} \right)^{\frac{n-1}{S_n}} - 1 \right]$$

Where S is the number of stages.

c) A two stage, single acting, reciprocating air compressor takes in air at 1 bar and 300 k. Air is discharged at 10 bar. The intermediate pressure is ideal for minimum work and perfect intercooling. The law of compression is $PV^{1.3} = \text{constant}$. The rate of discharge is 0.1 kg/s. Calculate : **10**

i) Power required to drive the compressor.

ii) Saving in work in compare with single stage compression.

iii) Isothermal Efficiency.

iv) Heat transferred in intercooler.

Take R = 0.287 kJ/kg k, Cp = 1 kJ/kg k.

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