* 4 0 8 2 *

Applied Thermodynamics
(124113 / 214113)

P. Pages : 3

Time : Three Hours **Max. Marks : 80**

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. Attempt **any two** sub-questions from each unit.
5. Use of steam table, Mollier chart and Non-programmable calculator is allowed.
6. Draw a neat sketches wherever necessary.
7. Assume suitable data if necessary.

UNIT – I

1. a) Derive the condition for maximum discharge of flue gases through the chimney. **8**

b) The following results were obtained in a boiler trial, **8**
Feed water/hr = 700 kg
Feed water inlet temp = 27ºC
Steam produced at a pressure = 8 bar
Dryness fraction = 0.97
Coal used = 100 kg/hr
Calorific value of coal = 25000 kJ/kg
Ash and unburnt coal collected from beneath the grate bars = 7.5 kg/hr
Calorific value of unburnt fuel = 2000 kJ/kg
Flue gases formed per kg of fuel = 17.3 kg
Flue gas temperature = 325 ºC
Temperature of air in the room = 16ºC
Specific heat of flue gases = 1.025 kJ/kg.k
Draw up energy balance on minute basis.

c) During a boiler trial following readings were noted, **8**
Chimney height = 90m
Feed water = 1400 kg/hr
Temperature of feed water = 30ºC
Boiler working pressure of dry & saturated steam = 20 bar
coal used = 200 kg/hr
Calorific value of coal = 28000 kJ/kg
Flue gas temp. in chimney = 300ºC
Flue gas formed = 18 kg/kg of coal burnt
Ambient temp. = 32ºC
Cp of products of combination = 1.028 $\frac{kJ}{kg \cdot k}$
Find
i) Thermal efficiency.
ii) Equivalent evaporation
iii) Heat carried away by flue gases.
iv) Natural draught produced in mm of H_2O.

UNIT – II

2. a) Explain Rankine cycle. Derive also an expression for its thermal efficiency. **8**

b) A steam power plant operates on a theoretical reheat cycle. Steam at boiler at 150 bar, 550ºC expands through the high pressure turbine. It is reheated at a constant pressure of 40 bar to 550ºC and expands through the low pressure turbine to a condenser at 0.1 bar. Draw T-S and h-s diagrams Find : **8**
i) Quality of steam at turbine exhaust.
ii) Cycle efficiency.
iii) Steam rate in kg/kwh.

c) Explain Edward's air extraction pump. **8**

UNIT – III

3. a) What are the effects of friction on the flow through a steam nozzle ? Explain with the help of h-s diagram. **8**

b) Dry saturated steam at a pressure of 11 bar enters a convergent – divergent nozzle and leaves at a pressure of 2 bar. If the flow is adiabatic and frictionless, determine : **8**
i) The exit velocity of steam.
ii) Ratio of cross-section at exit and throat.
Assume the index of adiabatic expansion to be 1.135.

c) Explain normal shocks in nozzle flow. **8**

UNIT – IV

4. a) Prove that the volumetric efficiency of single stage compressor is given by **8**

$$\eta_{vol.} = 1 + k - k\left(\frac{P_2}{P_1}\right)^{1/n}$$

where, k is clearance ratio.

b) A single acting single stage reciprocating air compressor, 250 mm bore and 350mm stroke runs at 200 rpm. The section and delivery pressure are 1 bar and 6 bar respectively. Calculate the theoretical power required to run the compressor under each of the following condition of compression : **8**

i) isothermal
ii) Polytropic at n = 1.3
iii) isentropic at γ = 1.4

Neglect the effect of clearance and also calculate isothermal efficiency in each of the above cases.

c) Calculate the power required to compress 25 m^3/min atmospheric air at 101.3 kPa, 20ºC to pressure ratio of 7 in L.P cylinder. Air is then cooled at a constant pressure to 25ºC in an inter cooler, before entering H.P. cylinder, where air is again compressed to a pressure ratio of 6. Assume polytropic compression with n = 1.3 and R = 0.287 kJ/kg.k. **8**

UNIT - V

5. a) Explain vane type blower. **8**

b) A axial flow fan delivering 10 m^3/s has the impeller diameter 1.25m and the hub diameter 0.75m had runs at 900 rpm. **8**
It develops a theoretical head equal to 50mm of water. Determine the blade angle at the tip and at the hub. Assume that the velocity of flow is constant throughout and the energy input per unit length of the blade is constant. (ρ = 1.2 kg/m^3)

c) Differentiate the following **8**

i) Rotary and reciprocating compressors.

ii) Compressor and blower.

****