

QP Code : 5145

(3 Hours)

[Total Marks : 80]

N. B. :

1. Question no.1 is compulsory.
2. Attempt any THREE from question no. 2 to 6.
3. Use illustrative diagrams wherever required.

- Q1) Attempt ANY FOUR
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|---------------|---|----|
| a)            | Intensive and Extensive properties with examples  | 05 |
| <del>b)</del> | Explain the principle of impulse turbine  | 05 |
| c)            | List the advantages and disadvantages of a two stroke cycle engine over a four stroke one.    | 05 |
| <del>d)</del> | What is 'Fourier's law of conduction'? State also the assumptions on which this law is based. | 05 |
| <del>e)</del> | What do you mean by 'fouling' in heat exchangers?   | 05 |
- Q2) a) For transient heat conduction, with negligible internal resistance with usual notations show that,  $\theta/\theta_0 = \exp(-Bi.Fo)$  10
- ~~b)~~ Explain the characteristic features of a fire tube boiler. How is it different from a water-tube boiler? 05
- ~~c)~~ Draw a neat boiling curve for water and mark the different regions. 05
- Q3) a) In a gas turbine plant working on the Brayton cycle, the air at inlet is at 0.1 MPa and 27°C. The pressure ratio is 6.25 and the maximum temperature is 800°C. The turbine and compressor efficiencies are each 80%, find: 10
- i. Compressor work per kg of air.
  - ii. Turbine work per kg of air
  - iii. Heat supplied per kg of air and
  - iv. Cycle efficiency
- b) A hot square plate, 50cm x 50cm, at 100°C is exposed to atmospheric air at 10 20°C. Find the heat loss from both the surfaces of the plate: 10
- i. If the plate is kept vertical
  - ii. If the plate is kept horizontal
- Properties of air at mean temperature of 60°C are given below:  
 $\rho = 1.06 \text{ kg/m}^3$ ,  $c_p = 1.008 \text{ kJ/kg K}$ ,  $\nu = 18.97 \times 10^{-6} \text{ m}^2/\text{s}$ ,  $k = 0.028 \text{ W/mK}$
- Following empirical relations can be used:  
Case (i):  $Nu = 0.13x (Gr.Pr)^{1/3}$   
Case (ii):  $Nu = 0.71x (Gr.Pr)^{1/4}$  for the upper surface, and  
 $Nu = 0.35x (Gr.Pr)^{1/4}$  for the lower surface



- Q4) a) Prove that heat absorbed or rejected during a polytropic process for an ideal gas is given by:  $Q_{1-2} = (\gamma - n / \gamma - 1) W_{1-2}$  08
- b) Explain or describe the working of 4-stroke SI engine. 05
- c) A wire of 8mm diameter at a temperature of  $60^\circ$  is to be insulated by a material having  $k = 0.174 \text{ W/m}^\circ\text{C}$ . Heat transfer coefficient on the outside,  $h_a = 8 \text{ W/m}^2\text{K}$ . Ambient temperature,  $T_a = 25^\circ\text{C}$ . For maximum heat loss, what is the minimum thickness of insulation and the heat loss per meter length? Find the increase in heat dissipation due to insulation 07
- Q5) a) Write the steady flow energy equation and apply it to: 08
- Nozzle
  - Throttling device
  - Turbine
  - Compressor
- b) A gas engine working on otto cycle has a cylinder diameter 20cm and stroke of 25 cm. The clearance volume is  $1570 \text{ cm}^3$ . Find air standard efficiency. Assume  $C_p = 1.004 \text{ kJ/kgK}$  and  $C_v = 0.717 \text{ kJ/kgK}$  06
- c) Derive expression for LMTD for counter flow type heat exchanger 06
- Q6) a) A flat plate, 1m wide and 1.5m long is maintained at  $90^\circ\text{C}$  in air with a free stream temperature of  $10^\circ\text{C}$ , flowing along 1.5m side of the plate. Determine the velocity of air required to have a rate of energy dissipation as 3.75 kW. 10
- Use correlations:  
 $Nu_L = 0.664 (Re)^{0.5} (Pr)^{1/3}$  for laminar flow, and  
 $Nu_L = [0.036 Re^{0.8} - 836] Pr^{1/3}$  for Turbulent flow  
 Take the average properties of air at  $50^\circ\text{C}$ :  
 $\rho = 1.0877 \text{ kg/m}^3$ ,  $c_p = 1.007 \text{ kJ/kg K}$ ,  $\mu = 2.029 \times 10^{-5} \text{ kg/ms}$ ,  $k = 0.028 \text{ W/mK}$ ,  
 $Pr = 0.703$
- b) Describe super heater, economizer and air preheater with neat sketches. Also indicate suitable location of these on a boiler with line diagram 10