Duration:[03 Hours] **[Total Marks: 80]**

N. B : (1) Question no.1 is **Compulsory**.
(2) Solve any **THREE** from question no.2 to 6.
(3) Use illustrative diagrams wherever possible.
(4) Assume suitable data if necessary and mention it clearly.

Q.1 Solve **Any Four** questions :

a) Name the various modes of heat transfer and also explain its governing laws. **5**

b) What do you understand by'Fin' ? Enlist the various types of fin? Also draw sketches for any three types of fins. **5**

c) State and Explain the following radiation laws- **5**

i) Planck's law
ii) Kirchhoff' law

d) Differentiate between Four stroke cycle and Two stroke cycle engines. **5**

e) State the modes of Mass Transfer. State & explain the Fick's law of diffusion. **5**

Q.2 a) The wall of a cold storage consists of three layers-an outer layer of ordinary bricks,0.25m thick, a middle layer of cork,0.1m thick and an inner layer of cement,0.06m thick. The thermal conductivities of the materials are 0.7W/m.K,0.043W/m.K and 0.72W/m.K, respectively. The temperature of the outer surface of the wall is 30^0C and that of inner is -15^0C.Calculate: **10**

i) Steady state rate of heat gain per unit area
ii) Temperature at the interfaces of composite wall
iii) The percentage of total heat resistance offered by individual layers

b) Derive an expression for log mean temperature difference (LMTD) in a parallel flow heat exchanger. State your assumptions. **10**

Q.3 a) Water at the rate of 0.8 kg/s at 90^0C flows through a steel pipe having 25mm ID and 30mm OD passing through the room. The outside surface temperature of the pipe is 84^0C and temperature of the surrounding air is 20^0C.The room pressure is 1 atm and the pipe is 15m long. How much heat is lost by free convection in the room.? **12**

You may use correlation

Nu = $0.53\ (Gr.Pr)^{0.25}$ for $10^4 < Gr\ Pr < 10^9$

= $0.10\ (GrPr)^{1/3}$ for $10^9 < Gr\ Pr < 10^{12}$

Take the properties of air as

$\mu = 1.9606 \times 10^{-5}$ kg/ms, k = 13.02W/m^0C , ρ = 1.0877 kg/m^3,Cp=1007.3 J/kg.K

k =0.02813W/m.K,

b) One end of the copper rod 15 cm long and 0.6 cm in diameter is connected to a wall maintained at 300^0C and the other end protrudes into a room whose air temperature is 20^0C.If the tip of the rod is insulated, Estimate -i) Heat loss by the rod. ii) The heat transfer efficiency of copper rod. Take h=28W/m^2K ,k=370W/mK. **08**

Q.4 **a)** In an open heart surgery, under hypothermic conditions, the patient blood is cooled before the surgery and rewarmed afterwards. It is proposed that a concentric tube, counter flow heat exchanger of length 0.5 m be used for this purpose with the thin walled inner tube having a diameter of 55mm. If the water at 60^0C and 0.10 kg/s is used to heat the blood entering the heat exchanger at 18^0C and 0.05kg/s, what is the temperature of blood leaving the heat exchanger? The overall heat transfer coefficient is 500W/m^2.K and specific heat of the blood is 3500J/kg.K, Specific heat of water is 4200 J/kg.K **10**

b) Explain the stages of combustion in SI engines with the help of pressure - crank angle diagram. **10**

Q.5 **a)** In a test of single cylinder four stroke oil engine with Bore 300mm and Stroke 450 mm , the following observations were made: **12**

Duration of Test	= 60 min
Engine speed	= 200 RPM
Fuel consumption	=7 kg
Calorific value of fuel	= 45000 kJ/kg
Average speed	=200 rpm
Indicated mean effective pressure	=5.867 bar
Net Brake load	=130 kg
Brake drum diameter	=1650 mm
Total weight of jacketed of cooling water	= 500 kg
Temperature rise of jacketed cooling water	=40^0C
Temperature of exhaust gases	=300^0C
Air consumption	=300kg
Specific heat of exhaust gases	=1.004kJ/kg.K,
Specific heat of water	= 4.19 kJ/kg.K
Room temperature	=25^0C

Determine: i) Mechanical Efficiency ii) Brake thermal efficiency iii) Draw up heat balance sheet on minute and percentage basis

b) What do you understand by the hydrodynamic and thermal boundary layer? Illustrate with reference to flow over a flat heated plate. **08**

Q.6 **(a)** A solid copper sphere of 10 cm diameter (ρ = 8954 kg/m^3, Cp=383 J/kg.K , k= 386 W/mk) ,initially at a uniform temperature ti=250^0C, is suddenly immersed in a well stirred fluid which is maintained ar a uniform temperature ta=50^0C.The heat transfer coefficient between the sphere and the fluid is h= 200 W/m^2K.Determine the temperature of the copper sphere at τ =5 min after the immersion. **08**

b) With a neat sketch explain the construction and working of Simple Carburetter. **06**

c) Enumerate various methods to control engine emission. Explain any one method in brief with neat sketch. **06**

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