



SF-8358

B. E. III (Sem. VI) (Mech.) Examination

May / June - 2011

H. M. T.

(New Syllabus)

Time : 3 Hours]

[Total Marks : 100

Instructions :

(1)

नीचे दृष्टावेक निशानीवाणी विगतो उत्तरवडी पर अवश्य लपवी.
Fillup strictly the details of signs on your answer book.

Name of the Examination :
B. E. 3 (Sem. 6) (Mech.)

Name of the Subject :
H. M. T. (New)

Subject Code No. : 8 3 5 8 Section No. (1, 2,.....): Nil

Seat No. :

Student's Signature

- (2) Attempt all questions.
(3) Fig. to the right indicate full marks.
(4) Assume suitable data if required.

- 1 Derive three dimensional heat conduction equation in cartesian coordinates. **10**
- 2 Attempt any **two** : **20**
- (i) A turbine blade 5 cm long, 4.5 cm² cross sectional area and 10 cm perimeter is made of stainless steel of thermal conductivity 100 kJ/m-hr-deg. The temp. of root of blade is 500°C and it is exposed to products of combustion passing through the turbine at 850°C. Determine the temperature at the middle of blade and rate of heat flow from it. The film coefficient between the blade and combustion gases is 1100 kJ/m² hr-deg. The blade may be treated as a Fin losing heat at the tip.
- (ii) A 6.5 m dia vertical kiln has a hemi-spherical dome at top, dome is fabricated from a 25 cm thick layer of chrome brick which has a thermal conductivity of 1.16 W/m deg. The kiln dome has inside temp. of 875°C and 20°C atm. air results into 11.4 W/m² deg. heat transfer coefficient between dome and air. Estimate outside surface temp. of dome and heat loss from kiln. Compare this heat with that would result from a flat dome fabricated from same material and with kiln operating under identical temp. conditions.
- (iii) Prove that heat conduction by hollow sphere is given by

$$Q = \frac{(t_1 - t_2) 4 \pi k r_1 r_2}{(r_2 - r_1)}$$

3 Attempt any **two** : 20

- (i) The wall of tube 4m long and 20 mm dia. is held at const. temperature providing a steam jacket. A viscous fluid enters tube at 30°C and leaves at 40°C at rate of 180 kg/hr. Determine the avg. heat transfer coefficient and wall temp. Use following correlation

$$Nu = 3.65 + \frac{0.67(d/l)RePr}{1 + 0.04 \left[\frac{d}{l} Re Pr \right]^{1/3}}$$

Take $\rho = 850 \text{ kg/m}^3$; $K = 0.1396 \frac{w}{m \text{ deg}}$

$C_p = 2000 \text{ J/Kg K}$ and $\nu = 5.1 \times 10^{-6} \text{ m}^2/\text{S}$

- (ii) Air at 25°C and 1 bar flows over a flat plate at a speed 1.25 m/s. Calculate the boundary layer thickness at distance of 15 cm and 30 cm from leading edge of the plate. What would be mass entrainment between these two sections ? Assume parabolic velocity distribution

$$\frac{U}{U_\infty} = \frac{3}{2} \left(\frac{y}{8} \right) - \frac{1}{2} \left(\frac{y}{8} \right)^3$$

The viscosity of air at 25°C is stated to be $6.62 \times 10^{-2} \text{ kg/hr.m.}$

- (iii) Air at 25°C flows past a flat plate at 2.5 m/s. The plate measures 60 cm × 30 cm and is maintained at uniform temp. of 95°C. Calculate the heat loss from the plate if the air flows parallel to the 60 cm side. How would this heat loss be affected if the flow of air is made parallel to the 30 cm side?

4 (a) Fill in the blanks : 5

(i) A body which absorbs all radiations falling on it is called _____.

(ii) A gas does not _____ any thermal radiation.

(iii) Fins are used to _____ the heat flow from the surface.

(iv) In evaporation, to separate liquid droplet from the vapour _____ is used.

(v) The reciprocal of thermal resistance is called _____.

(b) Differentiate between the filmwise and dropwise condensation. 3

(c) State Fick's Law of diffusion. What are its limitations ? 2

(d) Attempt any two from following : 10

(i) Derive expression for effectiveness by NTU for counter flow heat exchanger.

(ii) Enumerate the factors on which the rate of emission of radiation by a body depend and define radiation heat transfer.

(iii) Write a short note on radiation from gases, vapour and flames.

- 5 (a) Enumerate application of mass transfer. 5
 (b) Air is contained in a tyre tube of surface area 0.5 m^2 and wall thickness 10 mm . The pressure of air drops from 2.2 bar to 2.18 bar in a period of 6 days. The solubility of air in the rubber is 0.072 m^3 of air per m^3 of rubber at 1 bar determine the diffusivity of air in rubber at the operating temperature of 300 K if the volume of air in the tube is 0.028 m^3 . 10

OR

- 5 (a) List the various modes of mass transfer and explain. 5
 (b) Air at 20°C flows past a tray full of water with a velocity of 2.5 m/sec . Calculate the evaporation rate of water if temperature on the water surface is 15°C . The tray measures 25 cm along the flow of direction and its width is 40 cm . The moving air has a total pressure of 1.01 bar and the partial pressure of water associated with it is 0.0075 bar . Take the following properties of air :
 $\rho = 1.205 \text{ kg/m}^3$;
 Kinematic viscosity (μ) = $15.06 \times 10^{-6} \text{ m}^2/\text{sec}$
 $D = 0.15 \text{ m}^2/\text{hr}$.
 (c) Differentiate between molecular diffusion and eddy diffusion. 3

- 6 (a) What is heat exchanger ? How they are classified ? 5

OR

- (a) Draw a neat sketch of shell and tube type heat exchanger and explain it. 5
 (b) What is mean by fouling factor ? How does it effect the performance of heat exchanger ? 5
 (c) A one ton window air conditioner removes 3.5 kJ/sec from a room and in the process rejects 4.2 kJ/sec in the air cooled condenser. The ambient temperature is 30°C whereas condensing temperature of the refrigerant is 45°C . For the condenser the product of overall heat transfer coefficient and corresponding area is 350 W/k . Calculate the temperature rise of the air as it flows over the condenser tubes. 5