

4. **The following item consists of two statements, one labelled as the “Assertion (A)” and the other as “Reason(R)”. You are to examine those two statements carefully and select the answers to these items using the codes given below:** CO3 [K₁]
- Both A and R are individually true and R is the correct explanation of A
 - Both A and R are individually true and R is not the correct explanation of A
 - A is true but R is false
 - A is false but R is true
- Assertion (A):** Nusselt number may be characterized as the dimensionless temperature Gradient at the surface.
- Reason (R):** The thermal boundary layer thickness is thicker than the momentum Boundary layer thickness when prandtl number is less than one.
- Both A and R are Individually true and R is the correct explanation of A
 - Both A and R are Individually true but R is not the correct explanation of A
 - A is true but R is false
 - A is false but R is true
5. Boiling and condensation occurs at CO4 [K₃]
- Constant pressure and temperature
 - Constant temperature
 - Constant pressure
 - Both pressure and temperature are not constant.
6. Choose the relevant option for the following CO4 [K₂]
 A black body is one which
- Black in colour
 - absorbs all radiation
 - reflects all incident radiation
 - absorbs most of the incident radiation
- i,ii,iv
 - ii,iv
 - ii
 - Iv
7. **Assertion (A):** The monochromatic emissivity of a white body at all wave lengths And temperature is equal to zero. CO5 [K₃]
- Reason (R):** The wavelength range for thermal radiation is 10^{-1} to 10^2
- Both A and R are Individually true and R is the correct explanation of A
 - Both A and R are Individually true but R is not the correct explanation of A
 - A is true but R is false
 - A is false but R is true
8. Which of the following term does not pertain to radiation in heat transfer? CO5 [K₂]
- Solid angle
 - Configuration factor
 - Reynolds analogy
 - Spectral distribution
9. **Assertion (A):** The solutions of mass diffusion equations can be obtained from the solutions of corresponding heat conduction equations for the same type of boundary conditions. CO6 [K₃]
- Reason (R):** The differential equations for both heat conduction and mass diffusion are of the same form.
- Both A and R are Individually true and R is the correct explanation of A
 - Both A and R are Individually true but R is not the correct explanation of A
 - A is true but R is false
 - A is false but R is true

10. Driving force for mass transfer to take place CO6 [K₂]
- a) Concentration difference b) Potential difference
- c) Temperature difference d) Electromagnetic force difference.

PART B (10 x 2 = 20 Marks)
(Answer not more than 40 words)

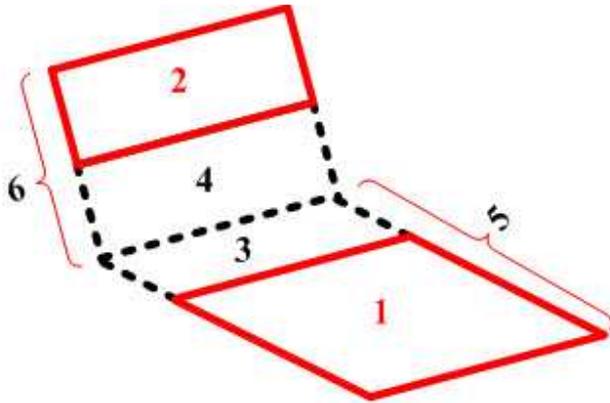
11. Define thermal diffusivity. CO1 [K₂]
12. Differentiate between steady state and transient heat conduction. CO2 [K₂]
13. Sketch velocity and temperature boundary layer on flat plate. CO3 [K₂]
14. Outline the significance of Grashoff number and Reynold's number. CO3 [K₂]
15. Differentiate between film wise and drop wise condensation. CO4 [K₂]
16. Sketch the temperature profile for parallel flow and counter flow heat exchanger. CO4 [K₂]
17. Distinguish between irradiation and radiosity. CO5 [K₂]
18. A person who sits in front of a fire place feels warm. Name the mode of heat transfer through which he receives heat and comment on that. CO5 [K₂]
19. State any two examples of mass diffusion. CO6 [K₂]
20. Define convective mass transfer coefficient. CO6 [K₂]

Answer any FIVE Questions:-
PART C (5 x 14 = 70 Marks)
(Answer not more than 300 words)

Q.No. 21 is Compulsory

21. (i) A furnace wall consist of three layers. The inner layer of 10 cm thickness is made up of fire brick $k = 1.04 \text{ W/mK}$. The intermediate layer of 25 cm thickness is made up of masonry brick $k = 0.69 \text{ W/mK}$ followed by a 5 cm thick concrete wall $k = 1.37 \text{ W/mK}$. when the furnace is in continuous operation ,the inner surface of the furnace is at 800°C ,while the outer surface of the concrete is at 50°C .Calculate (i) the rate of heat loss per unit area of the wall (ii) temperature at the interface of the fire brick and masonry brick and temperature at the interface of masonry brick and concrete. (10) CO1 [K₃]
- (ii) Derive an expression for critical radius of insulation. (4) CO1 [K₃]
22. An aluminium sphere weighing 5.5 kg and initially at a temperature of 290°C is suddenly immersed in a fluid at 15°C . The convective heat transfer coefficient is $58 \text{ W/m}^2\text{K}$.Estimate the time required to cool the aluminium to 95°C . CO2 [K₃]
23. (i) Air stream at 27°C is moving at 0.3 m/s across a 100 W electric bulb at 127°C .If the bulb is approximated by a 60 mm diameter sphere. Estimate the heat transfer rate and the percentage of power loss due to convection. (7) CO3 [K₃]
- (ii) A thin 80 cm long and 8 cm wide horizontal plate is maintained at a temperature of 130°C in a large tank full of water at 70°C .Estimate the rate of heat input into the plate necessary to maintain the temperature of 130°C . (7) CO3 [K₃]
24. An air stream at 0°C is flowing along a heated plate at 90°C at a speed of 75 m/s. The plate is 45 cm long and 60 cm wide. Assuming the transition of boundary layer to take place at $Re_{x,c} = 5 \times 10^5$,calculate the average values of friction coefficient for the full length of the plate and the rate of energy dissipation from the plate. CO3 [K₃]

25. A counter flow concentric tube heat exchanger is used to cool engine oil ($C = 2130 \text{ J/kgK}$) from 160°C to 60°C with water, available at 25°C as the cooling medium. The flow rate of cooling water through the inner tube of 0.5 m diameter is 2 kg/s while the flow rate of oil through the outer annulus O.D. = 0.7 m is also 2 kg/s . If the overall heat transfer coefficient is $250 \text{ W/m}^2\text{K}$, how long must the heat exchanger be to meet its cooling requirement? CO4 [K₃]
26. (i) Calculate the shape factor F_{1-2} , where $L_1 = 4 \text{ m}$, $L_2 = 4 \text{ m}$, $B = 2 \text{ m}$ for the geometry (7) CO5 [K₃]
given below.



Where L – Length, B - Breadth

- (ii) The net radiation from the surfaces of two parallel plates maintained at temperatures, T_1 and T_2 is to be reduced by 79 times. Calculate the number of screens to be placed between the two surfaces to achieve this reduction in heat exchange, assuming the emissivity of the screens as 0.05 and that of surface as 0.8 . (7) CO5 [K₃]
27. A mixture of O_2 and N_2 with their partial pressures in the ratio 0.21 to 0.79 is in a container at 25°C . Calculate the molar concentration, the mass density, the mole fraction, and the mass fraction of each species for a total pressure of 1 bar . What would be the average molecular weight of the mixture? CO6 [K₃]
