Reg.No. \_\_\_\_\_\_\_\_\_\_\_\_



**End Semester Examination – Nov / Dec – 2019**

|  |  |  |  |
| --- | --- | --- | --- |
| **Code :** | **18ME2006** | **Duration :** | **3hrs** |
| **Sub. Name :** | **HEAT AND MASS TRANSFER IN FOOD PROCESSING** | **Max. Marks :** | **100** |

|  |  |  |  |
| --- | --- | --- | --- |
| **Q. No.** | **Questions** | **Course Outcome** | **Marks** |
| **PART – A (20 X 1 = 20 MARKS)** | | | |
| 1. | The thermal conductivity is expressed as \_\_\_\_\_\_\_\_\_\_\_\_\_\_.  (a) W/m K (b) W/cm4 K (c) W/cm2 K4 (d) W2/cm K4 | CO1 | 1 |
| 2. | Heat conduction in gases is due to elastic impact of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. | CO1 | 1 |
| 3. | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ has least value of conductivity.  (a) Air (b) water (c) rubber (d) glass | CO1 | 1 |
| 4. | For spheres the critical thickness of insulation is given by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. | CO1 | 1 |
| 5. | \_\_\_\_\_\_\_\_\_\_\_ number is associated with natural convection heat transfer.  (a) Grashof (b) Reynolds (c) Prandtl (d) Peclet | CO1 | 1 |
| 6. | Fins are provided on heat transferring surface to \_\_\_\_\_\_\_\_\_\_\_ the heat transfer area. | CO2 | 1 |
| 7. | A fin will be effective only when biot number is \_\_\_\_\_\_\_\_\_ than one. | CO2 | 1 |
| 8. | \_\_\_\_\_\_\_\_\_\_\_ number has a significant role in forced convection.  (a) Mach (b) Reynolds (c) Prandtl (d) Peclet | CO1 | 1 |
| 9. | All bodies above absolute zero temperature emits \_\_\_\_\_\_\_\_\_\_\_\_\_\_. | CO1 | 1 |
| 10. | The heat transfer by radiation takes place by means of \_\_\_\_\_\_\_\_\_\_\_. | CO1 | 1 |
| 11. | A body which absorbs all the radiations falling on it, is called \_\_\_\_\_\_\_\_\_. | CO1 | 1 |
| 12. | The unit of Stefan Boltzmann constant is \_\_\_\_\_\_\_\_\_\_\_\_.  (a) watt/cm2 K (b) watt/cm4 K (c) watt/cm2 K4 (d) watt2/cm K4 | CO1 | 1 |
| 13. | What are the two modes of condensation? | CO5 | 1 |
| 14. | The condensation process is reverse of \_\_\_\_\_\_\_\_\_\_ process. | CO5 | 1 |
| 15. | Explain the term ‘LMTD’. | CO3 | 1 |
| 16. | Baffles are provided in heat exchangers to \_\_\_\_\_\_\_\_\_\_ the heat transfer rate. | CO3 | 1 |
| 17. | An automobile radiator is \_\_\_\_\_\_\_\_\_\_\_ type of heat exchanger.  (a) cross-flow (b) parallel flow (c) counter flow (d) regenerator | CO3 | 1 |
| 18. | LMTD in case of counter flow heat exchanger as compared-to parallel flow heat exchanger is \_\_\_\_\_\_\_\_\_\_\_\_. | CO3 | 1 |
| 19. | State Fick’s law of diffusion. | CO6 | 1 |
| 20. | The units of mass diffusion coefficient or diffusivity are \_\_\_\_\_\_\_\_\_\_.  (a) m2/s (b) kg m/s2  (c) s/m2 (d) kg s/m2 | CO6 | 1 |

|  |  |  |  |
| --- | --- | --- | --- |
| **PART – B (10 X 5 = 50 MARKS)**  **(Answer any 10 from the following)** | | | |
| 21. | Explain critical radius of insulation. | CO1 | 5 |
| 22. | An Aluminium sphere weighting 7 kg and initially at temperature of 320oC is suddenly immersed in a fluid at 25oC with convection heat transfer coefficient of 50 W/m2 oK. Estimate the time required to cool the sphere to 100oC. Take thermo physical properties as cp = 896 J/kgK, ρ = 2700 kg/m3 and k = 204.2 W/mK. | CO1 | 5 |
| 23. | Sketch the boundary layer development of a flow on a flat plate. | CO1 | 5 |
| 24. | Air at 20 oC flows over a flat plate at 60 oC with a free stream velocity of 6 m/s. Determine the value of the average convective heat transfer coefficient up to a length of 1 m in the flow direction. | CO4 | 5 |
| 25. | A black body at 3000 K emits radiation. Calculate the following.   1. Monochromatic emissive power at 1 μm wave length. 2. Wave length at which emission is maximum. 3. Maximum emissive power. 4. Total emissive power. 5. Total emissive power of a real surface having emissivity equal to 0.85. | CO1 | 5 |
| 26. | Distinguish between:  i) A black body and gray body.  ii) Absorptivity and emissivity of a surface. | CO1 | 5 |
| 27. | Explain the different regimes of boiling with neat sketch. | CO5 | 5 |
| 28. | Distinguish between filmwise and dropwise condensation. Which of the two gives a higher heat transfer coefficient? Why? | CO5 | 5 |
| 29. | Sketch the temperature variations in parallel flow and counter flow heat exchangers. | CO3 | 5 |
| 30. | How are the heat exchangers classified? | CO3 | 5 |
| 31. | Define Scherwood number and Schmidt number. | CO6 | 5 |
| 32. | Air at 1 atm and 250C containing small quantities of iodine, flows with a velocity of 6.2 m/s inside a 35 mm diameter tube. Calculate mass transfer coefficient for iodine. The thermophysical properties of air are ʋ = 15.5 × 10-6 m2/s ; D = 0.82 × 10-5 m2/s. | CO6 | 5 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **PART – C (2 X 15 = 30 MARKS)**  **(Answer any 2 from the following)** | | | | |
| 33. | a | Derive the general heat conduction equation in cartesian coordinates. | CO1 | 8 |
| b | A cylindrical body of 300 mm diameter and 1.6 m height is maintained at a constant temperature of 36.5°C. The surrounding temperature is 13.5°C. Find out the amount of heat to be generated by the body per hour if ρ = 1.025 kg/m3; cp = 0.96 kJ/kg°C; ʋ = 15.06 × 10-6 m2/s; k = 0.0892 kJ/m-h-°C; Pr = 0.598 and ß = 0.003355 K-1. Assume Nu = 0.12 (Gr.Pr)1/3. | CO1 | 7 |
|  |  |  |  |  |
| 34. | a | Estimate the net radiant heat exchange per square meter from a very large plate at a temperature of 5500C and 3200C. Assume the emissivity of hot plate is 0.8 and cold plate is 0.6. | CO1 | 7 |
| b | A steam condenser consisting of a square array of 900 horizontal tubes each 6 mm in diameter. The tubes are exposed to saturated steam at a pressure of 0.18 bar and the tube surface temperature is maintained at 230C. Calculate the heat transfer co-efficient (h) and the rate at which steam is condensed (m°). | CO4 | 8 |
|  |  |  |  |  |
| 35. | a | A counter flow heat exchanger is to heat air entering at 4000C with a flow rate of 6 kg/s by the exhaust gas entering at 8000C with a flow rate of 4 kg/s. The overall heat transfer coefficient is 100 W/m2K and the outlet temperature of the air is 551.50C. Specific heat at constant pressure for both air and exhaust gas can be taken as 1100 J/kgK. Calculate the heat transfer area needed. | CO3 | 8 |
| b | Ammonia and air are in equimolar diffusion in a cylindrical tube of 3.5 mm diameter and 25 m length. The total pressure is 1 atmosphere and the temperature is 270C. One end of the tube is connected to a large reservoir of ammonia and the other end of the tube is open to the atmosphere. If the mass diffusivity for the mixture is 0.3 × 10-4 m2/s, calculate the mass transfer rates of ammonia and air through the tube. | CO6 | 7 |