29. a. Air at 20°C at atmospheric pressure flows over a flat plate at a velocity of 3.5m/s. If the length of plate is 0.4m and width of the plate is 0.5m. Calculate the following if the plate is maintained at 60°C. (i) boundary layer thickness (ii) local friction and average friction coefficient (iii) average heat transfer coefficient (iv) heat transfer rate (v) total drag force on plate.

(OR)

b. A steam pipe of 0.1m diameter runs horizontally in a room at 23°C. Outside surface temperature of pipe is maintained at 165°C. Determine (i) the heat loss per unit length of pipe (ii) if the surface temperature is reduced to 80°C by adding 1.5cm thickness of insulation. Find the percentage of reduction in heat transfer.

30. a. Two parallel plates 3m×2m are spaced at 1m apart. One plate is maintained at temperature 500°C and emissivity 0.3, while the other plate is maintained at temperature 200°C and emissivity at 0.5. The plates are located in a large room and walls are maintained at 40°C. If the plate exchanges heat with each other and with room, find the heat lost by the hotter plate.

(OR)

b. Two large parallel plates are maintained at 800°C and 300°C. Emissivity of the plates are 0.3 and 0.5. (i) find net radiant heat exchange for unit area (ii) percentage of reduction in heat transfer when a polished aluminium radiation shield of emissivity 0.06 is placed between them (iii) temperature of shield.

31. a. Water at atmospheric pressure and saturated temperature is boiled in a 0.25 m diameter, electrically heated, mechanically polished stainless steel pan. The heated surface of the pan is maintained at a uniform temperature of 116°C. Calculate (i) heat flux (ii) rate of evaporation from pan (iii) peak heat flux.

(OR)

b. In a counter flow double pipe heat exchanger, water is heated from 25°C to 75°C by an oil with a specific heat of 1.45kJ/kgK and mass flow rate of 0.9 kg/sec. The oil is cooled from 230°C to 150°C. if the overall heat transfer coefficient is 425 W/m^2K. Calculate (i) rate of heat transfer (ii) mass flow rate of water (iii) surface area of heat exchanger.

32. a. Water in the tank 20mm deep is filled with water to 10 mm level and exposed to dry air at 40°. Calculate the time required for all the water to evaporate. What will be the time requirement for the evaporation if the air temperature is 80°C? Take diameter of tank = 2m, D_{ab}, (water to air) = $0.0925m^2$/hour.

(OR)

b. CO_2 and air experience equimolar counter diffusion in a circular tube whose length and diameter are 1.2 m and 60 mm. The system is at a total pressure of 1 atm and temperature of 273K. Ends of tube are connected to large chambers. Partial pressure of CO_2 at one end is 200 mm of Hg, while at other end is 90 mm of Hg. Calculate (i) mass transfer rate of CO_2 (ii) mass transfer rate of air.

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Reg. No.															

B.Tech. DEGREE EXAMINATION, NOVEMBER 2016
Fifth Semester

ME1021 – HEAT AND MASS TRANSFER

(For the candidates admitted during the academic year 2013 – 2014 and 2014 -2015)
(Use of approved steam table and Heat and mass graph table is permitted)

Note:
(i) **Part - A** should be answered in OMR sheet within first 45 minutes and OMR sheet should be handed over to hall invigilator at the end of 45th minute.
(ii) **Part - B** and **Part - C** should be answered in answer booklet.

Time: Three Hours Max. Marks: 100

PART – A (20 × 1 = 20 Marks)
Answer **ALL** Questions

1. The number which is relevant in transient heat conduction is _____
   (A) Reynold's number (B) Prandtl number
   (C) Grashoff number (D) Fourier number

2. Upto critical radius of insulation _____
   (A) Added insulation will increase heat loss (B) Added insulation will decrease heat loss
   (C) Convection heat loss will be less than conduction loss (D) Heat flux will decrease

3. Basic law of heat conduction is _____
   (A) Fourier's law (B) Stefen's law
   (C) Newton's law (D) First law of thermodynamics

4. Thermal diffusivity of a solid is given by _____.
   Where K-thermal conductivity, ρ – density, Cp- specific heat.
   (A) K/ρCp (B) $\frac{\rho Cp}{K}$
   (C) $\frac{\rho K}{Cp}$ (D) $\frac{KCp}{\rho}$

5. The ratio of energy transferred by convection to that by conduction is called _____
   (A) Stanton number (B) Nusselt number
   (C) Biot number (D) Preclet number

6. Air at 20°C flows over a plate of 0.5m×0.75m maintained at a temperature of 250°C. If the convective heat transfer coefficient is 25 W/m^2 °C, the heat transfer rate is _____
   (A) 215.6 kW (B) 2.56 kW
   (C) 2.156 kW (D) 21.56 kW

7. In natural convection Nusselt number is a function of _____
   (A) Reynold's number and Prandtl number (B) Weber number and Reynold's number
   (C) Grashoff's number and Prandtl number (D) Weber number and prandtl number

8. A grey body is one whose absorptivity _____
   (A) Varies with temperature
   (B) Varies with wavelength of incident ray
   (C) Is equal to emissivity
   (D) Does not vary with temperature and wavelength of incident ray

9. The ratio of energy absorbed by the body to the total energy falling on it is known as _____
   (A) Emissivity
   (B) Absorptivity
   (C) Emissive power
   (D) Absorptive power

10. Wave length corresponding to the maximum energy is inversely proportioned to the absolute temperature. Above element is _____
   (A) Wein's law
   (B) Stefan's law
   (C) Kirchoff's law
   (D) Plancb's law

11. Radiation shield should have _____
   (A) High emissivity
   (B) Low emissivity
   (C) Low reflectivity
   (D) High reflectivity

12. A body which reflects entire radiation incident on it is known as _____
   (A) Black body
   (B) White body
   (C) Gray body
   (D) Transparent body

13. Dropwise condensation usually occurs on _____
   (A) Glazed surface
   (B) Smooth surface
   (C) Oil surface
   (D) Coated surface

14. The excess temperature in free convection boiling is _____
   (A) 5°C
   (B) 10 °C
   (C) 30 °C
   (D) 50 °C

15. The overall heat transfer coefficient is highest in a heat exchanger when _____
   (A) Heat is transferred from steam to oil
   (B) Heat is transferred from steam to water
   (C) Heat is transferred from hot gas to tar
   (D) Heat is transferred from air to CO_2

16. Automobile radiator is a heat exchanger of _____
   (A) Counter flow type
   (B) Parallel flow type
   (C) Cross flow type
   (D) Regenerator type

17. In physical term, Schmidt number is _____
   (A) $\frac{\text{Thermal diffusivity}}{\text{Mass diffusivity}}$
   (B) $\frac{\text{Thermal diffusivity}}{\text{Momentum diffusivity}}$
   (C) $\frac{\text{Momentum diffusivity}}{\text{Mass diffusivity}}$
   (D) $\frac{\text{Mass diffusivity}}{\text{Thermal diffusivity}}$

18. Mass transfer between two fluids phase does not necessarily depends on _____
   (A) Physical properties
   (B) Chemical properties
   (C) Degree of turbulence
   (D) Interfacial area

19. The diffusivity D_{AB} (for component A diffusing in B) is equal to the diffusivity D_{BA} (for component diffusing in A) for binary mixture
   (A) Newtonian liquids
   (B) Non-Newtonian liquids
   (C) Ideal gas
   (D) Real gas

20. FICKS law of diffusion $\frac{ma}{D} =$
   (A) $-D_{AB}\frac{dC_A}{dx}$
   (B) $D_{AB}\frac{dC_A}{dx}$
   (C) $D_{AB}\,dC_A$
   (D) $D_{AB}\,dx$

PART – B (5 × 4 = 20 Marks)
Answer **ANY FIVE** Questions

21. What is biot number and Fourier number? Write down their physical significance.

22. An electric current is passed through a plane wall of thickness 25 mm and 120 mm wide, which is used to heat a fluid at 30°C. The heat generation is $65\times10^3 W/m^3$. Thermal conductivity of plate is 25 W/mK. Calculate the heat transfer coefficient to maintain the temperature of plate below 150°C.

23. What is entrance region and fully developed region in the internal flow?

24. Air at 30°C flows over a flat plate at a speed of 1.2 m/sec. Calculate hydrodynamic boundary layer and thermal boundary layer at a thickness of 0.15m and 0.3m.

25. A black body at 2500 K emits radiation. Calculate the wavelength at which emission is maximum, maximum emissive power and total emissive power.

26. Explain why C_{min} is used instead of C_{max} in the maximum possible heat transfer calculation in a heat exchanger.

27. Explain the various regimes of saturated pool boiling for a platinum wire submerged in water.

PART – C (5 × 12 = 60 Marks)
Answer **ALL** Questions

28. a. A furnace wall is made of insulation brick of 0.12 m thick (K=0.6 W/mK), fire brick of 0.10 m thick (k=0.8W/mK) and backed by 0.01m thick metal plate (K=46W/mK). The insulation brick is reposed to air at 30°C. The gas side heat transfer coefficient is $100 W/m^2K$ and air side is $15 W/m^2K$. The contact resistance between insulation brick and fire brick is $2.6\times10^{-4} m^2K/w$. The contact resistance between insulation fire brick and metal plate is $1.5\times10^{-4} m^2k/w$. Calculate (i) heat flow through the furnace wall/m^2. (ii) overall heat transfer coefficient (iii) temperature at the interface.

(OR)

b. A cylinder 1m long and 0.05 m in diameter is placed in atmosphere at 45°. It is provided with 10 longitudinal straight fins of material having thermal conductivity 120 W/mK. The height of fin is 0.02 m and thickness is 2×10^{-3}m. Heat transfer coefficient between cylinder and atmospheric air is $17 W/m^2K$. Calculate the rate of heat transfer and temperature at the end of fins. If the surface temperature of cylinder is 150°C.