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QUESTION BANK

Subject with Code: Advanced Heat and Mass Transfer **Course & Specialization**: M.Tech – Th. Engg

Year & Sem: I & I-Sem **Regulation:** R16

UNIT-I

1.		Discuss basic laws of 3 modes of heat transfer?	[12M]
2.		Derive general 3D conduction equation for steady state?	[12M]
3.	(a)	What are the applications of heat transfer? (b)Sheets of brass and steel, each of thickness 1 cm, are placed in contact. The outer surface of brass is kept at 100 ^{0}C and the outer surface of steel is kept at O ^{0} C. what is the temperature of common interface?. The thermal conductivity of brass and steel are in the ratio of 2:1	[12M]
4.	(a)	Define thermal conductivity and explain its significance in heat transfer (b) An un insulated wire suspended in air produces electrical heating at the rate of q^{i} =2 W/m. The wire is a bare cylinder of radius ri = 0.5 mm, and the temperature difference between it and the atmosphere is 25^{o} C. It is recommended that this wire be covered with a plastic sleeve of electrical insulation, the outer radius of which is ro = 1 mm. The thermal conductivity of plastic is k = 0.15 W/mk. calculate the critical radius.	[6M] [6]
5.	(a)	How does the science of heat transfer differ from the science of thermodynamics? (b)Two rods of same diameter, one made of brass(k = 85 W/mk) and the other made of copper (k = 375 W/mk) have one of their ends inserted into the furnace.Both rods are exposed to the same atmosphere. At a distance of 105mm away from the furnace end the temperature of the brass rod is 120^{o}C. At what distance from the furnace end , the same temperature would be attained by the copper rod?.	[4M] [8M]
6.	(a)	Define efficiency and effectiveness of fin.	[4M]
	(b)	At a certain time, the temperature distribution in a long cylinder for the tube radius 30 cm and outer radius 50cm is given by t= 800 + 1000r – 5000r^{2} where t is in ^{0}C and r in m. The thermal conductivity and thermal diffusivity of tube material are 58 w/mk and 0.004m^{2}/ h respectively. Find: (i)Rate of heat flow at inside and outside surface per unit length	[8M]
7.			

	(a)	Explain the overall Heat transfer coefficient.	[3M]
	(b)	The walls of sparsely furnished single room cabin consist of two layers of pine-wood(K=0.10W/mK),each 2cm thick,sandwiching 5cm of fiberglass(K=0.038W/mK) insulation.The cabin interior is maintained at 20^0C when the ambient air temperature is 2^0c.If the interior and exterior convective heat transfer coefficients are 3 and 6 W/m^2K respectively,and the exterior surface is coated with a white acrylic paint (Ɛ=0.9),Estimate the heat flux through the wall.	[7M]
8.	(a)	A stainless steel fin (K=20W/mK) having a diameter of 20 mm and length of 0.1 m is attached to a wall at 300^0C.The ambient temperature is 50^0C and the heat transfer coefficient is 10W/m^2K.The fin tip is insulated.Determine (a) The rate of heat dissipation from the fin,(b) The temperature at the fin tip.	[12M]
9.		Define Biot and Fourier numbers. And explain the Lumped thermal capacity analysis	[12M]
10.		A gas filled tube has 2mm inside diameter and 250mm length. The gas is heated by an electrical wire of diameter 0.05mm located along the axis of the tube .The current and voltage drop across the heating element are 0,5 A and 4V respectively.If the measure wire and inside wall temperatures are 175^0C and 150^0C respectively .Determine the thermal conductivity of gas filling the tube.	[12M]

UNIT-II

1.	(a)	What is the physical significance of the Reynolds number? How is it defined for external flow over a plate of length 'L'?.	[5M]
	(b)	A 2 m x 3 m flat plate is suspended in a room and is subjected to air flow parallel to its surfaces along its 3 m long side. The free stream temperature and velocity of air are 20 and 7 m/s. The total drag force acting on the plate is measured to be 0.86 N. Determine the average convective heat transfer coefficient for the plate.	[7M]
2.	(a)	What is critical Reynolds number for flow over flat plate	[4M]
	(b)	Calculate the average heat transfer coefficient and heat transfer at a distance of 10 cm from the leading edge of an entirely heated plate placed in an air stream. The air velocity is 10 m/sec,Ites temperature T=30^0C the surface temperature of plate is 70^0 C.The plate is 1m wide.	[8M]
3.		Explain the Boundary layer theory for forced convection.	[12M]
4.		Water 25^0c enter a pipe with a constant wall heat flux $q_{s''=1KW/}m^2{}_{.The}$ flow is	[12M]

		hydrodynamically and thermally fully developed.The mass flow rate of water is m=10 gr/sec and the pipe radius r_0=1cm.Calculate (a) Reynolds number (b) The heat transfer coefficient and (c) The difference between local wall temperature and local mean temperature(bulk).	
5.		Lubricating oil at a temperature of 60^0c enters a 1 cm diameter tube with a velocity of 3.5 m/sec. The tube surface is maintained at 30 ^{0}c.Calculate the tube length required to cool the oil to 450c.Assume that the oil has the following average properities.ρ=865 kg/m^3,K=0.14W/mK,Cp=1.78KJ/kgK,and v=9x10^{-6} $m^{2/}$sec.	[12M]
6.			
	(a)	Define Grashoff number and Nusselt number	[4M]
	(b)	The maximum allowable surface temperature of an electrically heated vertical plate 15 cm height and 10 cm wide is 140^0C.Estimate the maximum rate of Heat dissipation from both sides of the plate in an atmosphere at 20^0C.The radiation heat transfer coefficient is 8.72 W/m2K.For air at 80^0C take v = 21.09x10^{-6} m^2/sec, Pr=0.692 and k=0.03W/mK.	[8M]
7.		Define the different dimensionless parameters used in natural convection and explain their significance .Explain the combined natural forced convection.	[12M]
8.		A wall of a cold storage having an air gap is 6m high and 11 m wide .The air gap width is 2.5 cm if the walls surfaces across the air gap have a temperature of 45^0C and 35^0C,Find heat gained by natural convection and conduction through the air gap.	[12M]
9.		A fine wire having a diameter of 0.02mm is maintained at a constant temperature of 54^0C by an electrical current .The wire is exposed to air at 1 atm and 0^0c. Calculate the electrical power necessary to maintain the wire temperature if the length is 50 cm.	[12M]
10.		The door of a hot oven is 0.5 m high and is 200^0C. The outer surface is exposed to atmospheric pressure air at 20^0C Estimate the average heat transfer coefficient at outer surface of the door.	[12M]

UNIT-III

1.	(a)	Explain the film wise condensation	[4M]
	(b)	A tube of 15 mm outside diameter and 1.5 m long is used for condensing steam at 40 kPa. Calculate the average heat transfer coeffient when the tube is (a) horizontal,(b) vertical and its surface temperature is maintained at 50^0 C.	[8M]
2.		Explain the Nusselts theory of film condensation on a vertical plate	[12M]
3.	(a)	Explain the drop wise condensation .	[4M]
	(b)	A vertical plate 300mm wide 1.2 m high is maintained at 70^0C and is exposed saturated steam at 1 atm pressure. Calculate the heat transfer coefficient and the total mass of steam condensed per hour. What would the heat transfer coefficient if the plate is inclined at 30^0 to the vertical?	[8M]
4.		In a solar- assisted air conditioning system, 0.5 kg/s of ambient air at 270 K is to be preheated by the same amount of air leaving the system at 295 K. If a counter flow heat exchanger has an area of 30 m2, and the overall heat transfer coefficient is estimated to be 25W/m2K, determine the outlet temperature of the preheated air. Take cp for air as 1000J/kg K.	[12M]
5.	(a)	Explain the types of heat exchangers with neat sketch?	[5M]
	(b)	A square array of 400 tubes 15 mm outer diameter is used to condense steam at atmospheric pressure. The tube walls are maintained at 88 ^{0} C by a coolant flowing through the tubes. Calculate the amount of steam condensed per hour per unit length of the tubes.	[7M]
6.	(a)	How heat exchangers are classified?	[4M]
	(b)	A and B exchange heat in a counterflow heat exchanger. Fluid A enters at 420 ^{0}C and has a mass flow rate of 1kg/s. Fluid B enters at 20 ^{0}C and has a mass flow rate of 1kg/s.The effectiveness of heat exchange is 75%.determine (i) the rate of heat flow,(ii) the exit temperature of fluid B. Specific heat of fluid A is 1kj/kgK and that of fluid B is 4kj/kgK.	[08]
7.	(a)	Explain the Overall heat transfer coefficient and Fouling factor	[05]
	(b)	A and B exchange heat in a parallel heat exchanger. Fluid A enters at 450 ^{0}C and has a mass flow rate of 1kg/s. Fluid B enters at 20 ^{0}C and has a mass flow rate of 1kg/s. The effectiveness of heat exchange is 75%.determine (i) the rate of heat flow,(ii) the exit temperature of fluid B. Specific heat of fluid A is 1kj/kgK and that of fluid B is 4kj/kgK.	
8.	(a)	Compare the parallel flow and counter flow heat exchangers	[10M]
9.	(b)	In a solar assisted air –conditioning system, 0.5kg/s of ambient air at 270 k is to be preheated by the same amount of air leaving the system at 295 K.	

		If a counterflow heat exchanger has an area of 30 m^2, and the overall heat transfer coefficient is 25w/m^2k, determine the outlet temperature of preheated air. Take Cp for air is 1000j/kgk.	
10.	(a)	(a)explain the effectiveness of heat exchanger	[10M]
	(b)	Derive an expression for effectiveness of a counter flow heat exchanger in terms of number of transfer unit (NTU) and heat capacity ratio of two fluids .	

UNIT-IV

1.		Explain the Stefan-Boltzmann law,Planck's law and wien's displacement law	[12M]
2.	(a)	Explain the Wien's displacement law	[5M]
	(b)	What wave lengths correspond to maximum emissive power of the Sun and earth? .Take T_{sun} = 5762 K and T_{earth} = 290 K.	[7M]
3.	(a)	Explain the Absorptivity,Reflectivity and Transmissivity.	[6M]
	(b)	A 100 W electrical bulb has a filament temperature of 3001 ^{0}C.Assuming the filament to be black. Calculate (a) the diameter of the wire if the length is 250 mm and (b) the efficiency of the bulb if visible radiation lies in the range of wavelength from 0.5µ to 0.8µ.	[6M]
4.	(a)	Explain the Kirchhoff's law of radiation	[6M]
	(b)	Two parallel rectangular surfaces 1m x 2m are opposite to each other at a distance of 4m. the surfaces are black and at 100^{0}C and 200^{0}c respectively. Calculate the heat exchange by radiation between the two surfaces.	[6M]
5.	(a)	Explain the Stefan-Boltzmann law.	[5M]
	(b)	A Cubical oven has inside sides equal to 0.4m. One of the faces of the oven forms the door. If the five other inside faces are black and maintained at 600 ^{0} C, find the rate of heat loss if the oven door is kept open.	[7M]
6.	(a)	Explain about radiation from flames	[5M]
	(b)	The temperature in an industrial furnace is maintained at 2650 Considering the furnace as black body finds the following: (i) Spectral emissive power at (ii) Maximum spectral emissive power. (iii) Total emissive power.	[7M]
7.		The distance of the sun from earth is 150x10^6 km. if the radius of the sun is 0.7x10^6 km and its temperature is 6200 k,estimate approximately the mean temperature of the earth. Assume that the rate of radiative transfer from the	[12M]

		sun to the earth is equal to the rate of radiant transfer from earth to the outer space which is at 0 K.consider the earth and sun as black.	
8.	(a)	What is a gray body? How does it differ from black body?	[5M]
	(b)	A black body emits radiation at 2000 k. calculate (i) the monochromatic emissive power at 1µm wave length,(ii) wavelength at which the emission is maximum, and (iii) the maximum emissive power	[5M]
9.		Two very large parallel planes with emissiveties 0.3 and 0.8 exchange radiative energy.Determine the percentage reduction in radiative energy transfer when a polished aluminium radiation shield (Ɛ =0.04) is placed between them	[12M]
10.	(a)	State and explain Stefan Boltzmann law.	[5M]
	(b)	The overall heat transfer coefficient due to convection and radiation for a steam main at 2000C running in a large room at 30^0 is 17.95 W/m^2K. Calculate the heat transfer coefficient due to convection and radiation taking the emissivity of the pipe surface as 0.8.	[7M]

UNIT-V

1.			
	(a)	State Fick's law of diffusion. Find relation for diffusion of component A into component B.	[5M]
	(b)	Gaseous hydrogen is stored at elevated pressure in a rectangular steel container of 10 mm wall thickness. The molar concentration of hydrogen in steel at the outer surface is 2kgmol/m^3, while the concentration of hydrogen in steel at the outer surface is 0.5kgmol/m^3. The binary diffusion coefficient for hydrogen in steel is 0.26x 10^{-12} m^2/s. what is the mass flux of hydrogen through the steel?	[7M]
2.			
	(a)	Define mass fraction and molar concentration.	[5M]
	(b)	Air at 1 atm, 25^0C, containing small quantities of iodine flows with a velocity of 5.18 m/s inside a 3.048 cm diameter tube. Determine the mass transfer coefficient for iodine transfer from the gas stream to the wall surface. If C_m is the mean concentrate of iodine in kg mol/m^3 in the air stream, determine the rate of deposition of iodine on the tube surface where the iodine concentration is zero.	[5M]
3.			
	(a)	What do you understand by diffusion coefficient? Give its units.	[4M]
	(b)	Calculate the mass transfer coefficient of water vapour in air in turbulent flow at 60 m/s at 1 atm. 300 K, over a flate plate 0.3 m long. Assume concentration of vapour in air is sufficiently dilute so that. P_B/p=1.	[8M]
4.		State Fick's law. Derive the general mass transfer equation in Cartesian coordinates.	[12]
5.	(a)	Define mass fraction and molar concentration.	[5M]

	(b)	Estimate the value of mass transfer coefficient for the absorption of NH_3 by the wet surface of a cylinder placed in a turbulent air steam flowing across the cylinder at 5m/s. No data on mass transfer exist for this process, but heat transfer tests with the same geometry and air velocity show h= 56.8W/m^2K.For air, pr= 0.74, ρ = 1.2 kg/m^3 and Cp = 1.005kj/gk. For dilute NH_3-air mixture, p_{Bm} = P and Sc= 0.61.	[7M]
6.	(a)	Define Sherwood number and Schmidt number	[04]
	(b)	A thin plastic membrane is used to separate Helium from a gas steam. Under state conditions, the concentration of helium in the membrane is known to be 0.02 and 0.005 kmol/m^3 at the inner and outer surfaces, respectively. If the membrane is 1mm thick and the binary diffusion coefficient of helium with respect to plastic is 10^{-9} m^3/s, what is the diffusion flux?	[08M]
7.		Oxygen is maintained at pressure of 2 bar and 1 bar on opposite sides of rubber membrane that is 0.5 mm thick, and the entire system is at 25 ^{0}C. What is the molar diffusion flux of O_2 through the membrane?. What are the molar concentrations of O_2 on both sides of the membrane(outside the membrane)	[12M]
8.	(a)	State and explain the Fick's law	[5M]
	(b)	Calculate the mass transfer coefficient of water vapour in air in turbulent flow at 60 m/s at 1 atm. 400 K, over a flate plate 0.6 m long. Assume concentration of vapour in air is sufficiently dilute so that. P_B/p=1.	[7M]
9.		A thin plastic membrane is used to separate hydrohen from a gas steam. Under state conditions, the concentration of hydrogen in the membrane is known to be 0.02 and 0.005 kmol/m^3 at the inner and outer surfaces, respectively. If the membrane is 1mm thick and the binary diffusion coefficient of hydrogen with respect to plastic is 10^{-9} m^3/s, what is the diffusion flux?	10M
10.	(a)	Gaseous nitrogen is stored at elevated pressure in a rectangular steel container of 10 mm wall thickness. The molar concentration of nitrogen in steel at the outer surface is 2kgmol/m^3, while the concentration of nitrogen in steel at the outer surface is 0.5kgmol/m^3. The binary diffusion coefficient for nitrogen in steel is 0.26x 10^{-12} m^2/s. what is the mass flux of nitrogen through the steel?	[12M]

Prepared By: Dr. **D.Subramanyam**