ALPHA COLLEGE OF ENGINEERING &TECHNOLOGY
DEPARTMENT OF MECHANICAL ENGINEERING
HEAT TRANSFER (2151909)

ASSIGNMENT: 1

INTRODUCTION AND CONDUCTION

B.E. – 5th SEM CLASS: ME MARKS: 10

NO	QUESTIONS	YEAR	MARK
	INTRODUCTION AND CONDUCTION		
1	Derive general heat conduction equation in Cartesian co-ordinates. Also deduce the equation for (i) Steady state conduction (ii) No heat sources (iii) No heat source and steady state condition (iv) One dimensional heat conduction equation without heat generation under steady state	MAY-11,12 JUN-13 Dec-12	7
2	Define the effectiveness of fin? How to increase the effectiveness of fin? What happens if εfin = 1, εfin < 1 and εfin > 1	MAY-11	7
3	State and explain (i) Critical thickness of insulation (ii) efficiency of fins (iii) effectiveness of fins	MAY-12	6
4	Differentiate between steady state and transient heat conduction. Explain two examples of heat conduction under unsteady state.	MAY-12	7
5	Derive the one dimensional radial steady state heat conduction through hollow cylinder without heat generation. Also obtain the expression of logarithmic mean are for hollow cylinder.	MAY-12	7
6	Derive general heat conduction equation in spherical co-ordinates	DEC-11	7
7	Derive an expression for heat dissipation in Rectangular Fin of uniform cross section which is insulated at tip .	DEC-11	7
8	Derive the governing differential equation for temperature distribution of constant cross-sectional area fin. Hence derive expression for temperature distribution for long fin stating the assumption made.	JUN-13	7
9	What do you mean by critical radius of insulation? Derive critical radius of insulation rc = k / ho	JUN-13	7
10	Derive general heat conduction equation in cylindrical coordinate system.	DEC-13	7
11	Derive an expression for heat transfer for an adequately long of Rectangular fin with insulated tip.	DEC-13	7
12	What are Fourier and Biot Number? What is the physical significance of these number?	DEC-13	7
13	Derive the governing differential equation for temperature distribution of constant cross-sectional area fin. Hence derive expression for temperature distribution and total steady state heat transfer for the fin with insulated tip.	DEC-12	7
14	What is the significance of Biot number in Lumped parameter analysis?	DEC-12	7
15	A wall 30 mm thick of size 5m X 3m made of red bricks (k=0.35 W/mK). It is covered on both sides by the layers of plaster 2cm thick (k=0.6 W/mK). The wall has a window of size 1m X 2m. The 12 mm thick window glass is having thermal conductivity of 1.2 W/mK. Estimate the rate of heat flow through the wall. The temperatures of inner and outer face are 10^{O}C and 40^{O}C respectively.	MAY-11	7

16	Two rods A and B of equal diameter and equal length, but of different materials are used as fins. The both rods are attached to a plain wall aintained at 160 ^{O}C, while they are exposed to air at 30 ^{O}C. The end temperature of rod A is 100 ^{O}C while that of the rod B is 80 ^{O}C If thermal conductivity of rod A is 380 W/mK, calculate the thermal conductivity of rod B. These fins can be assumed as short with end insulated.	**MAY-11**	7
17	A hot gas at 330 ^{O}C with convection coefficient 222 W/m2K is following through a steel tube of outside diameter 8 cm and thickness 1.3 cm. It is covered with an insulating material of thickness 2 cm, having conductivity of 0.2 W/mK. The outer surface of insulation is exposed to ambient air at 25 ^{O}C with convection coefficient of 55 W/m2K.Calculate: 1) Heat loss to air from 5 m long tube. 2) The temperature drop due to thermal resistance of the hot gases, steel tube, the insulation layer and the outside air. Take conductivity of seel = 50 W/m2K.	**MAY-12**	7
18	A steel tube of 5 cm inner diameter and 8 cm outer diameter (k = 16 W/mK), is covered with an insulation of 3 cm thickness (k = 0.3 W/mK). A hot gas at 350 ^{O}C h = 400 W/m2K flows. Calculate the heat loss from the tube for 20 meter length. Also calculate the temperature at the interface of insulation and steel.	**MAY-12**	7
19	A furnace wall is made up of three layers of thickness 250mm,100mm and 150mm with thermal conductivity of 1.65,k and 9.2 W/m·C respectively .The inside is exposed to gases at 1250 ^{O}C with a convection coefficient of 25 W/m2· ^{O}C and the inside surface is at 1100 ^{O}C, the outside surface is exposed to air at 25 ^{O}C with convection coefficient of 12 W/m2· ^{O}C Determine:- 1)The unknown thermal conductivity k 2)The overall heat transfer coefficient 3)All Surface temperatures	**DEC-11**	7
20	A steel rod (k=30 W/m ^{O}C), 12 mm in diameter and 60 mm long, with an insulated end is to be used as spine. It is exposed to surrounding with a temperature of 60 ^{O}C and heat transfer coefficient of 55 W/m2 oC. The temperature at the base is 100 ^{O}C Determine : i) The fin effectiveness ii) The fin efficiency iii) The temperature at the edge of the spine iv) The heat dissipation	**JUN-13**	7

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ASSIGNMENT: 2

CONVECTION

B.E. – 5th SEM CLASS: ME MARKS: 10

NO	QUESTION	YEAR	MARK
1	For natural convection heat transfer, show that Nu = f(Gr, Pr).	MAY-11 JUN-13	7
2	Show physical significance of Following non-dimensional numbers: Nu (Nusselt Number),Gr (Grashof Number) ,Pr (Prandtl Number) Re (Reynold Number).	MAY-11	7
3	Define and discuss velocity boundary layer and thermal boundary layer over a fat plate. Show the thickness of these layers for different Prandtl numbers	MAY-12	7
4	By dimensional analysis show that for forced convection heat transfer the Nusselt number can be expressed as a function of Prandtl number and Reynolds number	MAY-12	7
5	What is the difference between the natural and forced convection	DEC-11	3
6	Derive momentum equation for hydrodynamic boundary layer over a flat plate	DEC-11	7
7	Define Nusselt number and Prandtle number	DEC-11	4
8	Velocity and thermal boundary layer	JUN-13	3
9	Discuss the concept of thermal boundary layer in case of flow over the plates. How it differ from velocity boundary?.	DEC-13	7
10	State the relationship between Nusselt, Grashoff and Prandtl number in case of heat transfer by nature convection from a vertical plate	DEC-13	7
11	Explain with neat sketch Boundary Layer concept and show velocity boundary layer growth due to flow over plate	DEC-13	7
12	Explain the concept of hydrodynamic and thermal boundary layers with reference to flow over a flat heated plate	DEC-12	7
13	A large fireplace has a glass fire screen which covers a vertical opening in the fireplace. The opening is 1.2m high and *2.50* m wide. Its surface temperature is 2300*C* and the ambient air temperature is 24°C. Determine the convective rate of heat transfer from the fireplace to the room. The air properties at mean film temperature are :*k* = 0.033 65 W/m.K, *v* = 25.90 X 10-6 m2/s, Pr = 0.689 Use correlation for given condition	MAY-11	7
14	Air at 20 ^{O}C and 1 atmosphere pressure is forced through a 25 mm diameter tube 400 mm long, at an average velocity of 0.33 m/sec. calculate the rate of heat transfer if the tube wall is maintained at 180 ^{O}C. The air properties at mean film temperature are : *k* = 3.208 W/m. ^{O}C ,*v* = 23.13 X 10-6 m2/s ,Pr = 0.688 Use correlation for given condition	MAY-11	7

	$\overline{Nu} = 1.671\left[Re.Pr\left(\frac{D}{L}\right) + 0.012\left(Re.Pr\left(\frac{D}{L}\right)(Gr)^{1/3}\right)^{4/3}\right]^{1/3}$		
15	The air at atmospheric pressure and temperature of 30 ^{O}C flows over one side of plate of a velocity of 90 m/min. This plate is heated and maintained at 100 ^{O}C over its entire length. Find out the following at 0.3 and 0.6 m from its leading edge. (1) Thickness of velocity boundary layer and thermal boundary layer. (2) Mass flow rate which enters the boundary layer between 0.3 m and 0.6 m per metre depth of plate.Assume unit width of plate. Properties of air at 30 ^{O}C: ρ = 1.165 kg/m3, v = 16 × 10-6 m2/s, Pr = 0.701, Cp = 1.005 kJ/kgk, k = 0.02675 W/mK	**MAY-12**	7
16	Air at 20 ^{O}C and at atmospheric pressure flows at a velocity 4.5 m/s past a flat plate with a sharp leading edge. The entire plate surface is maintained at a temperature of 60 ^{O}C. Assuming that the transition occurs at a critical Reynolds number of 5×10^5, find the distance from the leading edge at which the boundary layer changes from laminar to turbulent. At the location calculate: (1) thickness of hydrodynamic and thermal boundary layer, (2) Local and average heat transfer coefficients, (3) Heat transfer rate from both sides per unit width of plate. Use Nuxc = 0.332 $(Rexc)^{1/2}(Pr)^{1/3}$. Assume cubic velocity profile and approximate method. Thermophysical properties of air at mean film temperature of 40oC are, ρ =1.128 kg/m3, v = 16.96 × 10-6 m3/s, k = 0.02755 W/mk Pr=0.7.	**MAY-12**	7

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ASSIGNMENT: 3

HEAT EXCHANGER

B.E. – 5th SEM CLASS: ME MARKS: 10

NO	QUESTION	YEAR	MARK
1	Define effectiveness of heat exchanger. Derive equation for effectiveness of a parallel flow heat exchanger	MAY-11,12	7
2	Derive an expression for LMTD for counter flow heat exchanger	MAY-12 JUN-13	7
3	Derive the relationship between the effectiveness and number of transfer units for a counter flow heat exchangers.	DEC-11	7
4	Sketch a shell and tube type heat exchanger	DEC-11	4
5	Discuss the importance of heat exchangers for industrial use.	DEC-11	3
6	Derive equation of logarithmic mean temperature difference for parallel flow Heat-exchanger.	DEC-13	7
7	Show that logarithmic mean temperature difference is given by what wll be the value of LMTD if $\theta_1 = \theta_2$?	DEC-12	7
8	A counter flow heat exchanger is employed to cool oil of specific heat Cp=2.45 KJ/Kg ^{O}C with mass flow rate of 0.55 Kg/sec from 115 ^{O}C to 40 ^{O}C by water. The inlet and outlet temperature of cooling water are 150C and 75 ^{O}C respectively. The overall heat transfer co-efficient is 1450W/m2. ^{O}C Using NTU method, calculate (i) The mass flow rate of water (ii) The effectiveness of heat exchanger (iii) The surface area required.	MAY-11	7
9	A parallel flow heat exchanger has its tubes of 5 cm internal and 6 cm external diameter. The air flows inside the tubes and receives heat from hot gases circulated in the annular space of the tube at the rate of 100 kW. Inside and outside heat transfer coefficients are 250 W/m2K and 400 W/m2K respectively. Inlet temperature of hot gases is 500 ^{O}C, outlet temperature of hot gases is 300 ^{O}C, inlet temperature of air 50 ^{O}C, Exit temperature of air 140 ^{O}C Calculate : (1) Overall heat transfer coefficient based on outer surface area (2) Length of the tube required to affect the heat transfer rates. Neglect the thermal resistance of the tube.	MAY-12	7

	(3) If each tube is 3 m length find the number of tubes required.		
10	A chemical having a specific heat of 3.3 kJ/kg K flowing at the rate 20,000 kg/h enters a parallel flow heat exchanger at 120 ^{O}C. The flow rate of cooling water is 50,000 kg/h with an inlet temperature of 20 ^{O}C. The heat transfer area is 10 m^2 and overall heat transfer coefficient is 1200 W/ m^2 ^{O}C. Taking specific heat of water as 4.186 kJ/kgK. Find: (1)effectiveness of the heat exchanger (2) Outlet temperature of water and chemical	**MAY-12**	7
11	A heat exchanger is to be designed to condense 8 kg/sec of an organic liquid (tsat=80·C,hfg=600 Kj/kg)with cooling water available at 15· ^{O}C and at a flow rate of 60kg/sec.The overall heat transfer coefficient is 480 W/m2 ^{O}C calculate: (a)the number of tube required .The tubes are to be of 25 mm outer diameter ,2 mm thickness and 4.85 m length (b)The number of tube passes. The velocity of the cooling water is not to exceed 2m/sec.	**DEC-11**	7

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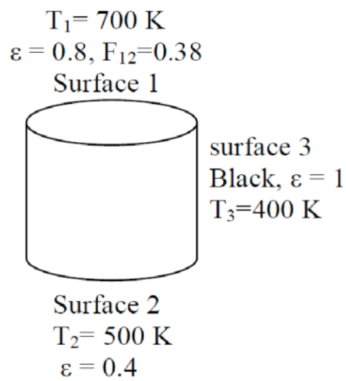
ASSIGNMENT: 4

RADIATION

B.E. – 5th SEM CLASS: ME MARKS: 10

NO	QUESTION	YEAR	MARK
1	Define: Emissivity ,Radiosity, Monochromatic emissive power, Irradiation, Absorptivity, Total emissive power, Solid angle.	MAY-11 JUN-13	7
2	Derive the expression for radiant heat exchange between two finite black surfaces by radiation.	MAY-12	7
3	Explain the following terms 1.Radiation 2.Thermal resistance 3.Thermal diffusivity 4.Thermal conductivity	DEC-11 JUN-13	4
4	Enumerate the factors on which the rate of emission of radiation by body depends.	DEC-11	3
5	What is black body? How does it differ from gray body? Give examples of each	DEC-11	3
6	Derive expression for Radiation Heat exchange between two concentric infinite long grey cylinder	DEC-13	7
7	(i) Derive a general relation for the radiation shape factor in case of radiation between two surfaces. (ii) Explain Wein's displacement law of radiation.	DEC-12	7
8	(i) Explain emissivity and absorptivity of a surface. Also differentiate between black body and grey body. (ii) Explain Kirchoff's law of radiation	DEC-12	7
9	Define intensity of radiation and prove that the intensity of normal radiation is $1/\pi$ times the total emissive power. Also explain Planck's law radiation heat transfer.	DEC-12	7
10	Two large parallel plates with emissivity (ε) = 0.5 each, are maintained at different temperatures and are exchanging heat only by radiation. Two equally large radiation shields with surface emissivity 0.05 are introduced in parallel to the plates. Find percentage reduction in net radiative heat transfer.	MAY-11	7

11	Consider a cylindrical furnace with radius = 1m and height = 1m as shown in fig. Take $\sigma = 5.67 \times 10^{-8}\ W/m^2K^4$  Determine the net rate of radiation heat transfer at each surface during the steady operation and explain how these surfaces can be maintained at specified temperatures.	**JUN-13**	7

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ASSIGNMENT: 5
TWO PHASE HEAT TRANSFER

B.E. – 5th SEM CLASS: ME MARKS: 10

NO	QUESTION	YEAR	MARK
1	Discuss various regimes of pool boiling	MAY-11	7
2	Write note on influence of non condensable gases on condensation	MAY-11	7
3	Distinguish between (1) Subcooled and Saturated boiling (2) Nucleate and film boiling	MAY-12	7
4	Differentiate between pool boiling and forced convection boiling		7
5	Explain the following in detail: (draw neat sketch if required), 1.Film wise and drop wise condensation, 2.Fouling factors and over all heat transfer coefficient	DEC-11	7
6	Draw : labeled boiling curve for water	JUN-13	7
7	Explain term Boiling also explain various regimes of boiling	DEC-13	7
8	Define condensation process also explain film condensation and drop-wise condensation	DEC-13	7
9	Discuss in details the various regimes in boiling and explain (i) the condition for the growth of bubbles and (ii) effect of bubble size on boiling.	DEC-12	7
10	A spherical element of 40 mm diameter is initially at temperature of 27 ^{O}C. It is placed in boiling water for 4 minutes. After 4 minutes, at what temperature, the spherical element will reach? If the same spherical element is initially at 0 ^{O}C, find out by lump theory that how much time will be taken by the element to reach at that temperature? Take properties of the given spherical element as: k = 10 W/m ^{O}C, ρ=1200kg/m^3 , c = 2KJ/kg ^{O}C heat transfer coefficient h= 100W/m^2 ^{O}C	MAY-11	7

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