UNIT-1

CO1: To understand the basic concept of mode of heat transfer.

CO-3: To analyze the complex problems of heat transfer with proper boundary conditions.

SN	CONTENTS	HOURS
1	Introduction: Objective, Scope and outcome of the course	1
2	Heat transfer processes, conduction and radiation. Fourier's law of heat conduction, thermal conductivity, thermal conductivity of solids, liquids and gases, effect of temperature on thermal conductivity. Newton's law of cooling, definition of overall heat transfer coefficient. General parameters influence the value of heat transfer coefficient	4
	Conduction: General 3-Dimensoinal conduction equation in Cartesian, cylindrical and spherical coordinates; different kinds of boundary conditions; nature of differential equations; one dimensional Heat conduction with and without heat generation; electrical analogy; heat conduction through composite walls; critical thickness of insulation.	3

Heat transfer and Thermodynamics

Thermodynamics :

- Thermodynamics" deals with the amount of energy in form of heat or work during a process and only considers the end states in equilibrium.
- How much heat is transferred (dQ)
- How much work is done (dW)

Heat transfer

- Heat Transfer" deals with the *rate of heat transfer* thus, Heat transfer deals with *time* and non equilibrium phenomena. Heat can only transfer when there is *a temperature gradient* exists in a body and which is indication of non equilibrium phenomena.
- How (with what **modes**) dQ is transferred
- o At what rate dQ is transferred
- Temperature distribution inside the body

Modes of Heat transfer

Conduction :

• The process by which heat directly transmitted through the material of a substance when there is a difference of temperature between adjoining regions, without movement of the material

Fourier's law of conduction: IT states that the heat transferred through conduction is proportional to

- Area of cross section perpendicular to the direction of heat flow. (A)
- Temperature difference between the points causing the heat flow. (dT/dx)
- Inversely proportional to the thickness of the material along which heat is flowing.(x)

$$q = kA dT/dx$$

Where,

- o q = heat transfer (W)
- \circ k = Thermal conductivity (W/mK)
- dT/dx = Temperature gradient (K)

Convection :

• An energy transfer across a system boundary due to a temperature difference by the combined mechanisms of intermolecular interactions and bulk transport. Convection needs fluid matter.

Newton's law of cooling:

• Rate of convective heat transfer is directly proportional to heat transfer surface area, convective heat transfer coefficient and temperature difference.



$$Q = hA dT$$

- Q = Convection heat transfer (W)
- h = Heat transfer coefficient (W/m²K)
- dT = Temperature gradient (K)

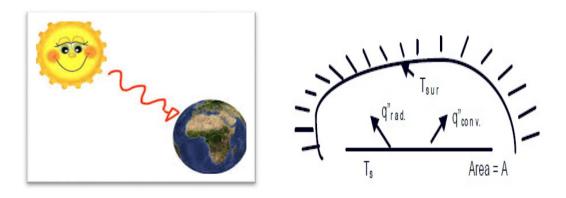
Radiation :

• Radiation is the emission or transmission of energy in the form of waves or particles through space or through a material medium. This includes: electromagnetic radiation, such as radio waves, microwaves, infrared, visible light, ultraviolet, x-rays, and gamma radiation (γ)

Stefan boltzmann law :

• It state that the total radiant heat power emitted from a surface is proportional to the fourth power of its absolute temperature.

However, the rate of radiation heat exchange between a small surface and a large surrounding is given by the following expression



Radiation from sun

Radiation heat transfer

$$Q = \varepsilon. \sigma. A. \left(T_s^4 - T_{surr}^4\right)$$

- Q = Radiation heat transfer (W)
- σ = Boltzmann constant (W/m²K⁴)
- $\mathcal{E} = \text{Emissivity}$

Thermal Conductivity

When a system gains heat, it stores some of its heat energy and transports the remaining heat energy to some other system. The ability of a system to transport heat energy is referred to as Thermal conductivity of the system. Basically, it is a Transport property of a system. Thermal conductivity is represented by k. The unit of thermal conductivity as we have seen earlier is W/m^*K .

Thermal conductivity in solids, liquids and gases

What governs conduction in solids, liquids and gases?

Before analyzing thermal conductivity for different phases, let us look at the phenomena which govern heat conduction through solids, liquids, and gases.

In solids, heat can be conducted through two mechanisms. First is lattice vibrations and the second is Flow of free electrons. Increased lattice vibrations facilitate the transport heat energy through the medium. The flow of free electrons increases electrical conductivity. This also helps in the process of diffusion of heat energy through the medium.

In liquids and gases, heat conduction occurs mainly through two mechanisms. First is the collision between atoms, molecules or ions, and second is molecular diffusion. As the number of collisions increases, the exchange of energy among molecules increases. This helps in the transport of heat energy through the medium. Molecular diffusion is the random movement of molecules in a medium. As the random movement of molecules increases, it obstructs the transport of heat energy in a particular direction.

On what factors does the thermal conductivity depend for metals, non-metals and alloys?

As we have seen above, the conduction of heat through solids is dependent on two effects, namely lattice vibrations and flow of free electrons. The thermal conductivity is obtained by adding lattice and electronic components.

In Pure metals, the electronic effect plays a dominant role. Thus, they have relatively higher values of thermal conductivity. For Pure metals, $k \sim ke$.

In Non-metals, the lattice vibrations effect plays a dominant role. Non-metals generally have high electric resistance, which obstructs the flow of electrons. Therefore, for non-metals $k \sim kl$.

The lattice component of thermal conductivity strongly depends on the way the molecules are arranged. For example, wood, which is an amorphous solid (molecules are arranged in highly disorderly manner), has relatively lower values of thermal conductivity and act as a thermal insulator. Now consider diamond. It is a highly ordered crystalline solid. Thus it has the highest thermal conductivity at room temperature. Beryllium Oxide (BeO), also a non-metal, has relatively higher thermal conductivity due to its crystallinity.

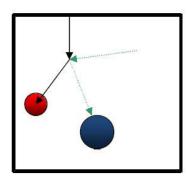
Metals are good electrical and heat conductors because they have free electrons as well as lattice vibrations. On the other hand, non-metals do not have free electrons, meaning they are electrically non-conducting materials. And in general non-metals like wood are thermally non-conducting materials. However, non-metals like diamond and Beryllium Oxide are good heat conductors. As a result, such materials find widespread use in the electronics industry.

E.g. diamond heat sinks used for cooling electronic components.

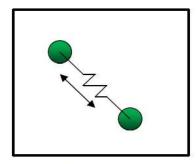
Pure alloys have high thermal conductivity. One would expect an alloy made of two metals of thermal conductivity k_1 and k_2 to have a conductivity k between k1 and k2. Surprisingly, this is not the case. The thermal conductivity of an alloy of two metals is usually much lower than that. For example, the thermal conductivities of Copper and Aluminum are 401 W/m°C and 237 W/m°C respectively.

Material	Thermal Conductivity, W/m K
Copper	401
Silver	429
Gold	317
Aluminum	237
Steel	60.5
Limestone	2.15
Bakelite	1.4
Water	0.613
Air	0.0263

Let us try to gain an insight into the basic concept of thermal conductivity for various materials. The fundamental concept comes from the molecular or atomic scale activities. Molecules/atoms of various materials gain energy through different mechanisms. Gases, in which molecules are free to move with a mean free path sufficiently large compared to their diameters, possess energy in the form of kinetic energy of the molecules. Energy is gained or lost through collisions/interactions of gas molecules.



Kinetic energy transfer between gas molecules.



Lattice vibration may be transferred between molecules as nuclei attract/repel each other.

Solids, on the other hand, have atoms/molecules which are more closely packed which cannot move as freely as in gases. Hence, they cannot effectively transfer energy through these same mechanisms. Instead, solids may exhibit energy through vibration or rotation of the nucleus. Hence the energy transfer is typically through lattice vibrations.

Another important mechanism in which materials maintain energy is by shifting electrons into higher orbital rings. In the case of electrical conductors the electrons are weakly bonded to the molecule and can drift from one molecule to another, transporting their energy in the process. Hence, flow of electrons, which is commonly observed in metals, is an effective transport mechanism, resulting in a correlation that materials which are excellent electrical conductors are usually excellent thermal conductors.

UNIT-I Thermodynamics and Heat Transfer 2. Martin Manager and Martin Martin States · Energy will be exist in various form in this Subject we are primarily interested up Heat energy, which is the form of energy that can be transferred from one system to another as a result of temperature dublienence. The science deals with the determination of rates of such energy transfer is heat transfer. 物が、うったものでもらわる。 Thermodynamics is concerned with the amount of heat transfer as a system undergoes a process from one equilibrium to another and it gives no indication about how long the process will take. The thermodynamic analysis simply tell us how much heat must be transfer to realise a speelfied change of state to satisfy the conservation de energy principle. sophila, inductions at 1.30 The basic requirment de Heat transfer is presence of a temperature debtesence. It is the driving force for the For Heat transfer The rate of heat transfer in certain direction depends on the magnitude of the temp. gradient. (The timp. dubtesence per unit length on rate of change of temp.) in that directory. Page NO G 1

classmate Application areas of Heat transfer Mechanical Bugg. : in Boilers heat exchangers 4) turbine system, internal combustion engine * Error by wall be east in valuate larger in *) methaluyical Enggi- in Furnace, heat treatment plant. of components a david press con be thursterred. from time system is a run electrical Engq" cooling system for electric X) motors generators transformens. such energy transfer is heat transfer. (chemical Engre: en process equipment- used in refineries chemical plant etc 6 of heat provester i as a system i worde goes a >>> Nuclear energy design of nuclear fuel 1 hods against apossible burnout etc. trates. The Intermody names and statistically * Aerospace Engg. In design of an crabt system rockets missife. etc. aprodu harfiegge of conservation of energy principle Cryogenic Engq.: in production, storage & 7) transportation of whilisation of conserve liquid for various industrial, research & defence application man animal som C The sale of these transfers to second with (1) civil Engo: In design of Suspension bridges (sailway track, air conditioning l insulation of buildings . prode to stor Page No O 2

CLASSI modes of heat transfer) conduction conduction occurs mostly in a stationary mediums. It is made of heat transfer in which energy exchange takes place from region of high temp to that or loss temp by direct molecular interaction and by the dust of electrons The thermal energy in solid may be conducted by two-mechanism, migration of free electrons and lattice - vibration. These two effects are additives, but in general the transport due to fre electrons is more effective than transport due to uibrational energy in lattice Structure. In non-metals the energy transfer is due to lattice vibration only produces but The conduction heat planster is liquid and gases ocurs due to collision & dubtusion of molecules duting there random motion, moban/ En gases The mechanism of heat conduction is simple. The teinetic energy of molecule to the function of temp Page No 03

OP	B
FI	These molecules are in continuous random
	motion exchanging energy and momentum
	when a molecule from the high temp region
	collides with molecule from the low
agoste a l	tomp region, it losses every by collision.
N N	as present a broad a for about a sub the second strain a pice
- px.s	en signeds the mechanism of heat
alle de	is near to that gases, However the molecules
3.41	are more closely spaced & informalecular
	forces come into play.
(È)	Convection provide proverty allowed and
	The convection is mode of heat transfer
- Ozon	is which the energy is transported by moving
d la	-fluid particles. The convection heat transfer.
der sta	comprises two Mechanism.
	1) Transfer of energy due to random motion
	(diffusion)
	* Thansfer of energy by bulk or mainoscropic
	motion of fluid (advection) and
	In absence of els any bulk Huid motion, the
	heat transter occurs by pure conductions.
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A set of the set of the	The conversion is not Fundamenty different
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irganike Londuction from Surface to adjusent layer of Hevid + energy transfer due to moss transfer t unduction to adjacent layer of fluid to receiving surface "...... I classified into two type that is based on nature of this de Flow bound a) forced conversory: its fluid motion is artificially induced by pump, fan, or blower, that Forces the fluid over surface to Plow. the heat transfers is said to be forced. b) iblatural convector: it fluid motory is setup by buyancy ebtects. resulting from density différence caused by demperature difference in the fluid, the heat transfer by natural convertion Radiation mermal radiation is the energy emitted by Jubstance because of its temp. The radiation energy emitted by a body to transmitted in the spare in the form of elebromagnetic waves aunding maxwell wave theory. Transter of energy orequire the presence of material medium ! radiation does not. . in fort radiation heat transfer is more efficient in Vacume . Thermal sadiation occurs in the region of wavelength o. Willing to Looking on electromagnetic spectrum. Page No 10 5

Laws of Heat transfer Their are dutivent fundamental and subsidiary leve of Heat transfer) Fourier Law of heat conductor whenever, a temperature gradient exist in a budy, these is an energy transter from the high temp region to low temp region. The fourier law state that " rate of heat conduction per unit area cheat flux) is directing proportional to temp gradient same dia di baruna anasi the beneficion and the contract $\frac{1}{K} = \frac{1}{2} = -\frac{1}{K} \frac{d\Gamma}{dr} = -\frac{1}{K} \frac{d\Gamma}{dr}$ portedix - q - heat flux (w/m2) 2 - rate of heat transfer (W) A - heat transfer area in m2 inormal to direction of heat flow. <u>dr = Temp. gradient in °C/m</u> da gran esterent esteres de salen k - constant of proportionality called thermal conductivity (W/mic cr W/mik) - ve sign inserted to make natural burs - positive heat quantity) Page No 0

(D) A simple case of one dimensional steady state heat flow through a plane wall is shown in big for constant thermal conductivity. K. E heat transfer aneg A galastiner to mast $\frac{q=22=-kdr}{d^2}$ dr ->A 2ª T2 integrating above eq. x $\frac{\Re}{A}\int dx = -K\int dT_{\text{monstrod}} dx$ \mathcal{Q} $L = - K (T 2 - \Gamma_i)$ grant dullarda $\frac{dr}{d\alpha} = (T_1 - T_2)$ Newton Lew of cosling 3 It is the Fundamental law of heart convertion it state that gate of heat pranster is directly proportional to temp dubterence between the surface and the fluid and surface aneq perpendicular to heat flow direction TWZTCO RdA (Tw-Ta) & = hA (Tw - Too) Page No 07 $\mathbb{R}^{1/2}$

classmate where h = constant of proportionality called co-ebtricient of convertive heat 5-1485 Same Sister at (w/m²k) transfer (Tw-For) devout wall be & = 1/hA tootento with Re convective thermal resistance (R) Tw-Tg 82 1-b.A-R= The stetan Boltzmann law of heat Thorma A Radiation It state that gate of the radition heat transter per unit aneq from a block Surface is directly proportional to fourth power of absolute temp. 2 = 5T4 R & TS A Ts - absolute tomp of surface - K o - const of proportionality is called CANADA R. steafan Baltzmann const. has -value 567 ×10-8 w/m2 k4 heat flux empired by real Surface is less than that of black surface and given by $\frac{2}{4} = 5 \in (\overline{1_4}^4)$ 4 $\overline{\xi} = empisibility$ f > 2(c)Page No 08

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) The wall of furnace is constructed	from
)) 	15 cm thick fire brick having constant	therma
	conductivity of 1.7 W/mK. The two side	
	wall are mainfained at 1400°K and	1150.K
	sesp. what is the sate of heat loss th	rough
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Soln @	Ti=1400 K T2=1150 10011 autourou	
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)	$= 0.5 \times 3 = 1.5 \text{ m}^2$ 1400	5
0	$K = 1.7 $ w/m·k \sim	12=1150 _
)	and the suble month of the of is	
9	Usa His	<u> </u>
)	Find Heat loss. De la sap	
	$= R = kA(T_1 - T_2) = 0$	
	$= 1.7 \times 1.5 \times (1400 - 1150) = 425$	ϗω
	6.15	1997 - 1997 -
	Page No	09

classmate 1 cenduching A refrigerator stands in a room where 0 alz temp is zic. The surface temp on the outside of refrigerator is 16°C. The sides are so my trick and has an equivalent thermal anductivity of 0.10 w/mk. The heat transfer coefficient on the outside is LOW/m2k ossume the dimensional conduction through sides. F calculat the net heat flow. rate and inside Subace temp of the refrigerator. Solh To = 21 Count pand and your 30. To=21C is=16°C k20.1 L = 30 mm 2 0.83 m q ~ h=10/ Work K = 0.1 W/m K F=\$0 h = LO W/m2/K convertive heat Flups $\frac{1}{2} = h(T_{cb} - T_{s})$ = 10(21-16) = 50 W/m2 7777777 It is also the net heat conducted through the wall q=Q = K (TS-Ti) a mon ball $50 = (0.1) (16 - T_i)$ Ti=ic Page No 10

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in the second classmate 1 (els H-HAR (A) A KLARK Sunface is positioned in vacume container so that it absorb solar radiant 17 2. 24 energy at the nate of 950 w/m2. its the -Surface conducts no heat to surrounding. VILL determine ils equilibrium temp. -Manager has been and the Saln : Given black budy aborb solar energy 110 in vaneur = q = 950 w/m2 + 0= 5.67 × 10-8 w/m2 ×4 + . Radicul heat flux for black Jurface -9= 0 Tg 1 14 14 (TS) = (%) = (950 5.67×108 TS= 359.78 K 8678'C ----tough the periods between build said a contraction producentar hand for entry swith & provide and den with white prophetably adding and Page No 11 a character

Three dimensional equation of heat * × conduction (in differential equation) conferian - condinate consider the dubterential element andy dzlocated (arikitratily) within a solid material. Contraction of the second assume that there is heat generation in the material due to some cause Printer and (eq. passage of an electric correct) Printing and at the rate of g units. differenti of view Aller 7 COLL GAM JUDDE (alles Property in Y dagtaz dqy+dy; 7 Solid a starting of alix dqx+dx dan 92 day differential equation of heat conduction in general, The rate of heat generation may 7777 vary from point to point and with time. Thus thus q = bex, y, st) ~ Rn simpler situation, q may vary only with even be a constant space and not time or may Page No 12 Scanned with CamScanner

classmate 1 6. from fouries Law, we can written down expression for the heat conducted into and out of six faces of debremential element. These heat flows are indicated by the symbol dqx, dqx+dx, dqy+ay + dqy, dqz, dqz+dz $\frac{dq_{x} = -k \frac{\partial \Gamma}{\partial x} dy dz$ B 3 $\frac{dq_{x+dx}}{dq_{x+dx}} = \frac{dq_{x+2}}{dq_{x+2}} \frac{dq_{x+2}}{dq_{$ 9 $= -\mathbf{E} \left[\frac{k\partial T}{\partial x} + \frac{\partial}{\partial x} \left(\frac{k\partial T}{\partial x} \right) dx \right] dy dy$ 1 Similarity Privily have growed the art of idqy=--KdTidzdz journe losi de la Acal bytership land dqytdy = - [kat + a (kat)dy] doldg. $dq_3 = -K\partial\Gamma dxdy$ dq3+d3 = - [K 21 + 2 (K 21) d3] drdy is is me required disserted any is suit Therefore , the net amount of heat conducted into differential element per unit time = (dq2+dqy+dq3) - (dqx+dx+dqy+dy+dqg+d3) Page No 13 28.1

classmate L $= \left[\frac{2}{2}\left(\frac{1}{2}\right) + \frac{2}{2}\left(\frac{1}{2}\right) + \frac{2}{2}\left(\frac{1}{2}\right) + \frac{2}{2}\left(\frac{1}{2}\right) - \frac{1}{2}\left(\frac{1}{2}\right) - \frac{1$ Total The quantity of heat generated in the debterential in the et dement per unit time = q drdy dz - sbyb J The rate of change of internal energy of the dement = gcp <u>PT</u> dx dydz By the First law of thermodynamics the Lun of net heat conducted into element the heat generated is it per unit time must be equal to rate of change of internal energy of the element $\frac{\partial}{\partial \chi} \left(\frac{\chi}{\partial \chi} \right) + \frac{\partial}{\partial \chi} \left(\frac{\chi}{\partial \chi} \right) +$ 1 = 90021 ət 11 This is the required deblenhial equation For unsteady state beat conduction for anisotropie material 0 A Product Program ((Page No 14

classmate 1) for isotropic material, therman conductivity 1s constant. K= const. $K\left[\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} + \frac{\partial^2 T}{\partial x^2}\right] + \frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} + \frac{\partial^2 T}{\partial x^2} + \frac{\partial^2$ $\nabla^2 T + \frac{q}{V} = \frac{2\varphi}{K} \frac{\partial T}{\partial L}$ $\frac{2}{\sqrt{1+\frac{1}{\kappa}}} = \frac{1}{\sqrt{2}} \frac{\partial \Gamma}{\partial \tau}$ 4 produces - grade $\nabla^2 = \frac{3^2}{3x^2} + \frac{3^2}{3y^2} + \frac{3^2}{3y^2}$ caved Laplace operator K = K is called thermal dittusivity (m²/s) SCP 2) 26 there is no internal heat generation within the material (i.e. q=0) the governing equation reduces to fourier equation as $\frac{\partial^2 \Gamma}{\partial x^2} + \frac{\partial^2 \Gamma}{\partial y^2} + \frac{\partial^2 \Gamma}{\partial x^2} = \frac{1}{\sqrt{2}} \frac{\partial \Gamma}{\partial x^2}$ at the case area been been when presents the sta 3) For steady state condition <u>2T</u> = 0 do road and not write and por w $\frac{\partial^2 \Gamma}{\partial x^2} + \frac{\partial^2 \Gamma}{\partial y^2} + \frac{\partial^2 \Gamma}{\partial x^2} + \frac{\partial^2 \Gamma}{K}$ The time dimensional duberantial equation For steady stale heat conduction with const thermal conductivity called poission eg Page No 15

classmate analy transform budators alone to the 4) its the solid has no heat generation q 20 Mar general and the 227 27 + 22T -0 212 - 322 2×2 $\nabla^2 T = 0$ above equation is the three dimensional dubbeyenhial equation for steady state heat conduction without heat generation with constant thermal conductivity also called with house de Laplace equation diversity lands landshall abreat grant of d Thermal conductivity success out nichtwo 1. 5 product parties to the contraction of Thermal conductivity is the property of material and is define as the ability of materials to conduct the heat through if. it can also be interpreted as the gate of heat transfer through a unit tuckness of material per unit area per unit temp dublicasence. unt: W/mik or W/mic Highest in solid , lowest in gases. Al-2 production traditions to above any Page No 16

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0	conduction is liquid is also same as in
	gases however the mechanism is slightly
<u> </u>	() complex due to close spacing of molecules
0	and molecular attraction.
*	an and the assisted of suty - statements
	Ettect on thermal conductivity by temperature
•	The temp is measure of kinetic energy of
0	molecule of a substance. Thus thermal conductivity
	is a function of temperature. it also change with
	pressure in Fluid. Page NO 17

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<u>k inter</u>	1) Metals: The heat may be conducted is
	metals by two mechanism (migration of free
	electrons & b) Lattice vibration in general
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2)	Non-metals: - due to observe of firce elaborar &
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is crease with increase in temp. Liguid: for most of the liquid, the thermal conductivity decreases with increase in the temp. But water and glycovine are the exceptional icase, the thermal inductivity of liquid is independent of pressure as general rule thermal conductivity of liquid decreases with increase in molecular weight: the value of chermal conductivity of liquid are joken gases: For the gases, the molecule are in continuous Andom motion, as a temp increases, udeothes of the molecules become higher than in some same temp region. The molecules move from high temp region to low tomp region and give up its energy the thermal conductivity of gases in arease with increase in temp, and it is proportical to square shoot do the program and the proportical to square alternet by change is pressure and humidity.))	classmate 1
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classmate Thermal diffusivity (a) It is the important characteristic quantity for the unsteady conduction situations. I is the ratio of thermal conductivity & of the medium to heat caposity gC (d) (m3g) m² K S in diec basis provide the nation of Thesemal conductivity is represent how well the material can conduct hearts and hear capasity fc uppendono represents how much energy a material can store per unit valume therefore the the thermal 19/2200 distusivity of material viewed as the ratio of heat conducted through the material to the heat stored per unit volume. In other words the thermal dubtusivity of material is associated with propagation of beat energy into the medium during change of temp with time. highes the thermal dibtusivity, faster the propagation of heat into the medium. a its temp will charge with time. Page No 20

one dimensional steady state conduction without heat Generation. Plane wall consider a plane wall of homogenous material through which heat is flowing only is 2- direction L- Frickness. It's left fore at 2000 is at temperature 9. Ti & right face temp Iz at x=L. The word had 3 The general heat conduction equation is cantersian wordinate is given by $\frac{\partial^2 \Gamma}{\partial x^2} + \frac{\partial^2 \Gamma}{\partial y^2} + \frac{\partial^2 \Gamma}{\partial z^2} + \frac{\partial^2 \Gamma}{\partial z^2} + \frac{\partial^2 \Gamma}{\partial z} + \frac{\partial^$ K T2 ." as their is no infernal hear generation, q=0 . The heat conduction takes place under steady state condition do =0 one dimensional - 225 24 =0 222 242 $\frac{\partial^2 T}{\partial x^2} = 0 \quad -0 \quad \sigma = \frac{d^2 T}{dx^2} = 0$ Integrating above equation $\partial \Gamma(x) = c_1 - (U)$ again integrating $T(x) = C_1 x + C_2 - (ii)$ where C, and C2 constant of integration and are Page No 2 1

CLASSMALE L evaluated with use of boundary conditions. The boundary conditions T(2)=Ti at 2=0 J(u) T2 at x=L put in (11) Using thist becanary condition いたなもの生 Lident C2==T, Jack 2th Be put is (1) using second boundary andhorns se provincipal receiption and hour of united in WENTZE CIL + Trabages antersta $C_1 = T_2 - \overline{\Gamma_1}$ Then the temp distribution is plane wall is given by love build which are $T(x) = (T_2 - T_1) \times + T_1 - 0$ The freed conduction products for This is the temp distribution T(K) is plane wall. It is the linear function of x as shown is bg. S - Additional and the second dubt envisate leg. (1) $\frac{d\mathcal{L}}{dx} = \frac{T_2 - T_1}{L}$ Heat flux from fourier law $q(x) = -k \frac{d\Gamma(x)}{dx} = -k \frac{(\Gamma_2 - \Gamma_1)}{L}$ Total Heat flow rate Q. through asea 'A' normal to direction Q= KA (TI-F2) Page No 22