MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

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Rasipuram - 637 408, Namakkal Dist., Tamil Nadu.

Estd. 2000

IQAC

MUST KNOW CONCEPTS

MKC

MECH

2019-20

Course Code & Course Name : 16MED13 & Heat and Mass Transfer

Year/Sem/Sec : III / V/ A

S.No.	Term	Notation (Symbol)	Concept/Definition/Meaning/ Units/Equation/Expression	Units
Unit-I Conduction				
1.	Conduction.		Transfer of heat in solid objects	
2.	Thermal Conductivity	K	Thermal conductivity is defined as the ability of a substance to conduct heat.	w/mK
3.	Newton's law		Heat transfer by convection is given by Newton's law of cooling $Q = hA (T_s - T_\infty)$	
4.	Fins		Heat transfer by extended surface	
5.	Applications of fins.		1. Cooling of electronic components 2. Cooling of motor cycle engines. 3. Cooling of transformers 4. Cooling of small capacity compressors	
6.	Biot number	Bi	It gives a simple index of the ratio of the heat transfer resistances inside of a body and at the surface of a body. Bi= hl/k	
7.	Types of Fins		1. Longitudinal fin 2. Radial fin 3. Pin fin	
8.	Fin Efficiency		The ratio of actual heat transfer rate taking place through the fin and the maximum possible heat transfer rate that could occur through the fin.	
9.	Fin Effectiveness		The ratio between heat transfer rate with fin and the heat transfer rate without fin.	
10.	Heat		Heat is a form of energy that can be transferred from one system to another as a result of temperature difference.	
11.	Heat transfer		The science that deals with the determination of the rates of such energy transfer	

12.	Mechanism of heat transfer		Conduction, Convection, Thermal Radiation	
13.	Fourier's law of heat conduction	Q_{cond}	It indicates that the rate of heat conduction in a direction is proportional to the *temperature gradient* in that direction. $\dot{Q}_{cond} = -k_t A \frac{dT}{dx}$ (W)	W
14.	Thermal diffusivity	α	The thermal diffusivity is a measure of how quickly a material can carry heat away from a hot source. $\alpha = \frac{k}{\rho C_p} = \frac{Heat\ conducted}{Heat\ stored}$	$\frac{m^2}{s}$
15.	Steady-State Heat Conduction		If the temperature of the body does not varies with time	
16.	Transient or Unsteady state heat conduction		If the temperature of the body varies with time	
17.	Periodic Heat flow		The temperature varies on regular basis. Examples: 1. Cylinder of IC engines 2. Surface of the earth during a period of 24 hours.	
18.	Non – Periodic Heat flow		The temperature at any point within the system varies non linearly with time. Examples: 1. Heating of an ingot in a furnace 2. Cooling of bars	
19.	Newtonian heating or cooling process		The process in which the internal resistance is assumed as negligible in comparison with its surface resistance	
20.	Lumped Heat Analysis		In a Newtonian heating or cooling process the temperature throughout the solid is considered to be uniform at a given time	
21.	Semi- infinite solids		At any instant of time, there is always a point where the effect of heating or cooling at one of its boundaries is not felt at all. At this point the temperature remains unchanged	
22.	Infinite solids		A solid which extends itself infinitely in all directions of space	
23.	Fourier Number		The ratio of characteristic body dimension to temperature wave penetration depth of time	
24.	Factors affecting Thermal conductivity		1. Moisture 2. Density of material 3. Pressure 4. Temperature 5. Structure of material	
25.	Heisler charts		The solutions for temperature distributions	

			and heat flow of plane walls, long cylinders and spheres with finite internal and surface resistance presented. It is nothing but a analytical solutions in the form of graphs.	
Unit – II Convection				
26.	Convection.		Transfer of heat in liquids	
27.	Laminar flow		The fluid particles in each layer remain in an orderly without mixing with each other.	
28.	Turbulent flow		The path of any individual particle is zig – zag and irregular.	
29.	Natural convection		If the fluid motion is produced due to change in density	
30.	Forced convection		If the fluid motion is artificially created by means of an external force like a blower or fan	
31.	Dimensional Analysis		It is a mathematical method which makes use of the study of dimensions for solving several engineering problems like heat flow problems in fluid mechanics and thermodynamics	
32.	Buckingham π theorem		If there are n variables in a dimensionally homogeneous equation and if these contain m fundamental dimensions, then the variables are arranged into $(n - m)$dimensionless terms.	
33.	Reynolds Number	Re	The ratio of inertia force to viscous force	
34.	Prandtl Number	Pr	The ration of momentum diffusivity to thermal diffusivity	
35.	Nusselt Number	Nu	The ratio of heat convection to heat conduction	
36.	Grashof Number	Gr	The ratio of product of inertia force and buoyancy force to the square of viscous force	
37.	Stanton Number	St	The ratio of Nusselt number to the product of Reynolds number and Prandtl number	
38.	Newtonian Fluid		The Fluid which obey the newton's law of viscosity	
39.	Non-Newtonian Fluid		The Fluid which does not obey the newton's law of viscosity	
40.	Hydrodynamic Boundary Layer		The velocity of fluid is less than 99% of free stream velocity	
41.	Thermal Boundary Layer		The temperature of fluid is less than 99% of free stream temperature	
42.	Boundary Layer Thickness		The distance from the surface at which the local velocity or temperature reaches 99% of external velocity or temperature	
43.	Displacement		It is the distance, measured perpendicular to	

	thickness		the boundary, by which the stream is displayed on account of formation of boundary layer.	
44.	Momentum thickness		It is the distance through which the total loss of momentum per second be equal to if it were passing a stationary plate	
45.	Energy Thickness		It is the distance, measured perpendicular to the boundary of the solid body, by which the boundary should be displaced to compensate for the reduction in kinetic energy of the flowing fluid on account of boundary layer formation.	
46.	Flow over cylinder field regions		1. Boundary layer region near the surface 2. An inviscid region away from the surface	
47.	Dimensionless parameters used in forced convection		1. Reynolds Number (Re) 2. Nusselt Number (NU) 3. Prandtl Number (Pr)	
48.	Advantages of Dimensional Analysis		1. It express the functional relationship between the variables in dimensionless terms 2. It enables getting up a theoretical solution in a simplified dimensionless form	
49.	Dis advantages of Dimensional Analysis		1. No information is given about the internal mechanism of physical phenomenon 2. Dimensional analysis does not give any clue regarding the selection of variables	
50.	Newton's law of Convection		Heat transfer by convection is given by Newton's law of cooling $Q = hA (T_s - T_\infty)$	
Unit-III : PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS				
51.	Boiling		The change of phase from liquid to vapour state is known as boiling.	
52.	Condensation		The change of phase from vapour to liquid state is known as condensation.	
53.	Applications of boiling and condensation.		1. Thermal and nuclear power plant. 2. Refrigerating systems 3. Process of heating and cooling 4. Air conditioning systems	
54.	Pool boiling		If heat is added to a liquid from a submerged solid surface	
55.	Film wise condensation		The liquid condensate wets the solid surface, spreads out and forms a continuous	

			film	
56.	Drop wise condensation		a large portion of the area of the plate is directly exposed to vapour.	
57.	Heat exchanger		A heat exchanger is defined as an equipment which transfers the heat from a hot fluid to a cold fluid.	
58.	Direct heat exchanger		In direct contact heat exchanger, the heat exchange takes place by direct mixing of hot and cold fluids.	
59.	Indirect contact heat exchanger		In this type of heat exchangers, the transfer of heat between two fluids and separated by wall	
60.	Regenerator		In this type of heat exchangers, hot and cold fluids flow alternately through the same space.	
61.	Recuperater		the hot and cold fluid do not come into direct contact with each other but are separated by a tube wall or a surface.	
62.	parallel flow		In this type of heat exchanger, hot and cold fluids move in the same direction.	
63.	counter flow		In this type of heat exchanger hot and cold fluids move in parallel but opposite directions.	
64.	shell and tube heat exchanger		In this type of heat exchanger, one of the fluids move through a bundle of tubes enclosed by a shell	
65.	compact heat exchangers		heat exchangers are small in size	
66.	LMTD		Log mean temperature difference	
67.	cross flow heat exchanger		hot and cold fluid moves at right angle to each other	
68.	NTU		Number of transfer units	
69.	Fouling factor		Deposits present in the tube reduces the heat transfer rate	
70.	Effectiveness of heat exchanger		ratio between actual heat transfer to maximum possible heat transfer	
71.	Compact heat exchanger		small in size .Radiator is a type of compact heat exchanger	
72.	Flow Boiling		It may occur when a fluid is forced through a pipe or over a surface which is maintained at a temperature higher than the saturation temperature of the fluid.	
73.	Modes of condensation process		1. Flimwise condensation 2. Dropwise condensation	
74.	Assumption of Nusselt's theory for		1. The fluid properties are constant 2. The shear stress at the liquid vapour	

	Flim condensation		interface is negligible	
75.	Types of Heat exchangers		It may be classified on the basis of 1. Nature of heat exchange process 2. Relative direction of fluid motion 3. Design and constructional features 4. Physical state of fluids	
Unit-IV : RADIATION				
76.	Emissivity		It is defined as the ability of the surface of a body to radiate heat.	
77.	Kirchhoff's law		This law states that the ratio of total emissive power to the absorptivity	
78.	Stefan Boltzmann law		Emissive power of a black body is proportional to the fourth power of absolute temperature	
79.	Shape factor		Actual participation of part in transmission of electricity	
80.	Eddy diffusion		When one of the diffusion fluids is in turbulent motion, eddy diffusion takes place.	
81.	Radiation shield		Reduces heat by keeping the shield	
82.	Heat flux		Saturation of heat per unit area is called heat flux.	
83.	Stefan–Boltzmann constant	σ	$\sigma = 5.67 * 10^{-8}$ W/m$^2 \cdot$ K^4	W/m$^2 \cdot$ K^4
84.	Black body		The idealized surface that emits radiation at this maximum rate is called black body	
85.	Absorptivity	α	The fraction of the radiation energy incident on a surface that is absorbed by the surface. Its value is in the range $0 \leq \alpha \leq 1$.	
86.	Radiation		The heat is transferred from one body to another body without any transmitting medium. It is a electromagnetic wave phenomenon.	
87.	Emissive power	E_b	The total amount of radiation energy emitted by the body per unit time and unit area.	W/m^2
88.	Monochromatic Emissive power	$E_{b\lambda}$	The energy emitted by the surface at a given length per unit time and per unit area in all directions	
89.	Reflectivity	P	The ratio of radiation reflected to the incident radiation	
90.	Transmissivity	T	The ratio of radiation transmitted to the incident radiation	
91.	Wein's Displacemt Law		The relationship between the temperature and wave length corresponding to the maximum spectral emissive power of the black body at that temperature $\lambda_{max} T = 2.9 \times 10^{-3}$ mk	
92.	Gray Body		If a body absorbs a definite percentage of incident radiation irrespective of their wave	

			length.	
93.	Intensity of radiation	I_n	As the rate of energy leaving a space in a given direction per unit solid angle per unit area emitting surface normal to the mean direction of space $I_n = E_b/\pi$	
94.	Lambert's Cosine law		The total emissive power E_b from the radiating plane surface in any direction propotional to the cosine of the angle of emission. $E_b \alpha \text{ Cos } \theta$	
95.	Irradiation	G	The total radiation incident upon a surface per unit time and per unit area	W/m^2
96.	Radiosity	J	It is used to indicate the total radiation leaving a surface per unit time and per unit area	W/m^2
97.	Shape factor	F_{ij}	The fraction of radiative energy that is diffused from one surface element and strikes the other surface directly with no intervening reflections	
98.	Other Names of Shape factors		1. View Factor 2. Angle Factor 3. Configuration Factor	
99.	wavelength range of radiation		0.1 to 100 μm (micrometer)	
100.	wavelength range of the visible light		350 to 750 nm (nanometer)	
Unit-V : MASS TRANSFER				
101.	Types of mass transfer		Convection mass transfer,diffusion mass transfer	
102.	Mass transfer		The process of transfer of mass as a result of the species concentration	
103.	Examples of mass transfer		1. Humidification of air in cooling tower 2. Evaporation of petrol in the carburetor of an IC engine. 3. The transfer of water vapour into dry air.	
104.	Modes of mass transfer		1. Diffusion mass transfer 2. Convective mass transfer	
105.	Convective mass transfer		It occur between surface and a fluid medium when they are at different concentration.	
106.	Free convective mass transfer		If the fluid motion is produced due to change in density resulting from concentration gradients,	

107.	Forced convective mass transfer		If the fluid motion is artificially created	
108.	Eddy diffusion		When one of the diffusion fluid is in turbulent motion, eddy diffusion takes place	
109.	Schmidt Number	Sc	The ratio of molecular diffusivity of the momentum to molecular diffusivity of mass	
110.	Scherwood Number	Sh	It is the ratio of concentration gradients at the boundary	
111.	Examples of Convective mass transfer		1. Evaporation of alcohol 2. Evaporation of water from an ocean when air blows over it	
112.	Mass Concentration (or) Mass Density		Mass of a component per unit volume of mixture	Kg/m^3
113.	Molar Concentration (or) Molar Density		Number of molecules of the component per unit volume of mixture	Kg – mole / m^3
114.	Mass fraction		The ratio of mass concentration of the species to the total mass density of the mixture	
115.	Mole fraction		The ratio of mole concentration of a species to the total molar concentration	
116.	Molecular diffusion		Molecular diffusion, often simply called diffusion, is the thermal motion of all (liquid or gas) particles at temperatures above absolute zero.	
117.	Examples of Molecular diffusion		Balloons, Food Coloring, Perfume, Soda	
118.	Distillation		It is the process of separating components of a mixture based on different boiling points.	
119.	Distillation Examples		Examples of uses of distillation include purification of alcohol, desalination, crude oil refining, and making liquefied gases from air.	
120.	Wetted wall column		The liquid-vapor contacting devices provides maximum contact surface area for a particular duty	
121.	spray chamber		The equipment frequently used for adiabatic humidification-cooling operation with recirculating liquid is called spray chamber	
122.	Physisorption		Physisorption, also called physical adsorption, is a process in which the electronic structure of the atom or molecule is barely perturbed upon adsorption	
123.	Lewis number	(Le)	It is the dimensionless number defined as the ratio of thermal diffusivity to mass diffusivity. It is used to characterize fluid flows where there is simultaneous heat and mass transfer	
124.	Relative humidity		The ratio of partial pressure of the vapour to the vapour pressure of the liquid at gas temperature.	

125.	Absorption		The separation of two or more components of a liquid solution cannot be achieved.	
Placement Questions				
126.	What is the average of first five multiples of 12?		A. 36 B. 38 C. 40 D. 42 Answer : A	
127.	A running man crosses a bridge of length 500 meters in 4 minutes. At what speed he is running?		A. 8.5 km/s B. 7.5 km/s C. 9.5 km/s D. 6.5 km/s Answer : B	
128.	If Suresh borrows Rs. 36000 from Mahesh at rate of interest 6% S.I, at the end of four years how much interest Suresh has to pay along with principal amount?		A. Rs. 12560 B. Rs. 12960 C. Rs. 13500 D. Rs. 14500 Answer : B	
129.	What is the HCF of 1095 and 1168?		A. 37 B. 73 C. 43 D. 83 Answer: B	
130.	A train moving at speed of 80 km/hr crosses a pole in 7 seconds. Find the length of the train.		A. 150 m B. 165 m C. 175 m D. 170 m Answer: C	
131.	How many times the hands of a clock coincide in a day?		A. 24 B. 22 C. 23 D. 21 Answer : B	
132.	40 % of 280 =?		A. 112 B. 116 C. 115 D. 120	

			Answer: A	
133.	A shopkeeper sold an article for Rs. 2500. If the cost price of the article is 2000, find the profit percent.		A. 23% B. 25% C. 27% D. 29% Answer: B	
134.	What is the area of a triangle with base 5 meters and height 10 meters?		A. 20 square meters B. 35 square meters C. 25 square meters D. 40 square meters Answer : C	
135.	A: B: C is in the ratio of 3: 2: 5. How much money will C get out of Rs 1260?		A. 252 B. 125 C. 503 D. None of these Answer: D	
136.	In a kilometer race, A beats B by 40 meters or by 5 seconds. What is the time taken by A over the course?		A. 1 minute 57 seconds. B. 2 minutes. C. 1.5 minutes. D. None of these. Answer: B	
137.	Find the solution of (935421 × 625) = ?		a. 584638125 b. 524896335 c. 542879412 d. 582365890 ANSWER: 584638125	
138.	Find which of the following number is divisible by 11?		a. 246542 b. 415624 c. 146532ANSWER: 415624 d. 426513	
139.	Find the unit digit in the product (365 × 659 × 771)		a. 1 b. 4 ANSWER: 4 c. 5 d. 9	
140.	The remainder is 3, when a number is divided 5. If the square of this number is divided by 5, then what is the remainder?		a. 5 b. 4 c. 7 d. 1 ANSWER: 4	
141.	A man walking at the rate of 6 km/hr crosses a bridge in 15 minutes. The length of the bridge is		a. 1000 m b. 1250 m c. 1500 m d. 1800 m ANSWER: 1500 m	

142.	Two pipes A & B can fill a tank in 5 min & 10 min respectively. Both the pipes are opened together but after 2 min, pipe A is turned off. What is the total time required to fill the tank?		a. 4 min b. 6 min c. 14 min d. 20 min ANSWER: 6 min	
143.	50 % of a number is 18 less than two-third of that number. Find the number		a. 123 b. 119 c. 115 d. 108 ANSWER:108	
144.	A shopkeeper sells an article for Rs. 200 with a loss of Rs. 20 %. Find the cost price of the article		a. 220 b. 250 c. 280 d. 260 ANSWER: 250	
145.	A merchant sells 30 metres of cloth and gains selling price of 10 metres. Find the gain percent		a. 15 % b. 25 % c. 50 % d. 75% ANSWER: 50%	
146.	The average of four consecutive even numbers is 27. Find the largest of these numbers.		a. 28 b. 30 c. 32 d. 34 ANSWER: 30	
147.	A batsman makes a score of 80 runs in the 16^{th} inning and increases average by 3. What is his average after 16^{th} inning?		a. 35 b. 32 c. 29 d. 25 ANSWER**:**35	
148.	Hirsute		a. Shaggy b. bald c. erudite d. glorious ANSWER: bald	
149.	Ostentatious		a. Nescient b. Awkward c. Bankrupt d. Reserved ANSWER: Reserved	

150.	What is the average of first five multiples of 12?		E. 36 F. 38 G. 40 H. 42 Answer : A	

Faculty Team Prepared **Signatures**

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HoD