SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES
(Autonomous)
DEPARTMENT of MECHANICAL ENGINEERING

QUESTION BANK **RENEWABLE ENERGY SOURCES (16MEC414A)**

III B.Tech II Semester

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18MEC321 HEAT AND MASS TRANSFER

Course Educational Objectives:

1. To understand and analyze the basics of heat transfer and steady state and unsteady state conduction
2. To understand the convective heat transfer systems with types
3. To illustrate the basic knowledge on phase change heat transfer and heat exchangers
4. To demonstrate the transfer of heat on radiation
5. To expand the basic knowledge of mass transfer in a system

UNIT – 1: CONDUCTION
Mechanism of heat transfer – General differential equation – Cartesian, cylindrical and spherical coordinates – One dimensional steady state heat conduction – Heat generation – Thermal conductivity – Composite system – Critical radius of insulation – System with heat resources – Extended surfaces – Unsteady heat conduction – Lumped heat analysis – Surface resistance – Semi infinite and infinite solids – Heislers chart for transient conduction.

UNIT – 2: CONVECTION
Convective Heat Transfer: Heat transfer coefficient – Boundary layer concepts and equations – Turbulence and time averaging equations – Flow through pipes – Dimensional analysis. **Forced Convection:** Flow over a flat plate, cylinders and spheres – Flow through tubes – Flow of liquid metals. **Natural Convection:** Free convection on vertical flat plate – Transition and turbulence in free convection – Free Convection in vertical plates, horizontal plates, inclined surfaces, blocks, cylinders and spheres.

UNIT – 3: PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS
Boiling and Condensation: Nusselt's theory of condensation – Regimes of Pool boiling and flow boiling – Condensation heat transfer – Film and dropwise condensation. **Heat Exchangers:** Types – Overall heat transfer coefficient – Fouling factors – LMTD and NTU methods – Introduction to TEMA Standards.

UNIT – 4: RADIATION
Radiation: Nature of radiation – Emissive power – Absorption, reflection, transmission – Black body and gray body Radiation – Laws of radiation – Radiation from real surfaces – Shape factor – Electrical network analogy – Radiation shields.

UNIT – 5: MASS TRANSFER
Diffusion Mass Transfer: Concepts – Fick's Law – Diffusion coefficient – Steady state molecular diffusion. **Convective Mass Transfer**: Mass transfer coefficient – Governing equations – Momentum, heat and mass transfer analogy – Convective mass transfer correlations.

Course Outcomes:

On successful completion of the course, Students will be able to		POs related to COs
CO1	Understand and analyze the basics of heat transfer and steady state and unsteady state conduction	**PO1,PO2,PO3,PO4**
CO2	Understand the convective heat transfer systems with types	**PO1,PO2,PO3,PO4**
CO3	Illustrate the basic knowledge on phase change heat transfer and heat exchangers	**PO1,PO2,PO3,PO4**
CO4	Demonstrate the transfer of heat on radiation	**PO1,PO2,PO3,PO4**
CO5	Know and expand the basic knowledge of mass transfer in a system	**PO1,PO2,PO3,PO4**

Text books:

1. Fundamentals of Engineering Heat and Mass Transfer (SI Units), Sachdeva, R.C., 5/e, 2018, New Age International (P) Ltd, Publishers, New Delhi.
2. Heat Transfer, J.P. Holman and Souvik Bhattacharyya, 10/e, 2017, Tata McGraw-Hill Education Pvt.Ltd., Noida.

Reference books:
1. Heat and Mass Transfer: Fundamentals and Applications (SI Units), Yunus A. Cengel and Afshin J. Ghajar, 2015, Tata McGraw-Hill Education Pvt.Ltd., Noida.
2. Fundamentals of Heat and Mass Transfer**,** C.P.Kothandaraman, 4/e, 2012, New Age International (P) Ltd, Publishers, New Delhi.
3. Heat and Mass Transfer, P.K.Nag, 3/e, 2011, Tata McGraw-Hill Education Pvt.Ltd., Noida.
4. Principles of Heat and Mass Transfer, Frank P. Incropera, David P. Dewitt, Theodore L. Bergman, Adrienne S. Lavine, 2018, Wiley India Edition
5. Principles of Heat Transfer, Frank Kreith, Raj M. Manglik and Mark S. Bohn, 7/e, 2011, Cengage Learning, India.
6. A Textbook of Heat and Mass Transfer (SI Units), R. K. Rajput, Concise Edition, 2015, S.Chand & Company Limited, New Delhi.

Codes/Tables: Heat and mass transfer data book is permitted in the examinations.

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO.1	3	3	1	1	-	-	-	-	-	-	-	-
CO.2	3	3	1	1	-	-	-	-	-	-	-	-
CO.3	2	3	1	1	-	-	-	-	-	-	-	-
CO.4	3	3	1	1	-	-		-	-	-	-	-
CO.5	2	3	1	1	-	-		-	-	-	-	-
CO*	**2.6**	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

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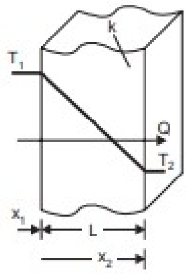
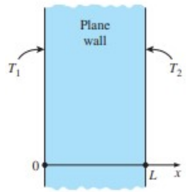
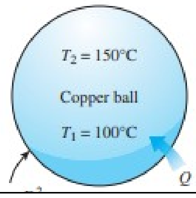
QUESTION BANK

Question No.	QUESTIONS
	UNIT 1 - CONDUCTION
	PART-A (Two Marks Questions)
1	State Fourier's Law of conduction.
2	State Newton's law of cooling or convection law
3	Define overall heat transfer co-efficient.
4	Write down the equation for heat transfer through composite pipes or cylinder.
5	What is critical radius of insulation (or) critical thickness?
6	Define Fin efficiency and Fin effectiveness.
7	Define critical thickness of insulation with its significance.
8	What is lumped system analysis? When is it applicable?
9	Write the three dimensional heat transfer poisson and laplace equation in Cartesian co-ordinates
10	Define fins (or) extended surfaces.
	PART – B (Ten marks questions)
1	Explain the following derivation one dimensional heat conduction.
2	Derive the equation for log mean area as applied to a hallow cylinder.
3	What is the critical thickness of insulation on a small diameter wire or pipe? Explain its physical significance and derive an expression for the same?
4	Derive the expression from systems with heat sources for hallow cylinder with internal heat generation?
5	Derive the equation for heat dissipating by fin with an insulated tip $Q=\sqrt{hpkA}(T_0 - T_\infty)\tan h(mL)$ By integrating the convection losses along its surface.
6	Determine the heat flow across a plane wall of 10 cm thickness with a constant thermal conductivity of 8.5 W/mK when the surface temperatures are steady at 100°C and 30°C. The wall area is 3m2. Also find the temperature gradient in the flow direction. 
7	A person stands in front of a fire at 65^0C in a room where air is at 5°C. Assuming the body temperature to be 37°C and a connection coefficient of 6 W/m^2k, the area exposed to convection as 0.6m^2, determine the net heat flow from the body. The fraction of radiation from the fire of 1m^2 are reaching the person is 0.01
8	Consider a large plane wall of thickness L = 0.2 m, thermal conductivity k = 1.2 W/m·K, and surface area A = 15 m^2. The two sides of the wall are maintained at constant temperatures of T1 = 120°C and T2 = 50°C, respectively, as shown in Fig. Determine (a) the variation of temperature within the wall and the value of temperature at x = 0.1 m and (b) the rate of heat conduction through the wall under steady conditions.

	
9	A 10-cm-diameter copper ball is to be heated from 100°C to an average temperature of 150°C in 30 minutes (Fig.). Taking the average density and specific heat of copper in this temperature range to be ρ= 8950 kg/m^3 and C_p =0.395 kJ/kg·°C, respectively, determine (a) the total amount of heat transfer to the copper ball, (b) the average rate of heat transfer to the ball, and (c) the average heat flux. 
10	A cylinder 1 m long 5 cm in diameter is placed in an atmosphere at 45^{0}C .It is provided with 10 longitudinal straight fins of materials having k=120 W/mK. The height of 0.76 mm thick fines is 1.27 cm from the cylinder surface. The heat transfer coefficient between cylinder and atmospheric air is 17 W/m^2 K. Calculate the rate of heat transfer and the temperature at the end of fines if surface temperature of cylinder is150^0 C.

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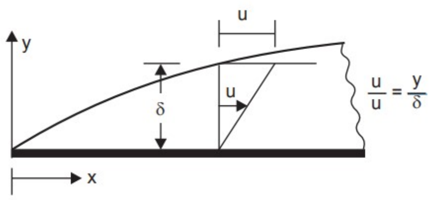
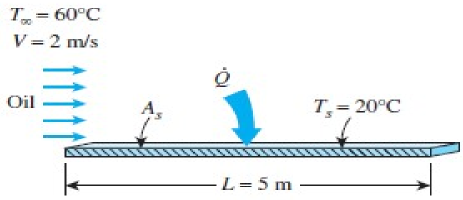
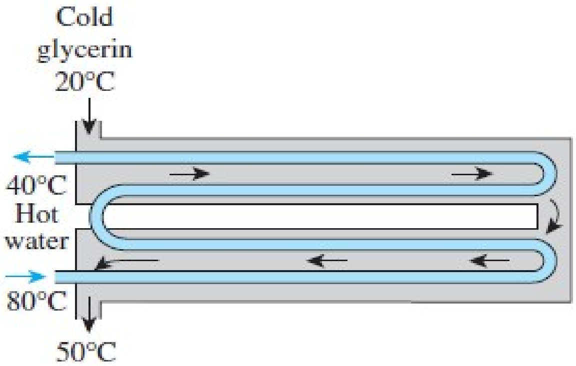
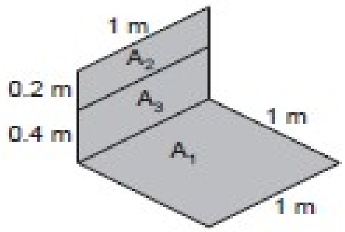
QUESTION BANK **RENEWABLE ENERGY SOURCES (16MEC414A)**

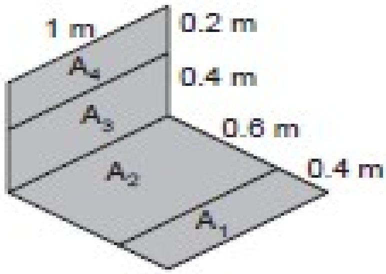
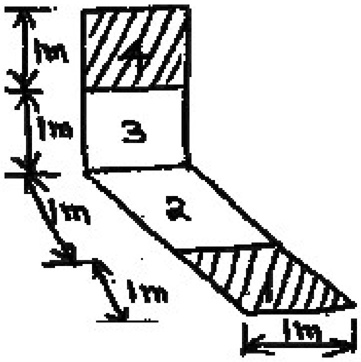
Question No.	QUESTIONS
	UNIT 2 – WIND ENERGY
	PART-A (Two Marks Questions)
1	Define critical Reynolds number. What is its typical value for flow over a flat plate and flow through a pipe?
2	How does or Distinguish laminar flow differ from turbulent flow?
3	Differentiate viscous sub layer and buffer layer.
4	Define grashoff number and prandtl number. Write its significance.
5	Define velocity boundary layer thickness.
6	Define the term thermal boundary layer thickness.
7	Why heat transfer coefficient for natural convection is much lesser than that for forced convection?
8	Mention the significance of boundary layer.
9	What is the difference between friction factor and friction coefficient?
10	Differentiate hydrodynamic and thermal boundary layer.
	PART-B (Ten Marks Questions)
1	Write the momentum equation for laminar boundary layer on a plate .list the assumptions made in deriving this equation.
2	Define Reynolds, Nusselt , Prandtl and Stanton numbers. Explain their importance in convective heat transfer.
3	State the Buckingham's π Theorem. Explain the various parameters used in forced convection. Using dimensional analysis obtain an expression for nusselt number in terms of reynolds and prandtl number.
4	Assuming linear variation of velocity in the boundary layer i.e. $\frac{u}{u_\infty} = \frac{y}{\delta}$, upto y = δ, and then u = u_∞, determine using the integral momentum equation, the boundary layer thickness. 
5	Air at 2 atm and 200^0C is heated as it flows through a tube with a diameter of 1 in (2.54 cm) at a velocity of 10 m/s. Calculate the heat transfer per unit length of tube if a constant-heat-flux condition is maintained at the wall and the wall temperature is 20^0C above the air temperature, all along the length of the tube. How much would the bulk temperature increase over a 3-m length of the tube?
6	Air at 20^0 C is flowing along heated flat plate at 134^0C at a velocity of 3 m/s .The plate is 2 m long and 1.5m wide. Calculate the thickness of the hydrodynamic boundary layer and the skin friction co efficient at 40 cm from leading edge of the plate. The Kinetic viscosity of air at 20^0C may be taken at 15.06×10^{-6} m^2/s. Calculate the local heat transfer coefficient at x=0.4 m and the heat transferred from the first 40 cm of the plate
7	Engine oil at 60^0C flows over the upper surface of a 5-m-long flat plate whose temperature is 20^0C with a velocity of 2 m/s Fig. Determine the total drag force and the rate of heat transfer per unit width of the entire plate.

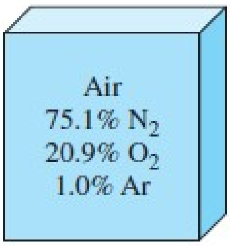
	
8	A 10-m-long metal pipe (k_{pipe}= 15 W/m·K) has an inner diameter of 5 cm and an outer diameter of 6 cm is used for transporting hot saturated water vapor at a flow rate of 0.05 kg/s. The water vapor enters and exits the pipe at 350°C and 290°C, respectively. In order to prevent thermal burn on individuals working in the vicinity of the pipe, the pipe is covered with a 2.25-cm thick layer of insulation (k_{ins} = 0.95 W/m·K) to ensure that the outer surface temperature Ts,o is below 45°C. Determine whether or not the thickness of the insulation is sufficient to alleviate the risk of thermal burn hazards.
9	Consider a 0.6-m ×0.6-m thin square plate in a room at 30^0C. One side of the plate is maintained at a temperature of 90^0C, while the other side is insulated. Determine the rate of heat transfer from the plate by natural convection if the plate is (a) vertical, (b) horizontal with hot surface facing up, and (c) horizontal with hot surface facing down.
10	The vertical 0.8-m-high, 2-m-wide double-pane window consists of two sheets of glass separated by a 2-cm air gap at atmospheric pressure. If the glass surface temperatures across the air gap are measured to be 12^0C and 2^0C, determine the rate of heat transfer through the window.

Question No.	QUESTIONS
	UNIT 3 – PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGER
	PART-A (Two Marks Questions)
1	What is burnout point in boiling neat transfer? Why is it called so?
2	Define NTU and LMTD of a heat exchanger.
3	What are the different regimes involved in pool boiling?
4	Write down the relation for overall heat transfer coefficient in heat exchanger with fouling factor
5	How heat exchangers are classified?
6	What are the limitations of LMTD method? Discuss the advantage of NTU over the LMTD method.
7	Differentiate between pool and forced convection boiling.
8	What is pool boiling? Give an example for it.
9	Define effectiveness.
10	What is meant by sub-cooled and saturated boiling?
	PART-B (Ten Marks Questions)
1	Discuss briefly the various regimes in boiling heat transfer.
2	Sketch the film wise condensation on a vertical wall showing film thickness ,velocity and temperature profiles
3	Distinguish between film wise and drop wise condensation? Which of the two gives a higher heat transfer co efficient?
4	What is the expression for LMTD in counter flow exchanger where capacity rates for the hot and cold fluids are the same ?
5	Derive an expression for the effectiveness of a heat exchanger in which a condensing vapor is used to heat and cold fluids .
6	Water at atmospheric pressure (saturation temperature = 100°C) is boiling on a brass surface heated from below. If the surface is at 108°C, determine the heat flux and compare the same with critical heat flux.
7	Saturated steam at 65°C condenses on horizontal cylinder of 0.2 m dia at 55°C. Determine the value of convection coefficient for (i) single tube and (ii) for a bank of tubes of 10 rows arranged vertically one below the other.
8	A 2-shell passes and 4-tube passes heat exchanger is used to heat glycerin from 20 ^{0}C to 50 ^{0} C by hot water, which enters the thin-walled 2-cm-diameter tubes at 80 ^{0}C and leaves at 40 ^{0}C (Fig.). The total length of the tubes in the heat exchanger is 60 m. The convection heat transfer coefficient is 25 W/m^{2}K on the glycerin (shell) side and 160 W/m^2 K on the water (tube) side. Determine the rate of heat transfer in the heat exchanger (a) before any fouling and (b) after fouling with a fouling factor of 0.0006 m ^{2}K/W occurs on the outer surfaces of the tubes.

	
9	Determine the area required in parallel flow heat exchanger to cool oil from 60°C to 30°C using water available at 20°C. The outlet temperature of the water is 26°C. The rate of flow of oil is 10 kg/s. The specific heat of the oil is 2200 J/kg K. The overall heat transfer coefficient U = 300 W/m2 K. Compare the area required for a counter flow exchager.
10	Hot exhaust gases, which enter a finned -tube, cross flow heat exchanger at 300^0C and leave at 100^0C , are used to heat pressurized water at a flow rate of 1Kg/s from 35 to 125^0C. The Exhaust gas specific heat is approximately 1000J/Kg.K , and the overall heat transfer co efficient based on the gas-side surface area is U_h =100 W/m^2.K.Determine the required gas-side surface area A_h using the NTU Method

Question No.	QUESTIONS
	UNIT 4 – RADIATION
	PART-A (Two Marks Questions)
1	State Planck's distribution law.
2	State Wien's displacement law & Stefan – Boltzmann law.
3	State Kirchoff's law of radiation.
4	What is the purpose of radiation shield?
5	Define irradiation (G) and radiosity (J)
6	What are the factors involved in radiation by a body.
7	What is meant by shape factor?
8	What is black body and gray body?
9	Define emissive power [E] and monochromatic emissive power. [Ebλ]
10	State Lambert's cosine law.
	PART-B (Ten Marks Questions)
1	Define radiation intensity.Prove that the intensity of ration is given by $I_b=E_b/\pi$
2	State and explain the i)Stefan Boltzmann law ii)Wien Displacement law iii)Kirchhoff's law
3	(i) Define emissivity, absorptivity and reflectivity (ii) Describe the phenomenon of radiation from real surfaces.
4	What is gray body? Also explain Total emissive power and monochromatic emissive power
5	Determine the shape factor between surfaces 1–2 and also 2 to 1. Also determine the heat flow if T1 = 1000 K and T2 = 5000 K,  Fig. P.13.14
6	Determine the shape factor between the surfaces 1–4 and 4–1. Also determine the heat flow if ε_1 = 0.4 and ε_4 = 0.6 and T1 = 1000 K and T4 = 500 K

	 Fig. P.13.15
7	(i) What are the radiation view factors and why they are used? (ii) determine the view factor (F1-2) for the figure shown below. 

Question No.	QUESTIONS
	UNIT 5 - MASS TRANSFER
	PART-A (Two Marks Questions)
1	What is mass transfer?
2	Give the examples of mass transfer.
3	What are the modes of mass transfer?
4	What is molecular diffusion?
5	What is Eddy diffusion?
6	What is convective mass transfer?
7	State Fick's law of diffusion
8	What is free convective mass transfer?
9	Define forced convective mass transfer.
10	Define Sherwood Number.
	PART-B (Ten Marks Questions)
1	i) Explain the Ficks first and second laws of diffusion ii) Explain the phenomenon of equimolar counter diffusion. Drive an expression for equimolar counter diffusion between two gases or liquids
2	In order to avoid pressure build up ammonia gas at atmospheric pressure in a pipe is vented to atmosphere through a pipe of 3 mm dia and 20 m length. Determine the mass of ammonia diffusing out and mass of air diffusing in per hour. Assume D = 0.28 × 10–4 m2/s, M = 17 kg/kg mole
3	If air at 30°C flows over a wet bulb thermometer, which reads 22°C, determine the relative humidity of the air.
4	Water flows down on the surface of a vertical plate at a rate of 0.05 kg/s over a width of 1m. The water film is exposed to pure carbon dioxide. The pressure is 1.013 bar and the temperature is 25°C. Water is essentially CO2 free initially. Determine the rate of absorption of CO2. The molal concentration at this condition for CO2 in water at the surface is 0.0336 kgmol/ m3 of solution. D = 1.96 × 10–9 m2/s, solution density = 998 kg/m3, μ = 0.894 × 10–3 kg/ms, G = 0.05 kg/ms, L = 1 m. The notation for convective mass transfer coefficient is hm.
5	A spherical tank of 0.18 m radius made of fused silica has a wall thickness of 2.5 mm. It is originally filled with helium at 6 bar gauge and 0°C. Determine the rate of pressure drop with time at this condition due to gas diffusion. D = 0.04 × 10–12 m2/s, the density of gas at the solid surface is given by 18 × 10^{-9} kg/m3 Pa. (also termed solubility)
6	The composition of dry standard atmosphere is given on a molar basis to be 78.1 percent N2, 20.9 percent O2, and 1.0 percent Ar and small amounts of other constituents (Fig. 14–12). Treating other constituents as Ar, determine the mass fractions of the constituents of air. 

7	Dry air at 27^0C and 1 atm flows over a wet flat plate 50cm long at a velocity of 50m/s. Calculate the mass transfer coefficient of water vapor in air at the end of the plate

*****ALL THE BEST*****