ModelTemplateforSchemeofCourseWork

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SCHEMEOFCOURSEWORK

CourseDetails:

CourseTitle	**HeatTransfer**		
CourseCode	**:13ME1127**	**L T P C**	**:3 0 03**
Program:	**:B.Tech.**		
Specialization:	**:MechanicalEngineering**		
Semester	**:VI**		
Prerequisites	**:FluidMechanics, Thermodynamics**		
Coursestowhichitisaprerequisite	**:Refrigeration & Air-Conditioning**		

CourseOutcomes(COs):

At theendofthecoursethestudentwillbeableto

1	Define different modes of heat transfer, apply one-dimensional steady state heat conduction to different geometries.
2	Determine transient heat conduction using Heisler's charts, and explain velocity and thermal boundary layers in flows over flat plate and through circular pipe.
3	Calculate Nusselt numbers in forced and natural convection using empirical equations.
4	Draw pool boiling curve, describe laminar film condensation, use LMTD and NTU methods in heat exchanger design.
5	Explain radiation laws and estimate radiation exchange between different surfaces and with radiation shields.

Program Outcomes (POs):

The undergraduate of mechanical engineering will be able to

PO 1	Apply the knowledge of mathematics, science, engineering fundamentals to solve complex mechanical engineering problems
PO 2	Attain the capability to identify, formulate and analyse problems related to mechanical engineering
PO 3	Design solutions for mechanical system components and processes that meet the specified needs with appropriate consideration for public health and safety
PO 4	Perform analysis, conduct experiments and interpret data by using research methods such as design of experiments to synthesize the information and to provide valid conclusions
PO 5	Select and apply appropriate techniques from the available resources and current mechanical engineering and software tools
PO 6	Carry out their professional practice in mechanical engineering by appropriately considering and weighing the issues related to society
PO 7	Understand the impact of the professional engineering solutions on environmental safety and legal issues
PO 8	Transform into responsible citizens by resorting to professional ethics and norms of the engineering practice

PO 9	Function effectively in individual capacity as well as a member in diverse teams and in multidisciplinary streams
PO 10	Communicate fluently with the engineering community and society, and will be able to prepare reports and make presentations effectively
PO 11	Apply knowledge of the engineering and management principles to managing projects and finance in multidisciplinary environments
PO 12	Engage themselves in independent and life-long learning to continuing professional practice in their specialized areas of mechanical engineering

CourseOutcomeVersusProgramOutcomes:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	S	S						M			M	
CO-2	S	M	S			M		M			M	
CO-3	S	S										
CO-4	S	S									M	
CO-5	S	S	S					M			M	

S -Stronglycorrelated,M-Moderatelycorrelated,Blank-Nocorrelation

Teaching-LearningandEvaluation

Assessment Methods:	Observation / Record / Internal Exam / End Exam

Week	Contents	Course Outcomes	Sample Questions	Teaching Learning Strategy	Assessment Method & Schedule
1	**INTRODUCTION:** Modes of heat transfer – Fourier's law of heat conduction– general heat conduction equation in Cartesian and cylindrical coordinates.	1	1.Give the assumptions of Fourier law of conduction. 2. Derive the general heat conduction equation in Cartesian coordinate system.	Derivations and Lectures	Internal 1, Assignment 1
2	**ONE DIMENSIONAL STEADY STATE HEAT CONDUCTION:**Steady state heat conduction in a slab - Composite slab, coaxial cylinders and concentric spheres conduction-convection systems - overall heat transfer coefficient - electrical analogy	1	The wall of a furnace of 0.7 m^2 area consists of a thin metal sheet covered inside with a 25 mm thick layer of insulation having a thermal conductivity of 0.25 W/m-°C. The heat transfer coefficients on each side of the door are 10 W/m^2-°C. The	Practice of Numericals	Internal 1, Assignment 1

			temperatures inside and outside the refrigerator are 100^{o}C and 20^{o}C respectively. Determine (a) the heat transfer rate through the door, and (b) the temperature of the metal sheet. The thermal resistance of the metal sheet may be neglected.		
3	critical radius of insulation - types of fins – rectangular fin with insulated tip – fin effectiveness and fin efficiency - application to error measurement of temperature.	1	1. Explain critical radius of insulation. 2. Explain efficiency and effectiveness of a fin 3. An aluminum fin k=200 W/m-K, c =0.9kJ/kg-K) of 3 mm thick and 75 mm long protrudes from a wall at 300^{o}C.The ambient temperature is 50^{o}C with heat transfer coefficient of 10 W/m^{2}-K. (a) Calculate effectiveness and efficiency of the fin. (b) If chrome steel fin of the same size isused instead of the aluminum fin, what would be the effectiveness and efficiency of the fin? For chrome steel: k=40 /m-K, c=0.46 kJ/kg-K.	Practice of Numericals	Internal 1, Assignment 1
4	**ONE DIMENSIONAL TRANSIENT HEAT CONDUCTION:** Lumped heat capacity analysis Biot and Fourier numbers – solution of transient conduction systems for slabs, cylinders and spheres using Heisler's charts.	2	1. A large plate of mild steel 5 cm thick and initially at 200^{o}Cis suddenly exposed to the convection environment of 70^{o}C with a heat transfer coefficient of 525 W/m^{2}-^{o}C. Calculate the centre line and surface temperatures 2 minutes after the plate is exposed to the convection environment. How much energy has been removed from the plate per unit area in this time? k = 35W/m ^{0}C, α = 8.7 x 10^{-6} m^{2}/s, ρ = 8620 kg/m^{3}, C = 460 J/kg-K 2. Explain lumped heat capacity analysis.	Practise of Numericals	Internal 1, Assignment 1
5	**DIMENSIONAL ANALYSIS:** Buckingham-ðtheorem– dimensionalanalysisappliedtoforcedconvection andnaturalconvection–significance of Reynold's, Prandtl and Nusselt numbers	2	1. Derive the relation for forced convection by buckinghamΠ theorem 2. Explain the physical significance of Prandtl number and Reynolds number.	Practise of dimensional relations by	Internal 1, Assignment 1

				buckingham Π theorem	
6	**FUNDAMENTALS OF CONVECTION:** Velocity and thermal boundary layers in flow on a horizontal flat plate - velocity and thermal boundary layers in laminar flow through a circular pipe – hydrodynamic and thermal entry lengths - Reynolds and Colburn analogies	3	1. Explain Hydrodynamic and thermal boundary layers in laminar flow over a horizontal flat plate. 2. Using a linear velocity profile $u/u_\infty = y/\delta$, for flow over a flat plate, obtain an expression for the boundary layer thickness as a functions of x.	Lecture	Internal 1, Assignment 1
7, 8	**FORCED CONVECTION:** Empirical correlations for Nusselt numbers for flow over flat plates – Empirical correlations for Nusselt numbers for flow through pipes	3	1. A thin flat plate has been placed longitudinally in a stream of air at 20°C and flows with undisturbed velocity of 7.5 m/s. The surface of the plate is maintained at a uniform temperature of 120°C. i. calculate the heat transfer coefficient 0.8 m from the leading edge of the plate, ii. Also calculate the rate of heat transfer from one side of the plate to the air over the first 0.8 m length. Assume unit width of the plate. 2. Water flows through a tube of 2.54 cm diameter and 3 m length at a mean velocity of 2 cm/s. The water enters the tube at a temperature of 60°C. The tube wall temperature is maintained constant at 80°C. Calculate the following: (i) the average convection heat transfer coefficient, (ii) the rate of heat transferred to water from the tube wall, and (iii)the exit temperature of water.	Practise of Numericals on emprical correlations for forced convection	Internal 1, Assignment 1
9	**Internal 1**				

10	**NATURAL CONVECTION:** Velocity and thermal boundary layers in heat transfer by naturalconvection from a vertical plate (derivations not included) – Boussinesq approximation – empiricalcorrelations for vertical plates and cylinders for laminar and turbulent natural convection	3	1. Buoyancy force and Rayleigh number in natural convection heat transfer. 2.A horizontal pipe of 6 cm diameter is located in a room, whose temperature of air is 20^{o}C. The surface temperature of the pipe is 140^{o}C. Calculate the free convection heat loss per meter length of the pipe. 2. A flat electrical heater of 0.4 m × 0.4 m size is placed vertically in still air at 20^{o}C. The heat generated is 1200 W/m^2. Determine the value of convective heat transfer co-efficient and the average plate temperature.	Practise of Numericals on emprical correlations for natural convection	Internal 2, Assignment 2
10	**BOILING AND CONDENSATION:** Regimes of saturated pool boiling – Dropwise and filmwise condensation-Nusselt's analysis for laminar filmwise condensation on a vertical plate	4	1. Difference between dropwise and filmwise condensation. 2. Draw the saturated pool boiling curve for water and explain about various regimes in boiling.	Lecture	Internal 2, Assignment 2
11,12, 13	**HEAT EXCHANGERS:**Parallel and counter flow double pipe heat exchangers - overall heattransfer coefficient – fouling factors - LMTD method of heat exchangeranalysis – effectiveness - NTU method of heat exchanger analysis.	4	1. Effectiveness of a heat exchanger. 2. In a cross flow heat exchanger hot exhaust gases (Cp = 1000 J/kgK) entering at300^{o}C and leaving at 100^{o}C are used to heat water, flowing at 1 kg/s from 35^{o}C to125^{o}C. The overall heat transfer coefficient based on the gas side surface area hasbeen found to be 100 W/m^{2}K. Using the NTU method, estimate the required gasside surface area.	Practise of Numericals	Internal 2, Assignment 2

			2. What is the limitation of the LMTD method? How is NTU method superiorto correction factor LMTD method?		
14	**THERMAL RADIATION:**Emissive power – black body – Stefan-Boltzmann’s law– Emissivity– Kirchhoff’s law	5	1. Emissivity and Kirchhoff’s law. 2. Estimate the rate of solar radiation on a plate normal to the sun rays. Assumethe sun to be a black body at a temperature of 5527 0C. The diameter of thesun is 1.39 × 106 km and its distance from the earth is 1.5 × 108 km.	Practise of Numericals	Internal 2, Assignment 2
15	radiation heat exchange between two blackisothermal surfaces – concept of radiation shape factor	5	1. Two equal discs of diameter 200 mm each are arranged in two parallel planes400 m apart. The temperature of the first disc is 500^{o}C and that of the seconddisc is 300^{o}C. Determine the radiating heat flux between them, if these are (i) black, and (ii) gray with emissivities 0.3 and 0.5 respectively.	Practise of Numericals	Internal 2, Assignment 2
16,17	heat exchangebetween two large gray planes, and concentric cylinders – exchangebetween a small gray body in a large enclosure – Radiation shields.	5	1. Two large parallel planes having emissivities 0.3 and 0.5 are maintained at temperatures of 800K and 400K respectively. A radiation shield having an emissivity of0.5 on both sides is placed between the two plates. Calculate: (a) the heat transfer rate per unit area if the shield were not present (b) the heat transfer rate per unit area with the shield present (c) the temperature of the shield.	Practise of Numericals	Internal 2, Assignment 2

			2. A long cylinder having a diameter of 2 cm is maintained at 600^{o}C and has anemissivity of 0.4. Surrounding the cylinder is another long, thin walled concentriccylinder having adiameter of 6 cm and an emissivity of 0.2 on both the inside andoutside surfaces. Theassembly is located in a large room having a temperatureof 27^{o}C. Calculate the net radiant energy lost by the 2 cm diameter cylinder permeter length. Also calculate the temperature of the 6 cm diameter cylinder.		
18	**Internal 2**				