

SCHEME OF COURSE WORK

Course Details:

Course Title	:Advanced Heat Transfer		
Course Code	: 15ME2303	L T P C	:3 0 0 3
Program:	: M.Tech.		
Specialization:	: Mechanical Engineering		
Semester	: I		
Prerequisites	: Fluid Mechanics and basic Heat Transfer		
Courses to which it is a prerequisite	: Elective-II: Design of Thermal Equipment		

Course Outcomes (COs):

At the end of the course the student will be able to

1	explain the general heat conduction equation, fin heat transfer, solution of two-dimensional steady state equation, and conduction shape factor
2	describe the solution of transient heat conduction equation by analytical methods and by Heisler's charts, and heat transfer in laminar flow over a flat plate
3	Analyze heat transfer in laminar and turbulent flows through pipe, liquid metal and high speed flow, describe pool and flow boiling
4	compare external and in-tube film condensation, and explain working of a heat pipe
5	explain radiation properties and apply radiation networks to calculate radiation exchange between surfaces, and gas radiation

Program Outcomes (POs):

PO1:Exhibit in-depth knowledge in thermal engineering specialization

PO2: Think critically and analyze complex engineering problems to make creative advances in theory and practice

PO3: Solve problem, think originally and arrive at feasible and optimal solutions with due consideration to public health and safety of environment

PO4: Use research methodologies, techniques and tools, and contribute to the development of technological knowledge

PO5: Apply appropriate techniques, modern engineering and software tools to perform modeling of complex engineering problems knowing the limitations

PO6: Understand group dynamics, contribute to collaborative multidisciplinary scientific research

PO7: Demonstrate knowledge and understanding of engineering and management principles and apply the same with due consideration to economical and financial factors

PO8: Communicate complex engineering problems with the engineering community and society, write and present technical reports effectively

PO9: Engage in life-long learning with a high level of enthusiasm and commitment to improve knowledge and competence continuously

PO10: Exhibit professional and intellectual integrity, ethics of research and scholarship and will realize his/her responsibility towards the community

PO11: Examine critically the outcomes of his/her actions and make corrective measures without depending on external feedback

Course Outcome Versus Program Outcomes:

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

S - Strongly correlated, M - Moderately correlated, Blank - No correlation

Assessment Methods:	Assignment / Quiz / Seminar / Case Study / Mid-Test / End Exam
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Teaching-Learning and Evaluation

Wee k	Topic / CONTENTS	Course Outcomes	Sample questions	Teaching-Learning Strategy	Assessment Method & Schedule
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1	Heat conduction equation in Cartesian, cylindrical, and spherical coordinates	CO-1	1. Derivation of heat conduction equation in Cartesian, cylindrical, and spherical coordinates 2. Transform from Cartesian to cylindrical coordinates	Lecture Derivations	Assignment (Week 2 - 4)
2	Heat transfer from extended surfaces – infinitely long fin	CO-1	1. Derivation of heat transfer from extended surfaces 2. Find effectiveness and efficiency of fin	Lecture / Discussion Problem solving	Mid-Test 1 (Week 9)
3	rectangular and triangular fins – boundary conditions - fin performance.	CO-1	Derive equation for temperature distribution in triangular fins	Lecture Problem solving	Quiz (Week 2 - 4)
4	Steady state two-dimensional heat conduction equation – boundary conditions	CO-1	Derive equation for steady state two-dimensional heat conduction equation. Specify the boundary conditions	Lecture Derivations and analysis	
5	numerical solution by finite difference method.	CO-2	Obtain numerical solution by finite difference method.	Lecture Problem solving	
6	Lumped heat capacity system - transient heat conduction in a semi-infinite rod	CO-2	Derive equation for temperature distribution in transient heat conduction in a semi-infinite rod	Lecture Problem solving	
7	transient heat conduction in an infinite plate with convection boundary condition at the surface	CO-2	Derive equation for temperature distribution in transient heat conduction in an infinite plate with convection boundary condition at the surface	Lecture Problem solving	

8	Transient heat conduction in an infinite cylinder exposed to a convection environment - transient heat conduction in a sphere - Heisler's charts	CO-2	Problems on transient heat conduction in a sphere using Heisler's charts	Lecture Problem solving	
9	Laminar boundary layer on a flat plate – Von Karman analysis through integral equations for hydrodynamic boundary layer thickness	CO-2	Obtain the equation for hydrodynamic boundary layer in laminar flow on a flat plate by Von Karman analysis through integral equations for hydrodynamic boundary layer thickness	Lecture Problem solving	
10	energy balance equation and thermal boundary layer on a flat plate, turbulent boundary layer – mixing length and eddy viscosity	CO-2	energy balance equation and thermal boundary layer on a flat plate, turbulent boundary layer – mixing length and eddy viscosity	Lecture Discussion Problem solving	Mid-Test 2 (Week 18)
11	Heat transfer in laminar tube flow	CO-3	Heat transfer in laminar tube flow	Lecture Problem solving	Case Study (Week 10 - 14)
12	turbulent flow in a tube, heat transfer in high speed flow	CO-3	turbulent flow in a tube, heat transfer in high speed flow	Lecture Problem solving	
13	liquid metal heat transfer – high speed heat transfer for a flat plate	CO-3	liquid metal heat transfer – high speed heat transfer for a flat plate	Lecture Problem solving	
14	Regimes of saturated pool boiling – Rohsenow's correlation for nucleate pool boiling	CO-3	Explain various regimes of saturated pool boiling Problems using Rohsenow's correlation for nucleate pool boiling	Lecture Problem solving	
15	flow boiling: external flow boiling, internal flow boiling, two-phase flow regimes	CO-3	Describe external flow boiling, internal flow boiling, two-phase flow regimes	Lecture Problem solving	Seminar (Week 15)

16	Nusselt's analysis for laminar film condensation on a vertical plate – condensate Reynolds number – film condensation inside horizontal tubes	CO-4	Explain Nusselt's analysis for laminar film condensation on a vertical plate	Lecture Problem solving	
17	Heat pipe components, materials and working fluids – Applications of heat pipe – Cooling of electronic components	CO-4	Describe the working of heat pipe at pipe and its applications	Lecture Demonstration Problem solving	
18	Radiation properties – Kirchhoff's law – Wien's displacement law – Planck's distribution law – black body - gray body. Radiation heat exchange between black isothermal surfaces - radiation shape factor, Irradiation–radiosity–space resistance – surface resistance – radiation networks – radiation between two hot plates enclosed by a room	CO-5	Explain radiation properties such as Kirchhoff's law, Wien's displacement law , Planck's distribution law Problems using radiation shape factor, Irradiation–radiosity– space resistance – surface resistance – radiation networks	Lecture Problem solving	
19/20	END EXAM				