SCHEME OF COURSE WORK

Course Details:

Course Title	**Advanced Heat Transfer**		
Course Code	**19ME2203**	**C L P**	**: 3 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 (19ME2203)**		

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
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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**

Teaching-Learning and Evaluation

Week	Topic / CONTENTS	Course Outcomes	Sample questions	Teaching-Learning Strategy	Assessment Method & Schedule
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**				