HEAT AND MASS TRANSFER

Module 1: Introduction (2)

Units, definitions, Basic modes of Heat transfer, Thermal conductivity for various types of materials, convection heat transfer co-efficient, Stefan Boltzman's law of Thermal radiation.

Module 2: One Dimensional Steady State Heat Conduction (5)

Thermal conductivity and other relevant properties, Heat diffusion equation in Cartesian co-ordinates, boundary and initial conditions. One dimensional, steady state heat conduction without and with heat generation through plane slabs, cylinders and spheres, Concept of thermal resistance, Electrical analogy. Heat transfer through composite slabs, cylinders and spheres, contact resistance. Critical thickness of insulation for cylinder and sphere.

Module 3: Extended surface heat transfer (2)

Steady state heat conduction through fins of uniform cross section, fin effectiveness and fin efficiency.

Module 4: Multi-dimensional Steady State Heat Conduction (4)

Two-dimensional steady state conduction, analytical solution, conduction shape factor, finite difference and finite volume methods

Module 5: Unsteady State Heat Conduction (4)

Transient conduction in solids with negligible internal temperature gradients (lumped parameter), Biot number and Fourier number. One dimensional transient conduction in slab and radial systems: exact and approximate solutions. Finite difference methods: explicit and implicit formulations.

Module 6: Convection (8)

Flow over a body, velocity and thermal boundary layers, drag-co-efficient and heat transfer coefficient. Flow inside a duct; hydrodynamics and thermal entry lengths; fully developed and developing flow. Use of various correlations in forced convection heat transfer, flow over a flat plate, flow across a single cylinder and tube bundles. Free convection heat transfer from vertical surface and vertical cylinder, horizontal surface and horizontal cylinders.

Module 7: Heat Exchangers (3)

Heat exchanger types, flow arrangements, overall heat transfer coefficient, fouling factor, LMTD for parallel flow and counter flow heat exchangers. Effectiveness-NTU method, expression for effectiveness of a parallel flow and counter flow heat exchangers. Multi-pass and cross flow heat exchangers.

Module 8: Boiling and Condensation (3)

Different regimes of boiling, mechanism of condensation, Nusselt’s theory of film condensation on a vertical surface, use of correlations in solving film wise condensation on plane surfaces, horizontal tubes and tube banks.

Module 9: Radiation Heat Transfer (4)

Definitions, concept of a black body, Kirchoff's law, Lambert's Cosine Law, Stefan-Boltzman's law, Plank's distribution law, Wein's displacement law, configuration factor. Radiation heat exchange between two parallel plates, radiation shielding, radiation heat exchange in an enclosure.

Module 10: Mass Transfer (2)

Fick's law of diffusion, Mass transfer coefficient, Evaporation of water into air, Schmidt number, Sherwood number.

Lecture Plan

Module	Sub-Modules	Hours per topic	Total Hours
1. Introduction	1. Modes of heat transfer	1	**2**
	2.Rate equations: conduction, convection and radiation	1	
2. One Dimensional Steady State Heat Conduction	1.Heat diffusion equation, boundary and initial conditions	1	**5**
	2. One dimensional steady state conduction	3	
	3. Conduction with thermal energy generation	1	
3. Extended surface heat transfer		2	**2**
4. Multi-dimensional Steady State Heat Conduction	1. Two-dimensional steady state conduction: analytical solutions.	1	**4**
	2. Conduction shape factor	1	
	3. Finite difference and finite volume methods	2	
5. Unsteady State Heat Conduction	1. Transient conduction: lumped capacity, Biot and Fourier numbers	1	**4**
	2. One dimensional transient conduction in slab and radial systems: exact and approximate solutions.	2	
	3. Finite difference methods: explicit and implicit formulations.	1	
6. Convection	1. Flow over a body, velocity and thermal boundary layers, drag-co-efficient and heat transfer coefficient.	3	**8**
	2. Use of various correlations in forced convection heat transfer, flow over a flat plate, flow across a single cylinder and tube bundles.	1	
	3. Flow inside a duct; hydrodynamics and thermal entry lengths; fully developed and developing flow.	2	
	4. Free convection heat transfer from vertical surface and vertical cylinder, horizontal surface and horizontal cylinders.	2	
7. Heat Exchangers	1. Heat exchanger types, flow arrangements, overall heat transfer coefficient, fouling factor, LMTD for parallel flow and counter flow heat exchangers.	2	**3**
	2. Effectiveness-NTU method, expression for effectiveness of a parallel flow and counter flow heat exchangers. Multi-pass and cross flow heat exchangers.	1	
8. Boiling and	1. Different regimes of boiling	1	

Condensation	2. Mechanism of condensation, Nusselt's theory of film condensation on a vertical surface, use of correlations in solving film wise condensation on plane surfaces, horizontal tubes and tube banks.	2	**3**
9. Radiation Heat Transfer	1. Definitions, concept of a black body, Kirchoff's law, Lambert's Cosine Law, Stefan-Boltzman's law, Plank's distribution law, Wein's displacement law, configuration factor.	2	**4**
	2. Radiation heat exchange between two parallel plates, radiation shielding,	1	
	2. Radiation heat exchange in an enclosure	1	
10. Mass Transfer	1. Fick's law of diffusion, Mass transfer coefficient	1	**2**
	2. Evaporation of water into air, Schmidt number, Sherwood number.	1	