TRANSPORT PHENOMENA

Course Code: 13CH2103

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Prerequisites: The student should have knowledge of how to formulate differential equations relating to mass, momentum and heat transfer.

Course outcomes:

On successful completion of the course, the student should be able to

CO1 : Identify the type of flow system and choose the suitable coordinate system for a given problem

CO2 : Derive the equations of change for isothermal, non-isothermal flow and multi component systems and use the same for solving problems.

CO3 : Analyze the system and derive the velocity/temperature/ concentration distribution with more than one independent variable.

CO4 : Formulate the governing equations and solve complex chemical engineering problems.

CO5 : Revise the fluctuating, time smoothed velocities, Reynolds stresses and write the time smoothed equations of change.

Introduction:

Review of mathematics: Scalars, Vectors, Tensors, divergence, relation between rectangular coordinates and cylindrical coordinates, relation between rectangular coordinates and spherical coordinates, partial derivative, substantial derivative, total derivative, line integral, surface integral, integral theorems, frames of reference (Eulerian and Lagrangian).

UNIT-I

The equations of change for isothermal flow: Equations of continuity, equation of motion, the equation of mechanical energy, application of Navier-Stokes equation to solve problems like falling film, flow in a tube, shape and surface of a rotating fluid.

Velocity distribution with more than one independent variable like flow over a plate set in motion, unsteady flow between plates, and laminar flow over a flat plate.

UNIT-II

The equations of change for non-isothermal flow: Equations of energy, the energy equation in curvilinear coordinates, use of equations of change to set up steady state heat transfer problems, steady state forced and free convection, flow with viscous dissipation, free convection heat transfer over a vertical plate.

Temperature distribution with more than one independent variable: heating of a semi infinite slab and finite slab, cooling of a sphere in contact with a fluid, laminar tube flow with constant heat flux at the wall.

UNIT-III

The equations of change for multi component systems: The equations of continuity for a binary mixture, the equation of continuity of A in curvilinear coordinates, the multicomponent equations of change in terms of the flows, the multicomponent fluxes in terms of the transport properties, use of equations of change to setup diffusion problems and solve problems related to simultaneous heat and mass transfer, concentration profile in a tubular reactor, catalytic oxidation of CO.

UNIT-IV

Setting up and solving problems like: Diffusion with heterogeneous reaction, gas absorption with chemical reaction, diffusion in a falling film, diffusion and reaction in a spherical catalyst particle.

UNIT-V

Turbulent flow: Introduction, fluctuations and time smoothened equations for velocity, time smoothing of equation of change, Reynolds stresses.

TEXTBOOK:

1. Bird R.B, Stewart W.E and Lightfoot E.N., *"Transport Phenomena"* Wiley international Edition, New York, 2002.

REFERENCE:

1. Welty J.R, Wicks C.E, Wilson R.E, *"Fundamental of Momentum, Heat and Mass Transfer"*, 4th Edition, John Wiley, 2009.

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