# Fluid Mechanics and Rate Processes Swayam Prabha Course Code – M02	
PROFESSOR'S NAME	Prof. Sanjay Mittal
DEPARTMENT	Department of Aerospace Engineering
INSTITUTE	Indian Institute Of Technology Kanpur
COURSE OUTLINE	1. Introduction to transport phenomena: gallery of diverse phenomena and applications. 2. Distinction between uids and solids, Continuum hypothesis, Concept of a property, Viscosity, Newtonian and Non-newtonian uids 3. Body and Surface forces, Stress tensor, Shear and normal components, Symmetry of stress tensor 4. Fluid statics; pressure as a scalar, manometry, forces on submerged surfaces by integration of pressure forces 5. Kinematics: Lagrangian and Eulerian descriptions, Substantial derivative: relation be- tween Eulerian (local) and Lagrangian (material) rates of change, Steady vs unsteady ows, Graphical description of ows: path lines, streak lines and stream lines, Rate of deformation of a uid element, Vorticity and angular rotation, strain rate tensor, decom- position of velocity gradient into shear strain rate and rotation. 6. Control Mass vs Control Volume analysis, Reynolds Transport Theorem 7. Conservation of mass; integral and di_erential approaches, incompressible ows 8. Momentum Theorem: force balance; Derivation of the di_erential form of momentum equation. Newtonian Fluid, Boundary conditions 9. Applications of Navier-Stokes' equation for simple 1-D problems; Poiseuille ow, Couette ow, Cylindrical coordinates 10. Total energy equation; Bernoulli equation; applications including ow measurement (Pitot tube, ori_ce meters) 11. Similitude and modeling using non-dimensionalization of Navier-Stokes' equations and boundary conditions

	12. Low Re ows: ow past circular cylinders; stream functions; Stokes' ow; drag coe_cient correlations 13. High Re ow: Prandtl's approximation; basic inviscid ow; need for boundary layer; Magnus-Robin e_ect 14. Boundary layer ow; ow over at plates; separation; ow past immersed bodies (blu_, streamlined) 15. Physics of ball-games: Role of seam on a cricket ball, e_ect of surface roughness, conventional- and reverse-swing. Aerodynamics of other sports projectiles (tennis ball, badminton shut- tle cock, golf ball, soccer ball). 16. HEAT TRANSFER: Introduction: Fourier's law; unsteady conduction equation; bound- ary conditions; Convection: heat transfer coe_cient and correlations 17. MASS TRANSFER: Introduction; Fick's law; unsteady species conservation equations mass transfer coe_cient and correlations

COURSE DETAILS

S. No	**Module ID/ Lecture ID**	**Lecture Title/Topic**
1	M0L1	Introduction to the Course. Its conduct and policies .
2	M1L1	Introduction to Fluid Mechanics and Rate Processes
3	M1L2	The continuum hypothesis and property
4	M1L3	The stress tensor
5	M2L4	Fluid statics
6	M2L5	Kinematics-1
7	M3L6	Kinematics-2
8	M3L7	Reynolds Transport Theorem: conservation of mass
9	M3L8	Conservation of mass: integral and differential forms

10	M4L9	Integral form of momentum theorem
11	M10	Derivation of differential form of momentum equation
12	M11	Continuity and Momentum Equations in cartesian and cylindrical coordinate system
13	M12	Boundary conditions and various kind of flows.
14	M13	Flow between two parallel plates
15	M14	Flow in a pipe of circular section
16	M15	Integral Form of Total Energy Equation-I
17	M16	Integral Form of Total Energy Equation-II
18	M17	Integral Form of Total Energy Equation-III
19	M18	Bernoulli Equation
20	M19	Similitude and Modeling-I
21	M20	Similitude and Modeling-II
22	M21	Similitude and Modeling-III
23	M22	Flow in a pipe-I
24	M23	Flow in a pipe-II