Course Code	Course Name	Credits
MEC402	**Fluid Mechanics**	**03**

Objectives:

1. To study Fluid Statics and Fluid Dynamics.
2. To acquaint with dimensional analysis of Thermal and Fluid systems.
3. To familiarize with application of mass, momentum and energy equations in fluid flow.
4. To study various flow measurement techniques.
5. To familiarize with the dynamics of fluid flows and the governing nondimensional parameters.

Outcomes: Learner will be able to…

1. **Define** properties of fluids**, classify** fluids and **evaluate** hydrostatic forces on various surfaces.
2. **Illustrate** understanding ofdimensional analysis of Thermal and Fluid systems.
3. **Differentiate** velocity potential function and stream function and solve for velocity and acceleration of a fluid at a given location in a fluid flow.
4. **Formulate** and **solve** equations of the control volume for fluid flow systems and Apply Bernoulli's equation to various flow measuring devices.
5. **Calculate** pressure drop in laminar and turbulent flow, evaluate major and minor losses in pipes.
6. **Calculate** resistance to flow of incompressible fluids through closed conduits and over surfaces.

Module	Detailed Contents	Hrs.
1.	**1.1 Basic Concepts:** Significance of fluid mechanics, physical properties of fluid, Newton's law of viscosity, Newtonian and non-Newtonian Fluid. **1.2 Fluid Statics:** Pascal's law, hydrostatic law, hydrostatic force on submerged surfaces (vertical, inclined & curved). Archimedes principle, buoyancy.	**06**
2.	**2.1 Fluid Kinematics:** Classification of fluid flow, streamline, path line, streak line, acceleration of fluid particle, differential equation of continuity, rotational flow and vortices, stream function, potential function, concept of circulation. **2.2 Dimensional Analysis:** Introduction to dimensional analysis of thermal and fluid systems, Methods of dimensional analysis - Buckingham π Theorem and Rayleigh's Method (Only derivations, no numerical)	**07**
3.	**3.1 Fluid Dynamics:** Concept of control volume and control surface, Importance of Reynolds Transport theorem (RTT) and its derivation (No numerical). Forces acting on fluid in motion, Euler's equation in Cartesian coordinates, Expression of Bernoulli's equation from principle of energy conservation and by integration of Euler's equation. Application of Bernoulli's equation in Orifice meter, Venturi meter, Rotameter and Pitot tube. Momentum of fluid in motion: impulse momentum relationship and its applications for determination of thrust for pipe bend.	**09**

4.	**4.1 Laminar Viscous flow:** Introduction to Reynolds number, critical Reynolds number, Navier-Stokes equation of motion, Relationship between shear stress and pressure gradient in laminar flow, Laminar flow between parallel plates (Plane Poiseuille&Couette flow), Laminar flow in circular pipe (Hagen-Poiseuille flow).	**06**
5.	**5.1 Flow through pipes** : Reynolds experiment, Head loss in pipes due to friction (Darcy-Weisbach equation), Loss of energy in pipe (major and minor), Hydraulic gradient and Energy gradient line, Pipes in series and parallel, concept of equivalent pipe.	**06**
6.	**6.1 Hydrodynamic Boundary Layer Theory:** Concept of formation of boundary layer, boundary layer parameters, boundary layer along a long thin plate and in pipe, Prandtl boundary layer equation, Separation of boundary layer and its methods of control. **6.2 Flow around submerged objects:** Concept of drag and lift, Types of drag, Streamlined and bluff bodies, Drag and lift on an aerofoil.	**05**

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Examination: Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved

References:

1. Fluid Mechanics by Yunus A Cengel and John M Cimbala, Tata McGraw Hill Education, 3rd Edition, 2014.
2. Fluid Mechanics and Machinery by C S P Ojha, Chandramouli and R Berndtsson, Oxford University Press, 1st Edition, 2010.
3. Fox and McDonald's Introduction to Fluid Mechanics by Philip J. Pritchard and John W. Mitchell, Wiley Publishers, 9th Edition,2016.
4. A textbook of Fluid Mechanics by R K Bansal, Laxmi Publication, 1st Edition, 2015.
5. Fluid Mechanics by Frank M. White, McGraw Hill Education, 7th Edition, 2011.
6. Fluid Mechanics by Victor Streeter, Benjamin Wylie and K W Bedford, McGraw Hill Education, 9thEdition, 2010.
7. Engineering Fluid Mechanics by K. L. Kumar, Eurasia Publishing House (P) Ltd, 1st Edition and Reprint 2016.
8. Introduction to Fluid Mechanics by James A. Fay, MIT Press, Campbridge, 1st Edition, 1996.
9. Fluid Mechanics and Hydraulics by Suresh Ukarande, Ane Books Pvt.Ltd, Revised & Updated 1st Edition, 2016.

Links for online NPTEL/SWAYAM courses:

1. https://nptel.ac.in/courses/112/105/112105269
2. https://swayam.gov.in/nd1_noc20_ce59/preview