# Course Outline Format

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| Program | MTH-701 Advanced Topics in Fluid Dynamics-I |
| Credit Hours | 3 |
| Duration |  |
| Prerequisites | Calculus and Analytical Geometry includes limits, continuity, integration and differentiation. Ordinary differential equations, Vector analysis, Basic Physics includes mechanics &heat transfer. |
| Resource Person | Dr. Imran Siddique |
| Counseling Timing | **Tuesday: 12:00 – 02:00****Thursday: 11:00-01:00****02:00 – 04:00****Saturday: 010:00 – 12:00** |
| Contact | **03349869929** |

**Chairman/Director Program signature………………. Dean’s signature…………**

**Date………………………………….**

**Learning Objective**

**Credit Hours: Three**

**Resource Person: Dr. Imran Siddique Semester:**

**Objective:**The main purpose of this course is to develop the understanding of the fundamental principles and the ability to solve, quickly and efficiently, a variety of real fluid mechanics problems from basic principles. The lectures demonstrate the basic principles, methods and modeling approximations that form the basis of fluid mechanics. The main descriptions of the course are:

* Obtaining a solid understanding of the fundamentals of Fluid Mechanics.
* Developing concepts and physical intuitions of fluids at rest and in motions
* Formulating basic equations and laws of fluids in rest and in motion.
* Modeling various fluid flow problems mathematically and solve them using the mathematical techniques.

Analyzing various fluid flow phenomenon through pipes/ducts, plates and different geometries which are familiar in many fluid engineering applications

**Syllabus:**A Brief Historical Introduction to fluid mechanics, Definition of fluid, Difference between a solid and a fluid, Viscosity.Some Basic definitions, System and environment, Control volume and Control surface, Dimensions & Units. Differential versus integral approach, Description of method, Deformation in a fluid element.A brief introduction of Newtonian and non-Newtonian fluids, Newton's law of viscosity, Shear Stress and Shear strain relation. Surface Tension, Capillarity, Fluid Kinematics, Field, Lagrange's and Euler's form of field representation,Velocity field, Acceleration, Types of flow, Uniform and non-uniform flow, rotational and irrotational flow. Steady and unsteady flow, laminar and turbulent flow, one-, two- and three-dimensional flow, Path lines, Streak lines, time lines, stream lines and stream tubes, Equations of stream lines and stream tubes.Stream function and flow rate, Equations of Path lines and Streak lines. Fluid Statics Static Equilibrium, Pressure, Gravity, Basic Hydrostatic Equations.Law of conservation of mass, Continuity equation, Continuity equation for compressible and incompressible fluid.Velocity potential and its relationship with stream function, Fluid rotation, fluid deformation. Motion of incompressible inviscid flow, Bernoulli equation, Euler equation of motion, General analysis of fluid motion, forces acting on fluid particles,Constitutive Equations, Law of conservation of momentum Navier-Stokes equations, Exact solutions of Navier-Stokes equations, Dimensional analysis and similitude, Bukingham Pi theorem, Determining the Pi group.Fully developed laminar flow; Steady unidirectional low, Poiseuille flow, Couette flow, Fully developed laminar flow inside pipe,Similarity analysis,Similarity transforms and solutions,Stokes first problem and its solutionStokes second problem and its solution

**Learning Methodology**

**Grade Evaluation Criteria**

**Marks Evaluation Marks in percentage**

Quizzes

*Assignments : 10*

*Mid Term: 30%*

Attendance & Class Participation

Term Project

Presentations: 10%

Final exam: 50%

Total: 100%

**Recommended Books**

1. **Introduction to fluid mechanics**
By Robert W Fox & Alant McDonald
John Wiley & Sons 2001
2. **Fluid Mechanics**
Frank M. White
McGraw-Hill
3. **Fluid Mechanics**
Nazeer Ahmed

Engineering Press Inc. San Jose, California

**Reference Books**

1. **An introduction to fluid dynamics**
By G.K. Batchelor
Cambridge University Press 1969

 **5 Fluid Mechanics**
By L.D. Landau & E.M. LIfshitz

Pergmon Press 1966

**Calendar of Course contents to be covered during semester**

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| --- | --- | --- |
| **Week** |  **Activity** |  **Reference** |
| **WEEK-1** | **A Brief Historical Introduction to fluid mechanics, Definition of fluid, Difference between a solid and a fluid, Viscosity.** |  |
| **WEEK-2** | **Some Basic definitions, System and environment, Control volume and Control surface, Dimensions & Units. Differential versus integral approach, Description of method, Deformation in a fluid element** |  |
| **WEEK-3** | **A brief introduction of Newtonian and non-Newtonian fluids, Newton's law of viscosity, Shear Stress and Shear strain relation. Surface Tension, Capillarity, Fluid Kinematics, Field, Lagrange's and Euler's form of field representation.** |  |
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| **WEEK-4** | **Velocity field, Acceleration, Types of flow, Uniform and non-uniform flow, rotational and irrotational flow. Steady and unsteady flow, laminar and turbulent flow, one-, two- and three-dimensional flow, Path lines, Streak lines, time lines, stream lines and stream tubes, Equations of stream lines and stream tubes.** |  |
| **WEEK-5** | **Stream function and flow rate, Equations of Path lines and Streak lines. Fluid Statics,Static Equilibrium, Pressure, Gravity, Basic Hydrostatic Equations.** |  |
| **WEEK-6** | **Law of conservation of mass, Continuity equation, Continuity equation for compressible and incompressible fluid.Velocity potential and its relationship with stream function, Fluid rotation, fluid deformation.** |  |
| **WEEK-7** | **Motion of incompressible inviscid flow, Bernoulli equation, Euler equation of motion** |  |

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| **WEEK-8** | **Mid Term** |  |
| **WEEK-9** | **General analysis of fluid motion, forces acting on fluid particles, Constitutive Equations, Law of conservation of momentum Navier-Stokes equations.** |  |
| **WEEK-10** | **Exact solutions of Navier-Stokes equations, Dimensional analysis and similitude, Bukingham Pi theorem, Determining the Pi group.** |  |
| **WEEK-11** | **Fully developed laminar flow; Steady unidirectional low, Poiseuille flow, Couette flow, Fully developed laminar flow inside pipe** |  |
| **WEEK-12** | **Similarity analysis, Similarity transforms and solutions** |  |
| **WEEK-13** | **Stokes first problem and its solution****Stokes second problem and its solution** |  |
| **WEEK-14** | **Sources, sinks and doubletsAxi-symmetric flows, Stokes stream function, Stream function,** |  |
| **WEEK-15** | **Complex potential for two-dimensional, irrotational, Incompressible flow and complex velocity potential for uniform stream.** |  |