Semester - 04

FLUID MECHANICS (IPCC)			
Course Code	21ME43	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2*:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 12 Lab slots	Total Marks	100
Credits	04	Exam Hours	03

**** One additional hour may be considered if required***

Course Learning objectives:

The course will enable the students to

- Acquire a basic understanding of properties of fluids and the measurement of pressure and fluid kinematics.
- Acquire a basic understanding of fundamentals fluid dynamics, and Benoulli's equation and flow meters.
- Acquire the basic concepts of flow through pipes and losses in pipe flows.
- Understand the basic concepts of flow over bodies and usefulness of dimensionless analysis.
- Acquire the fundamentals of compressible flow and the basic knowledge of working of CFD packages.
- Acquire the knowledge of simple fluid mechanics experimental setups and carry out the necessary analysis of these experiemts
- Acquire knowledge experimental errors and the ability to estimate the experimental uncertainties.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different type of teaching methods to develop the outcomes through Power-Point Presentation and Video demonstration or Simulations.
- Chalk and Talk method for Problem Solving.
- Arrange visits to show the live working models other than laboratory topics.
- Adopt collaborative (Group Learning) Learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information.
- Conduct Laboratory Demonstrations and Practical Experiments to enhance experiential skills.

MODULE-1 **8 HOURS**

Introduction: Definition and properties, types of fluids, pressure at a point in static fluid, variation of pressure, Pascal's Law, (To be reviewed in class but not for examination)

Pressure- absolute, gauge, vacuum, pressure measurement by manometers and gauges, hydrostatic pressure on plane submerged bodies. Buoyance and metacentre, Stability of submerged bodies

Fluid Kinematics: Velocity of fluid particle, types of fluid flow, streamlines, path-lines and streak-lines continuity equation, acceleration of fluid particle, strain rate, vorticity, stream function, potential function, Circulation, Reynolds transport theorem

Teaching-Learning Process	1.	Power-point Presentation,
	2.	Video demonstration or Simulations,
	3.	Chalk and Talk are used for Problem Solving.
	4.	Laboratory Demonstrations and Practical Experiments

MODULE-2 **8 HOURS**

Fluid Dynamics: Introduction, Forces acting on fluid in motion, Linear momentum equation, Impact of jets, Moment of momentum equation, Euler's equation of motion along a streamline,

Bernoulli's equation – assumptions and limitations. Introduction to Navier-Stokes equation, Venturi-meters, orifice-meters, rectangular and triangular notches, pitot tubes, Rota-meter, electromagnetic flow meter

Teaching-Learning Process	1.	Power-point Presentation,
	2.	Video demonstration or Simulations,

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	3. Chalk and Talk are used for Problem Solving. 4. Laboratory Demonstrations and Practical Experiments

MODULE-3 **8 HOURS**

Laminar and Turbulent flow: Flow through circular pipe, between parallel plates, Power absorbed in viscous flow in bearings, Poiseuille equation

Loss of head due to friction in pipes, Major and minor losses, pipes in series and parallel.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving. 4. Laboratory Demonstrations and Practical Experiments

MODULE-4 **8 HOURS**

Flow over bodies: Development of boundary layer, Lift and Drag, Flow around circular cylinders, spheres, aerofoils and flat plates, Streamlined and bluff bodies, boundary layer separation and its control.

Dimensional Analysis: Derived quantities, dimensions of physical quantities, dimensional homogeneity, Rayleigh method, Buckingham Pi-theorem, dimensionless numbers, similitude, types of similitude.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving. 4. Laboratory Demonstrations and Practical Experiments

MODULE 5 **8 HOURS**

Compressible flows: Speed of sound, adiabatic and isentropic steady flow, Isentropic flow with area change stagnation and sonic properties, normal and oblique shocks, flow through nozzles.

Introduction to CFD: Necessity, limitations, philosophy behind CFD, applications

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving. 4. Laboratory Demonstrations and Practical Experiments

PRACTICAL COMPONENT OF IPCC

Modern computing techniques are preferred for estimation and analysis.

Sl.NO	Experiments
1	Determine the viscosity of oil using Red wood viscometer and Say-bolt viscometer.
2	Measurement of pressure using different Manometers for high and low pressure measurements (manometers using different manometric fluids).
3	Working principle of different flow meters and their calibration (orifice plate, venture meter, turbine, Rota meter, electromagnetic flow meter)
4	Working principle of different flow meters for open channel and their calibration
5	Determination of head loss in pipes and pipe fittings having different diameters, different materials and different roughness
6	Reynolds apparatus to measure critical Reynolds number for pipe flows
7	Effect of change in cross section and application of the Bernoulli equation
8	Impact of jet on flat and curved plates

9	Measurement of coefficient of pressure distribution on a cylinder at different Reynolds Numbers
10	Wind tunnel calibration using Pitot static tube
11	Determination of drag and lift co-efficients of standard objects using wind tunnel.
12	Use any CFD package to study the flow over aerofoil/cylinder

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

CO 1. Understand the basic principles of fluid mechanics and fluid kinematics

CO 2. Acquire the basic knowledge of fluid dynamics and flow measuring instruments

CO 3. Understand the nature of flow and flow over bodies and the dimensionless analysis

CO 4. Acquire the compressible flow fundamental and basics of CFD packages and the need for CFD analysis.

CO 5. Conduct basic experiments of fluid mechanics and understand the experimental uncertainties.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks (duration 01 hour)**

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test **(duration 03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks.

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

8. The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be reduced proportionally to 50 marks

9. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
10. The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included. The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Reference Books

- Fox, R. W., Pitchard,P. J.,and McDonald, A. T., (2010), Introduction to Fluid Mechanics, 7thEdition, John Wiley & Sons Inc.
- Cimbala, J.M., Cengel, Y. A. (2010),Fluid Mechanics: Fundamentals and Applications, McGraw-Hill
- Frank M White., (2016), Fluid Mechanics, 8thEdition , McGraw-Hill

Additional References:

- A text book of Fluid Mechanics and Hydraulic Machines, Dr. R K Bansal, Laxmi publishers
- Fndamentals of Fluid Mechanics, Munson, Young, Okiishi & Hebsch, John Wiley Publicationss, 7th Edition

Web links and Video Lectures (e-Resources):

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- **Industrial visits**
- **Course seminar**
- **Term project**