Gyanmanjari Innovative University

Syllabus
Gyanmanjari Institute of Technology
Semester-3 (B. Tech.)

Subject: Statics and Dynamics in the World of Fluid Mechanics– BET2CV13305

Type of Course: Professional Core

Prerequisite: Knowledge of Engineering Insights into Material Strength

Rationale: Fluid Mechanics is a fundamental engineering course that develops understanding of fluid properties, statics, kinematics, dynamics, pipe flow, and flow measurement principles for analyzing practical engineering systems. The subject builds problem-solving, experimental, and analytical skills through theory, laboratory work, and active learning activities. It provides the foundation for advanced subjects such as Fluid Machinery, Advanced Fluid Mechanics, Hydraulics, Heat Transfer, and CFD, while supporting outcome-based education and industry-oriented engineering applications.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks		Total Marks
CI	T	P	C	SEE	CCE	
4	0	2	5	100	50	150

Legends: CI-Classroom Instructions; T-Tutorial; P -Practical; C –Credit; SEE -Semester End Evaluation; CCE-Continuous and Comprehensive Evaluation

Course Content:

Sr. No.	Course Content	Hrs.	% Weightage
1	**Fluid Properties and Fluid Statics** ***Theory Topics:*** Introduction to Fluid Mechanics and Engineering Applications, Fluid as Continuum, System and Control Volume Concept, Dimensions, Units and Dimensional Homogeneity, Classification of Fluids and Flow Regimes, Density, Specific Weight, Specific Gravity, Dynamic and Kinematic Viscosity, Newtonian and Non-Newtonian Fluids, Compressibility and Bulk Modulus, Vapour Pressure and Cavitation, Surface Tension and Capillarity, Pressure and Pressure Variation in Static Fluids, Pascal's Law, Hydrostatic Law, Pressure Measurement using Manometers and Gauges, Hydrostatic Forces on Plane and Curved Surfaces, Buoyancy and Archimedes Principle, Stability of	10	20 %

Floating and Submerged Bodies.

Practical:

1. Study the variation of hydrostatic pressure in static fluids and verify the Hydrostatic Pressure Law through observation and measurement.
2. Determine the metacentric height of a floating body and analyze its stability characteristics.
3. Measure fluid pressure using simple and differential manometers and interpret the results for engineering applications.
4. Verify Pascal's Law and demonstrate the transmission of pressure through confined fluids using hydraulic apparatus.
5. Determine the specific gravity of fluids through experimental methods and analyze the observed results.
6. Observe capillary rise and surface tension phenomena and study their effects on fluid behavior.
7. Measure the viscosity of fluids using a viscometer and relate the results to practical engineering applications.

Evaluation Method:

Sr. No.	Evaluation Methods	SEE	CCE
1	**Fluid Statics Numerical Problem** Students will be assessed through descriptive and numerical problem-solving tasks related to fluid mechanics and fluid statics. The evaluation will require students to solve problems involving pressure measurement, hydrostatic forces on submerged surfaces, buoyancy, stability of floating bodies, and fluid properties. Students may also be required to interpret fluid behavior under static conditions and apply theoretical concepts to engineering situations. The assessment will focus on conceptual understanding, accuracy of calculations, logical problem-solving approach, and clear presentation of solutions.	20	
2	**Active Learning Assignments: Hydrostatic Principles Model Demonstration and Case Study on Fluid Statics Applications.** Students will study and demonstrate hydrostatic principles using physical models, experiments, or real-life engineering case studies related to dams,		10

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<tr><td></td><td>tanks, floating bodies, pressure measurement devices, and hydraulic structures. Students will analyze fluid statics applications, explain pressure distribution and buoyancy effects, and present their observations with diagrams and explanations in a structured PDF/report for submission on the GMIU Portal.</td><td></td><td></td></tr>
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Examination Style:

Fluid Statics Numerical Problem (20 Marks)
Students will be assessed through descriptive and analytical evaluation designed to test their understanding and application of fluid statics principles. The examination will require students to solve numerical problems related to pressure measurement, hydrostatic forces, buoyancy, stability of floating bodies, and fluid properties. Students may also be required to explain theoretical concepts, interpret fluid behavior under static conditions, and apply engineering principles to practical situations. The assessment will focus on conceptual clarity, accuracy of calculations, logical problem-solving approach, and structured presentation of answers.

Hydrostatic Principles Model Demonstration and Case Study on Fluid Statics Applications (10 Marks)
Students will be assessed through an application-based and analytical evaluation focusing on hydrostatic principles and their practical applications in engineering. The examination will require students to demonstrate or analyze models and case studies related to pressure distribution, buoyancy, floating bodies, hydraulic structures, and fluid statics devices. Students may be given practical scenarios or diagrams and asked to explain fluid behavior, identify hydrostatic effects, and interpret engineering applications. The assessment will focus on conceptual understanding, analytical ability, visualization of fluid behavior, and clarity in explanation and presentation.
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Fluid kinematics
<u>Theory Topics:</u>
Eulerian and Lagrangian Approaches, Types of Fluid Flow, Streamline, Path line and Streak line, Velocity and Acceleration Fields, Material Derivative, Rotation and Vorticity, Continuity Equation, One, Two and Three-Dimensional Continuity Forms, Stream Function and Velocity Potential, Flow Nets.
<u>Practical:</u>
8. Observe fluid flow patterns such as streamlines and path lines to understand the behavior of fluid motion.
9. Verify the continuity principle by measuring flow rates and
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analyzing the conservation of mass in fluid flow.

10. Develop and interpret flow nets to study flow characteristics and velocity distribution in fluids.
11. Measure the velocity profile of fluid flow and analyze the variation of velocity across the flow section.
12. Demonstrate and compare different flow descriptions such as streamlines and path lines through visualization techniques.
13. Study vortex motion and rotational flow behavior to understand concepts of circulation and vorticity.
14. Analyze fluid flow patterns using simulation or visualization tools and interpret the observed flow behavior for engineering applications.

Evaluation Method:

Sr. No.	Evaluation Methods	SEE	CCE
1	**Velocity and Acceleration Potential function exercise** Students will be assessed through theory-based, derivation-oriented, and numerical problem-solving tasks related to fluid kinematics. The evaluation will include concepts of fluid motion, flow descriptions, continuity equation, velocity and acceleration analysis, stream function, and flow net applications. Students may also be required to apply kinematic principles to practical engineering problems and interpret fluid flow behavior under different conditions. The assessment will focus on conceptual understanding, analytical ability, derivation skills, accuracy of calculations, and structured presentation of solutions.	20	
2	**Active Learning Assignments:** **Flow Visualization and Kinematic Analysis Activity, and Continuity and Flow Modeling Assignment.** Students will perform activities related to flow visualization and fluid kinematics to observe and analyze streamlines, path lines, streak lines, and flow behavior. Students will also carry out continuity verification, flow net construction, or kinematic modeling of fluid flow systems through problem-based assignments. The activities will		10

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<tr><td></td><td>help students understand fluid motion behavior and application of continuity principles in engineering practice. Students will submit observations, analysis, diagrams, and explanations in a structured report or PDF on the GMIU Portal.</td><td></td><td></td></tr>
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Examination Style:
Velocity and Acceleration Potential function exercise (20 Marks)
Students will be assessed through theory, derivations, numerical problem solving, and application-oriented questions related to fluid kinematics. The evaluation may include concepts of fluid motion, flow descriptions, continuity equation, velocity and acceleration analysis, stream function, and flow net applications. The assessment shall emphasize conceptual understanding, analytical ability, derivation skills, and application of kinematic principles in engineering problems.
Flow Visualization and Kinematic Analysis Activity, and Continuity and Flow Modeling Assignment. (10 Marks)
Activity 1: Flow Visualization and Kinematic Analysis Activity (5 Marks) Students will perform a flow visualization activity to observe and analyze streamlines, path lines, streak lines, or flow patterns for understanding fluid motion behavior. Evaluation shall be based on observation, conceptual interpretation, participation, and presentation of findings.
Activity 2: Continuity and Flow Modeling Assignment (5 Marks) Students will carry out a problem-based activity involving continuity verification, flow net construction, or kinematic modeling of fluid flow systems. Evaluation shall be based on problem-solving approach, analysis, application of concepts, and report submission.
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Fluid Dynamics
<u>Theory Topics:</u>
Euler's Equation, Bernoulli's Equation, Energy Equation and Assumptions, Bernoulli Applications, Hydraulic and Energy Grade Lines, Venturi meter, Orifice meter, Pitot Tube, Linear Momentum Equation, Impulse-Momentum Principle, Forces due to Fluid Jets on Vanes and Bends.
<u>Practical:</u>
15. Verify Bernoulli's theorem experimentally by measuring pressure, velocity, and energy changes in fluid flow.
16. Determine the discharge through a Venturi meter and study its application in flow measurement.
17. Study the impact of a fluid jet on vanes and analyze the forces developed using momentum principles.
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18. Measure discharge through an orifice meter and evaluate its flow characteristics and coefficient of discharge.
19. Determine fluid flow velocity using a Pitot tube and analyze dynamic pressure measurements.
20. Verify the momentum equation through experimental study of forces acting in fluid flow systems.
21. Analyze flow through nozzles to study fluid acceleration and energy conversion in flowing fluids.

Evaluation Method:

Sr. No.	Evaluation Methods	SEE	CCE
1	**Analytical methods for Discharge** Students will be assessed through theory-based, derivation-oriented, and numerical problem-solving tasks related to fluid dynamics. The evaluation will include Bernoulli's equation, energy principles, momentum analysis, flow measurement devices, force analysis in fluid flow systems, and hydraulic applications. Students may also be required to apply fluid dynamic principles to practical engineering problems and analyze fluid behavior under different operating conditions. The assessment will focus on conceptual understanding, analytical ability, derivation skills, numerical accuracy, and structured presentation of solutions.	20	
2	**Active Learning Assignments:** **Flow Visualization and Kinematic Analysis Activity, and Continuity and Flow Modeling** Students will perform activities related to fluid dynamics to understand Bernoulli's principle, momentum principles, flow measurement devices, and practical fluid flow behavior. Students will also carry out design-based demonstrations, industrial case studies, or application-oriented assignments involving pipelines, nozzles, jets, Venturimeters, hydraulic systems, or other engineering flow systems. These activities will help students understand the practical application of fluid dynamic principles in engineering practice. Students will		10

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<tr><td></td><td>submit observations, analysis, diagrams, calculations, and explanations in a structured report or PDF on the GMIU Portal.</td><td></td><td></td></tr>
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Examination Style:

Analytical methods for Discharge (20 Marks)
Students will be assessed through theory, derivations, numerical problem solving, and application-oriented questions related to fluid dynamics. The evaluation may include Bernoulli's equation, energy principles, momentum analysis, flow measurement devices, and force analysis in fluid flow systems. The assessment shall emphasize conceptual understanding, analytical problem-solving ability, derivation skills, and application of fluid dynamic principles in engineering situations.
Flow Visualization and Kinematic Analysis Activity, and Continuity and Flow Modeling (10 Marks)
Activity 1: Flow Dynamics Design and Demonstration Activity (5 Marks) Students will perform a design-based or demonstration activity related to Bernoulli's principle, momentum principles, or flow measurement devices such as Venturi meter or nozzle systems. Evaluation shall be based on conceptual understanding, practical implementation, analytical interpretation, participation, and presentation of findings.
Activity 2: Industrial Application Case Study on Fluid Dynamics (5 Marks) Students will carry out a case study or application-based activity related to practical fluid dynamic systems such as pipelines, nozzles, jets, or hydraulic applications. Evaluation shall be based on analysis, problem-solving approach, report quality, engineering relevance, and presentation.
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Internal Flow Through Pipes

<u>Theory Topics:</u>

Laminar and Turbulent Flow, Reynolds Number and Reynolds Experiment, Hagen-Poiseuille Law, Darcy-Welsbach Equation, Major Losses, Minor Losses, Friction Factor and Moody Chart, Pipes in Series and Parallel, Equivalent Pipe, Hydraulic Gradient Line (HGL), Energy Gradient Line (EGL), Power Transmission through Pipes.

<u>Practical:</u>

22. Reynolds Experiment: Determine laminar and turbulent flow regimes through Reynolds number evaluation and flow observation.
23. Pipe Friction Loss Experiment: Measure major head losses in pipe flow and analyze frictional resistance characteristics.
24. Minor Loss Coefficient Determination: Determine losses due to bends, valves and fittings through experimental analysis.
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25. Flow through Pipes in Series and Parallel: Study discharge distribution and head losses in interconnected pipe systems.
26. Verification of Hagen–Poiseuille Law: Analyze laminar pipe flow behavior through experimental verification of flow relations.
27. Hydraulic and Energy Gradient Line Demonstration: Observe and interpret HGL and EGL behavior in pipe flow systems.
28. Pipe Network Performance Analysis Experiment: Evaluate practical pipe network behavior through flow and pressure measurements.

Examination Style:

Sr. No.	Evaluation Methods	SEE	CCE
1	**Friction analysis in pipe through flow** Students will be assessed through theory-based, derivation-oriented, and numerical problem-solving tasks related to internal flow through pipes. The evaluation will include flow regimes, Reynolds number, head losses, friction factor, pipe flow analysis, and pipe network problems. Students may also be required to apply pipe flow principles to practical engineering systems and analyze fluid flow behavior under different operating conditions. The assessment will focus on conceptual understanding, analytical ability, derivation skills, numerical accuracy, and structured presentation of solutions.	20	
2	**Pipe Flow Analysis and Experimental Activity, and Pipe Network Survey and Design Assignment.** Students will perform activities related to pipe flow behavior, Reynolds experiment, friction loss analysis, and internal flow characteristics to understand practical pipe flow systems. Students will also carry out survey-based or design-oriented assignments involving pipe network analysis, water distribution systems, and piping layouts. These activities will help students understand the practical application of pipe flow principles in engineering practice.		10
	Total	**20**	**10**

Friction analysis in pipe through flow (20 Marks)

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<td>Students will be assessed through theory, derivations, numerical problem solving, and application-oriented questions related to internal flow through pipes. The evaluation may include flow regimes, Reynolds number, head losses, friction factor, pipe flow analysis, and pipe network problems. The assessment shall emphasize conceptual understanding, analytical skills, numerical accuracy, derivation ability, and application of pipe flow principles in engineering systems.
Pipe Flow Analysis and Experimental Activity, and Pipe Network Survey and Design Assignment. (10 Marks)
Students will perform an activity related to pipe flow behavior, Reynolds experiment, or friction loss analysis to study internal flow characteristics. Evaluation shall be based on experimental observation, concept application, analytical interpretation, data analysis, participation, and presentation of findings. Students will carry out a survey or design-based activity involving practical pipe network analysis such as water distribution systems, pipe fittings, or piping layouts. Evaluation shall be based on problem-solving approach, analytical design, engineering application, report quality, and presentation.</td>
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<td>Flow Measurement and Introduction to External Flows
<u>Theory Topics:</u>
Flow through Orifices and Mouthpieces, Notches and Weirs, Discharge Measurement Techniques, Boundary Layer Concept, Laminar and Turbulent Boundary Layers, Boundary Layer Separation, Drag and Lift Concepts, Streamlined and Bluff Bodies, Introduction to Open Channel Flow Specific Energy Concept, Hydraulic Jump, Practical Applications of External Flows.
<u>Practical:</u>
31. Determine discharge over notches and weirs through experimental measurement and flow analysis.
32. Evaluate the discharge characteristics of orifices and mouthpieces and determine relevant flow coefficients.
33. Measure fluid velocity using a Pitot tube and analyze practical flow measurement techniques.
34. Determine the coefficient of discharge for an orifice experimentally and compare it with theoretical values.
35. Study boundary layer development, drag effects, and external flow characteristics through observation and analysis.
36. Observe flow patterns over bluff and streamlined bodies to understand flow separation and drag behavior.
37. Demonstrate the formation and characteristics of a hydraulic jump and analyze its behavior in open channel flow.
Evaluation Method:
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No.			
1	**Discharge analysis through various hydraulics apparatus** Students will be assessed through theory-based, derivation-oriented, and numerical problem-solving tasks related to flow measurement and external flow concepts. The evaluation will include discharge measurement techniques, notches and weirs, orifices, boundary layer fundamentals, drag and lift concepts, and introductory open channel flow applications. Students may also be required to apply external flow principles to practical engineering problems and analyze flow behavior under different operating conditions. The assessment will focus on conceptual understanding, analytical ability, derivation skills, numerical accuracy, and structured presentation of solutions.	20	
2	**Flow Measurement and Experimental Demonstration Activity and External Flow Application Case Study / Innovation Activity** Students will perform activities related to flow measurement devices such as notches, weirs, orifices, and discharge measurement systems to understand practical flow analysis and measurement techniques. Students will also carry out case study–based or innovation-oriented activities involving boundary layer behavior, drag effects, aerodynamic applications, or external flow phenomena. These activities will help students understand the practical application of flow measurement and external flow principles in engineering systems.		10
	Total	**20**	**10**

Examination Style:

Discharge analysis through various hydraulics apparatus (20 Marks)

Students will be assessed through theory, derivations, numerical problem solving, and application-oriented questions related to flow measurement and external flow concepts. The evaluation may include

	discharge measurement techniques, orifices and weirs, boundary layer fundamentals, drag and lift concepts, and introductory open channel flow applications. The assessment shall emphasize conceptual understanding, analytical problem-solving ability, numerical accuracy, derivation skills, and application of external flow principles in engineering systems. **Flow Visualization and Kinematic Analysis Activity, and Continuity and Flow Modeling Assignment. (10 Marks)** Activity 1: Flow Measurement and Experimental Demonstration Activity (5 Marks) Students will perform an activity related to flow measurement devices such as notches, weirs, orifices, or practical discharge analysis through experimentation or model demonstration. Evaluation shall be based on conceptual understanding, experimental execution, analytical interpretation, data analysis, participation, and presentation of findings. Activity 2: External Flow Application Case Study / Innovation Activity (5 Marks) Students will carry out a case study or innovation-based activity related to boundary layer behavior, drag effects, aerodynamic applications, or external flow phenomena. Evaluation shall be based on analytical approach, creativity, engineering relevance, innovation, report quality, and presentation.		

Suggested Specification table with Marks (Theory): 100

Distribution of Theory Marks (Revised Bloom's Taxonomy)						
Level	Remembrance (R)	Understanding (U)	Application (A)	Analyze (N)	Evaluate (E)	Create (C)
Weightage %	20%	20%	20%	20%	10%	10%

Course Outcome:

After learning the course, the students should be able to:	
CO1	Explain fundamental fluid properties, hydrostatic principles, buoyancy, and stability concepts for analyzing fluids at rest.
CO2	Apply principles of fluid kinematics, continuity equation, and flow description methods to analyze fluid motion.
CO3	Analyze fluid dynamic behavior using Bernoulli's equation, momentum principles, and energy relations in engineering applications.
CO4	Evaluate internal flow through pipes, head losses, and pipe network behavior for solving practical flow problems.
CO5	Apply principles of flow measurement and basic external flow concepts to analyze engineering systems and conduct experimental investigations.

Instructional Method:

The course delivery method will depend upon the requirement of content and need of students.

A minimum of 20–30% of the course content shall be suggested to deliver through Flipped Learning, where students study digital learning resources before the classroom session. Classroom time shall be utilized for discussion, problem-solving, practical applications, and higher-order learning activities.

Students shall be encouraged to use AI-powered learning platforms, simulation software, virtual laboratories, digital libraries, research databases, online certification courses, NPTEL, SWAYAM, MOOCs, and other technology-enabled learning resources to strengthen conceptual understanding and practical competence.

Continuous assessment shall be conducted through Active Learning Assignments (ALAs), quizzes, skill demonstrations, presentations, practical exercises, projects, case studies, innovation activities, peer assessment, reflective learning, and industry-oriented tasks instead of relying primarily on conventional written assignments.

Reference Books:

[1] Fluid Mechanics and Hydraulic Machines, Dr. R.K. Rajput, S. Chand Publications, ISBN: 978-8121926173.
[2] A Textbook of Fluid Mechanics and Hydraulic Machines, Dr. R.K. Bansal, Laxmi Publications, ISBN: 978-8131808155.
[3] Fluid Mechanics and Fluid Power Engineering, Dr. D.S. Kumar, S.K. Kataria & Sons, ISBN: 978-9350143256.
[4] Fluid Mechanics and Machinery, Dr. C.P. Kothandaraman & R. Rudramoorthy, New Age International Publishers, ISBN: 978-8122431102.
[5] Fluid Mechanics and Hydraulic Machines, Dr. R.K. Singal, I.K. International Publishing House, ISBN: 978-9382332871.