INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

CIVIL ENGINEERING

COURSE DESCRIPTOR

Course Title	**FLUID MECHANICS**				
Course Code	ACE005				
Programme	B. Tech				
Semester	IV	CE			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Dr. G.V. Ramana, Professor				
Course Faculty	Dr. G.V. Ramana, Professor Mr. CH.V. S. S. Sudheer, Assistant Professor				

I. COURSE OVERVIEW:

This course provides students with an introduction to principal concepts and methods of fluid mechanics. Topics covered in the course include pressure, hydrostatics, and buoyancy; open systems and control volume analysis; mass conservation and momentum conservation for moving fluids; viscous fluid flows, flow through pipes; dimensional analysis; boundary layers, and lift and drag on objects. Students will work to formulate the models necessary to study, analyze, and design fluid systems through the application of these concepts, and to develop the problem-solving skills essential to good engineering practice of fluid mechanics in practical applications.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AHS002	I	Linear Algebra And Ordinary Differential Equations	4
UG	AME002	II	Engineering mechanics	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Fluid Mechanics	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✓	Chalk & Talk	✓	Quiz	✓	Assignments	x	MOOCs
✓	LCD / PPT	✓	Seminars	✓	Mini Project	✓	Videos
✓	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five units and each unit carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each unit. Each question carries 14 marks. There could be a maximum of two sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):
CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	Theory		Total Marks
Type of Assessment	CIE Exam	Quiz / AAT	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration consisting of two parts. Part–A shall have five compulsory questions of one mark each. In part–B, four out of five questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz / Alternative Assessment Tool (AAT):
Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course.
The AAT may include seminars, assignments, term paper, open ended experiments, five minutes' video and MOOCs.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Assignments/ Exams
PO 2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	2	Assignments/ Exams
PO 3	**Design / development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations	2	Assignments
PO 4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	1	Open Ended Experiments
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large such as , being able to comprehend and write effective reports and design documentation, make effective presentations and give receive clear instructions.	2	Assignments
PO 12	**Life-long learning:** Recognize the need for, and have the preparations and ability to engage in independent and life-long learning in the broad cast context of technology change.	1	Seminars

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Engineering Knowledge**: Graduates shall demonstrate sound knowledge in analysis, design, laboratory investigations and construction aspects of civil engineering infrastructure, along with good foundation in mathematics, basic sciences and technical communication.	2	Seminar
PSO 2	**Broadness and Diversity:** Graduates will have a broad understanding of economical, environmental, societal, health and safety factors involved in infrastructural development, and shall demonstrate ability to function within multidisciplinary teams with competence in modern tool usage.	-	-
PSO 3	**Self-Learning and Service:** Graduates will be motivated for continuous self-learning in engineering practice and/or pursue research in advanced areas of civil engineering in	1	Workshop

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
	order to offer engineering services to the society, ethically and responsibly.		

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand and study the effect of fluid properties on a flow system.
II	Apply the concept of fluid pressure, its measurements and applications.
III	Explore the static, kinematic and dynamic behavior of fluids.
IV	Assess the fluid flow and flow parameters using measuring devices.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
CACE005.01	CLO 1	Define fluid and its properties. Describe surface tension and relations in different conditions.	PO 1	3
CACE005.02	CLO 2	Explain Newton's law of viscosity. Classify fluids based on Newton's law of viscosity and solve problems on Viscosity.	PO 1 PO 2	3
CACE005.03	CLO 3	Employ capillary principle to calculate capillary rise/fall in a given tube.	PO 2	2
CACE005.04	CLO 4	Interpret different forms of pressure measurement.	PO 2	2
CACE005.05	CLO 5	Employ principle of manometry to measure gauge and differential pressure.	PO 2	2
CACE005.06	CLO 6	Employ principle of manometry to measure gauge and differential pressure surface.	PO 2	2
CACE005.07	CLO 7	Examine the possibility of a flow using continuity equation	PO 1 PO 2	3
CACE005.08	CLO 8	Employ Archimedes principle to solve numerical examples on Buoyancy	PO 1 PO 2	3
CACE005.09	CLO 9	Identify and interpret different flows with relevant equations	PO 1 PO 2	3
CACE005.10	CLO 10	Distinguish velocity potential function and stream function and solve for velocity and acceleration of a fluid at a given location in a fluid flow	PO 1 PO 2	3
CACE005.11	CLO 11	Examine stability of a floating body by determining its metacentric height	PO 1 PO 2	3
CACE005.12	CLO 12	Establish Euler's theorem and deduce Bernoulli's equation for a ideal fluid and comment on validation assumption made.	PO 1 PO 2	3
CACE005.13	CLO 13	Examine Bernoulli's equation for ideal and real fluids and evaluate the direction of flow	PO 1 PO 2	3
CACE005.14	CLO 14	Flow and velocity measuring instruments.	PO 1	3
CACE005.15	CLO 15	Employ Darcy-Weischbach and Chezy's equation to calculate friction losses	PO 1	3
CACE005.16	CLO 16	Describe flow through pipes, and Distinguish between major loss and minor loss in pipes.	PO 3	2
CACE005.17	CLO 17	Sketch HGL and TEL for a given pipe setting.	PO 2	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
CACE005.18	CLO 18	Distinguish between Drag force and lift force and Examine drag and lift force for a given set	PO 1	3
CACE005.19	CLO 19	Write the boundary layer concept.	PO 3	2
CACE005.20	CLO 20	Distinguish displacement, momentum, and energy thickness	PO 2	2
CACE005.21	CLO 21	Explain the concept of Prandtl contribution.	PO 3	2
CACE005.22	CLO 22	Evaluate the Vonkarmen momentum integral equation.	PO 3	2
CACE005.23	CLO 23	Analyze the closed conduit flows using Reynolds experiment. Sketch laminar and turbulent	PO 3	2
CACE005.24	CLO 24	Possess the knowledge and skills for employability and to succeed in national and International level competitive examinations.	PO 10	1

3 = High; 2 = Medium; 1 = Low

X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3												3		
CLO 2	3	2	2										2		
CLO 3	3												3		
CLO 4		2											1		
CLO 5		2											2		
CLO 6		2	2										1		
CLO 7			3	1									3		
CLO 8			2	1									1		
CLO 9		2											3		
CLO 10		2	2										3		1
CLO 11	3												2		
CLO 12	3												2		1
CLO 13	3												1		2
CLO 14	3	2	2									1	1		
CLO 15		2	1									1	1		
CLO 16		2		2									3		
CLO 17	3	2											1		

Course Learning Outcomes (CLOs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 18	3	2											1		
CLO 19	3	2											1		
CLO 20	3	2											1		
CLO 21	3												1		
CLO 22	3												1		1
CLO 23	3		3										2		
CLO 24										1			1		

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XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1, PO 2, PO 3, PO 4, PO10 & PO 12	SEE Exams	PO 1, PO 2, PO 3, PO 4, PO10&PO 12	Assignments	PO 1, PO 2, PO 3&PO10	Seminars	PO 12
Laboratory Practices	-	Student Viva	PO 1	Mini Project	-	Certification	-
Term Paper	-						

XII. ASSESSMENT METHODOLOGIES - INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✔	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

UNIT - I	INTRODUCTION & HYDROSATICS FORCES
Dimensions and units – Physical properties of fluids - specific gravity, viscosity, surface tension, Vapour pressure and their influences on fluid motion, Pressure at a point, Pascal's law, Hydrostatic law - atmospheric, gauge and vacuum pressures. Measurement of pressure, Pressure gauges, Manometers: Simple and differential U-tube Manometers. Hydrostatic forces on submerged plane, horizontal, vertical, inclined and curved surfaces. Center of pressure, buoyancy, meta-center, meta-centric height. Derivations and problems.	
UNIT - II	**FLUID KNIEMATICS**
Description of fluid flow, Stream line, path line and streak lines and stream tube. Classification of flows: Steady and unsteady, uniform and non-uniform, laminar and turbulent, rotational and irrotational flows. Equation of continuity for 1 - D, 2 - D, and 3 - D flows – stream and velocity potential functions, flow net analysis.	
UNIT-III	**FLUID DYNAMICS**
Euler's and Bernoulli's equations for flow along a streamline for 3 - D flow, Navier – Stokes equations (Explanationary), Momentum equation and its applications. Forces on pipe bend. Pitot-tube,	

Venturimeter and Orifice meter, classification of orifices, flow over rectangular, triangular, trapezoidal and stepped notches, Broad crested weirs.	
UNIT-IV	**BOUNDARY LAYER THEORY**
Approximate Solutions of Navier-Stoke's Equations, Boundary layer (BL) – concepts, Prandtl contribution, Characteristics of boundary layer along a thin flat plate, Vonkarmen momentum integral equation, laminar and turbulent boundary layers (no deviation), BL in transition, separation of BL, control of BL, flow around submerged objects, Drag and Lift forces , Magnus effect.	
UNIT-V	**CLOSED CONDUIT FLOW**
Reynolds experiment – Characteristics of Laminar & Turbulent flows. Flow between parallel plates, flow through long pipes, flow through inclined pipes. Laws of Fluid friction – Darcy's equation, minor losses, pipes in series and pipes in parallel. Total energy line and hydraulic gradient line. Pipe network problems, variation of friction factor with Reynolds number – Moody's chart, Water hammer effect..	
Text Books:	
1. Modi and Seth, "Fluid Mechanics‖", Standard book house, 2011. 2. R.K. Rajput, "A text of Fluid mechanics and hydraulic machines", S. Chand & company Pvt. Ltd, Sixth Edition, 2015. 3. S.K. Som & G. Biswas, ―Introduction to Fluid Machines‖, Tata Mc Grawhill publishers Pvt. Ltd, 2010. 4. D. Ramdurgaia, ― Fluid Mechanics and Machinery‖, New Age Publications, 2007.	
Reference Books:	
1. Shiv Kumar, ―Fluid Mechanics Basic Concepts & Principles‖, Ane Books Pvt Ltd., 2010. 2. R.K. Bansal ,‖A text of Fluid mechanics and hydraulic machines‖ - Laxmi Publications (P) ltd., New Delhi 2011.	

XIV. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1 - 2	Explain of various units	CLO1	T1: 1.1-3 R2:1-1.7
3 - 4	Explain fluid properties	CLO1	T1: 2.4 R2:1-1.7
5 - 6	Understand the concept Newton laws of viscosity	CLO2	T1: 2.6-14 R2:1-1.7
7 - 8	Understand the concept of capillarity and surface tension	CLO3	T1: 2.15-20 R2:1-1.7
9	Distinguish various pressures	CLO4	T1: 3.1-.3 R2:2-2.8
10 - 13	Determine pressure with different instruments	CLO5	T1: 3.5-14 R2:2-2.8
14	Differentiate various flow lines	CLO10	T1: 6.1-5 R2:2-2.8
15 - 16	Classify and describe various flows	CLO8	T1: 9.1-5 R2:2-2.8
17 - 19	Compute rate of flow or Discharge	CLO9	T1: 9.6-7 R2:2-2.8
20 - 22	Explore the continuity equation	CLO8	T1: 9.6-7 R2: 3-3.8
23 - 25	Distinguish the various acceleration	CLO10	T1: 9.6-7 R2: 3-3.8

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
26	Explore velocity potential function and stream function	CLO10	T1:9.6-11 R2: 3-3.8
27 - 28	Define various forces	CLO11	T1: 10.1-5 R2: 4-4.8
29 - 30	Formulate Euler's equation of motion	CLO12	T1: 10.5-7 R2: 4-4.8
31 - 32	Formulate Bernoulli's equation of motion	CLO13	T1: 10.7 R2: 4-4.8
32 - 35	Details Apply momentum equation for a pipe bend	CLO16	T1: 11.1-7 R2: 11-11.10
35 - 38	Define boundary layer	CLO19	T4: 2.1 -2.2 R2: 13-13.7
39 - 41	Distinguish boundary layer of laminar, turbulent and transition	CLO20	T4: 2.3 -2.6 R2: 13-13.7
42 - 45	Explain separation of boundary layer	CLO20	T4: 2.7 - 2.9 R2: 13-13.7
46 - 48	Demonstrate Reynolds experiment	CLO15	T4: 3.8 - 3.10 R2: 19&20
49 - 52	Formulate the Darcy's equation	CLO15	T4: 4.1 - 4.6 R2: 19&20
53 - 55	Discuss the series and parallel connection of pipes	CLO17	T4: 6.1 - 6.3 R2: 19&20
56 - 58	Construct total energy and hydraulic gradient lines	CLO17	T4: 7.1 - 7.6 R2: 19&20
59 - 60	Measure the discharge	CLO14	T4: 8.1 - 8.9 R2: 19&20

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	To improve standards and analyze the concepts.	Seminars	PO 1	PSO 1
2	Conditional probability, Sampling distribution, correlation, regression analysis and testing of hypothesis	Seminars / NPTEL	PO 4	PSO 1
3	Encourage students to solve real time applications and prepare towards competitive examinations.	NPTEL	PO 2	PSO 1

Prepared by:

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