INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

AERONAUTICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**FLUID MECHANICS AND HYDRAULICS**				
Course Code	AAE003				
Programme	B.Tech				
Semester	III	AE			
Course Type	Foundation				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	3	2
Chief Coordinator	Mr. G Satya Dileep, Assistant Professor.				
Course Faculty	Mr. R Sabari Vihar, Assistant Professor.				

I. COURSE OVERVIEW:

The primary objective of this course is to introduce the concept of algorithm as a precise mathematical concept, and study how to design algorithms, establish their correctness, study their efficiency and memory needs. The course consists of a strong mathematical component in addition to the design of various algorithms.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites
UG	AHS002	I	Linear Algebra and Differential Equations
UG	AME002	II	Engineering Mechanics

III. MARKS DISTRIBUTION:

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

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✔	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	Presentation on real-world problems
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
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.	2	Videos

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO1	**Professional skills:** Able to utilize the knowledge of aeronautical/aerospace engineering in innovative, dynamic and challenging environment for design and development of new products	1	Seminar
PSO2	**Problem-solving Skills:** Imparted through simulation language skills and general purpose CAE packages to solve practical, design and analysis problems of components to complete the challenge of airworthiness for flight vehicles.	-	-
PSO3	**Practical implementation and testing skills:** Providing different types of in house and training and industry practice to fabricate and test and develop the products with more innovative technologies	-	-
PSO 4	**Successful career and entrepreneurship:** To prepare the students with broad aerospace knowledge to design and develop systems and subsystems of aerospace and allied systems and become technocrats.	-	-

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Illustrate about the basic properties of a fluid, hydrostatic forces on submerged bodies and different manometers.
II	Derive the basic principles of a fluid-continuity, momentum, Euler and Bernoulli‘s equations.
III	Explain the concept of boundary layer theory and importance of Prandtl‘s boundary layer theory.
IV	Understand the flow through pipes and their losses for different geometries.

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
AAE003.01	CLO 1	Define the properties of fluids and its characteristics, which will be used in aerodynamics, gas dynamics, marine engineering etc.	PO 1	3
AAE003.02	CLO 2	Explain the hydrostatic forces on submerged bodies, variation with temperature and height with respect to different types of surfaces.	PO 1	3
AAE003.03	CLO 3	Define different types of manometers and explain buoyancy force, stability of floating bodies by determining its metacentre height.	PO 1	3
AAE003.04	CLO 4	Define fluid kinematics and classification of flows, concepts of stream function and velocity potential function which provides solution for velocity and acceleration of fluid flow in real time applications.	PO 2	2
AAE003.05	CLO 5	Explain one dimensional, two dimensional flows in wind tunnel with classification of both compressible and in compressible flows in continuity equation.	PO 3 PO 4	2
AAE003.06	CLO 6	Recognize the surface and body forces required for obtaining momentum equation and energy equation and explain types of derivatives utilized in various flow field conditions.	PO 2	1
AAE003.07	CLO 7	Develop Bernoulli's equation from Euler's equation and explain phenomenological basis of Navier – stokes equation which are widely used in aerodynamics and gas dynamics for real time problems.	PO 2	2
AAE003.08	CLO 8	Demonstrate Buckingham's π theorem and explain similarity parameters used for scale down models and explain flow measurements with dimensionless parameters.	PO 3 PO 4	2
AAE003.09	CLO 9	Demonstrate for competitive exams, the concepts of boundary layer and qualitative description of boundary layer thickness and velocity profile on a flat plate.	PO 3	2
AAE003.10	CLO 10	Distinguish the pressure drag and skin friction drag and state the relation between the frictions of both the drags.	PO 2	2
AAE003.11	CLO 11	Demonstrate the various types of major and minor losses in pipes and explain flow between parallel plates.	PO 1	3
AAE003.12	CLO 12	Discuss fully developed flow through pipes and variation with friction factor with Reynolds number.	PO 1	3
AAE003.13	CLO 13	Understand Moody's chart for identifying friction factor against Reynold's number for various values of roughness.	PO 3	3
AAE003.14	CLO 14	Describe the concepts of turbo machinery in the field of aerospace engineering and concepts of internal flows through engines.	PO 2	3
AAE003.15	CLO 15	Explain the velocity triangles for turbine blades and centrifugal pumps.	PO 2	3

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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	PSO4
CLO 1	3												1			
CLO 2	3												1			
CLO 3	3												1			
CLO 4		2														
CLO 5		2	2													
CLO 6		1														
CLO 7		2														
CLO 8			2	2												
CLO 9			2													
CLO 10		2														
CLO 11	3												1			
CLO 12	3												1			
CLO 13			3													
CLO 14		3														
CLO 15		3														

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1, PO 2 PO 3	SEE Exams	PO 1, PO 2 PO 3	Assignments	PO 1, PO 2	Seminars	PO 2 PO 3
Laboratory Practices	PO 3, PO 4	Student Viva	-	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	FLUID PROPERTIES AND FLUID STATICS
Density, specific weight, specific gravity, surface tension and capillarity, Newton‘s law of viscosity, incompressible and compressible fluid, numerical problems; Hydrostatic forces on submerged bodies - Pressure at a point, Pascal's law, pressure variation with temperature and height, center of pressure plane, vertical and inclined surfaces; Manometers - simple and differential Manometers, inverted manometers, micro manometers, pressure gauges and numerical problems. Buoyancy - Archimedes principle, metacenter, Meta centric height calculations; Stability.	
UNIT-II	**FLUID KINEMATICS AND BASIC EQUATIONS OF FLUID FLOW ANALYSIS**
Stream line, path line, streak line, stream surface, stream tube, classification of flows, steady, unsteady, uniform, non-uniform, laminar, turbulent flows, one dimensional approximation, examples of real 1-D flows, two dimensional approximation, 2-D flow in wind tunnel; Continuity equations for 1-D and 2-D flows both compressible and incompressible, stream function for two dimensional incompressible flows; Vortices, Irrotational flow, velocity potential function.	
UNIT-III	**FLUID DYNAMICS**
Basic laws for a system in integral form: Reynolds transport theorem, Conservation of mass, Newton‘s 2nd law; Application of the basic laws for a control volume; Kinematics; Motion of a fluid particle; Fluid deformation; Differential analysis of fluid motion: Continuity equation, Differential momentum equation, Surface and body forces, substantive derivative, local derivative and convective derivative, momentum equation, Euler's and Bernoulli's equation, phenomenological basis of Naviers- stokes equation, introduction to vortex flows, flow measurements : pressure, velocity and mass flow rate, viscosity, pitot-static tube, venturi meter and orifice meter, viscometers. Statement of Buckingham‘s π- theorem, similarity parameters - Reynolds number, Froude number, concepts of geometric, kinematic and dynamic similarity, Reynolds number as a very approximate measure of ratio of inertia force and viscous force.	
UNIT-IV	**BOUNDARY LAYER THEORY AND PIPE FLOW**
Boundary layer - introductory concepts of boundary layer, large Reynolds number flows and Prandtl‘s boundary layer hypothesis Pressure drag and skin friction drag; Pipe flow - Reynolds experiment, Darcy‘s equation, major and minor losses in pipes and numerical problems. Flow between parallel plates, flow through long tubes –fully developed flow, Turbulent flow, variation of friction factor with Reynolds‘s Number, Moody's chart.	
UNIT-V	**TURBO MACHINERY**
Introduction and classification of fluid machines: Turbo machinery analysis; The angular momentum principle; Euler turbo machine equation; Velocity triangles; Application to fluid systems - Working principle overview of turbines, fans, pumps and compressors.	
Text Books:	
1. Shames I H, “Mechanics of Fluids: Kogakusha”, Tokyo, 7th Edition, 2007. 2. R. K Bansal, “Fluid mechanics and hydraulic machines”, Laxmi publications ltd, 9th Edition, 2011. 3. Robert W Fox, Alan T McDonald, “Introduction to fluid Mechanics”, John Wiley and Sons, 6th Edition, 1995. 4. Streeter V. L, Wylie, E.B., “Fluid Mechanics”, McGraw-Hill, 9th Edition, 1983.	
Reference Books:	
1. Yuan S W, “Foundations of fluid Mechanics”, Prentice-Hall, 2nd Edition, 1987. 2. Milne Thompson L M, “Theoretical Hydrodynamics”, MacMillan, 5th Edition, 1968. 3. Rathakrishnan. E, “Fundamentals of Fluid Mechanics”, Prentice-Hall, 5th Edition, 2007. 4. Som S. K, Biswas. G, “Introduction to fluid mechanics and fluid machines”, Tata McGraw-Hill, 2ndEdition, 2004.	

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	Density, Specific weight, Specific gravity.	CLO 1	T2 : 1.2
3-4	Surface tension and capillarity	CLO 1	T2 : 1.6
5	Newton's law of viscosity	CLO 1	T2 : 1.3
6	Incompressible and compressible fluid, numerical problems.	CLO 1	T2 : 1.3
7	Hydrostatic forces on submerged bodies: Pressure at a point	CLO 2	T2 : 3.1
8	Pascal's law, pressure variation with temperature and height	CLO 2	T2 : 3.1
9-11	Center of pressure plane, vertical and inclined surfaces.	CLO 2	T2 : 3.2
12-13	Manometers: simple and differential Manometers	CLO 3	T2 : 2.5
14	Inverted manometers, micro manometers	CLO 3	T2 : 2.5
15-16	Pressure gauges and numerical problems. Buoyancy : Archimedes principle	CLO 3	T2 : 2.5 T2 : 4.2
17-18	Metacenter, meta centric height calculations.	CLO 3	T2 : 4.4
19	Stream line, path line, streak line, stream surface, stream tube	CLO 4	T2 : 5.2
20-21	Classification of flows, steady, unsteady, uniform, non- uniform, laminar, turbulent flows.	CLO 5	T2 : 5.3
22	One dimensional approximation, examples of real 1-D flows,	CLO 5	T2 : 5.3.6
23	two dimensional approximation, 2- D flow in wind tunnel	CLO 5	T2 : 5.3.6
24	Continuity equations for 1-D and 2-D flows both compressible and incompressible	CLO 5	T2 : 5.6
25	Stream function for two dimensional incompressible flows.	CLO 5	T2 : 5.6
26	Vortices, irrotational flow, velocity potential function.	CLO 4	T2 : 5.8
27-28	Basic laws for a system in integral form: Reynolds transport theorem	CLO 7	T2 : 5.9
29-30	Conservation of mass, Newton's 2nd law; Application of the basic laws for a control volume	CLO 6	T2 : 6.8
31-32	Kinematics; Motion of a fluid particle; Fluid deformation; Differential analysis of fluid motion	CLO 2	T2 : 5.9
33	Continuity equation	CLO 6	T2 : 5.6
34	Differential momentum equation, Surface and body forces	CLO 6	T2 : 6.8
35	Substantive derivative, local derivative and convective derivative,	CLO 6	T2 : 6.8
36	Momentum equation,	CLO 7	T2 : 6.3
37	Euler's and Bernoulli's equation.	CLO 7	T2 : 6.4
38-39	Phenomenological basis of Naviers- stokes equation, introduction to vortex flows.	CLO 7	T2 : 5.10
40	Flow measurements: pressure, velocity and mass flow rate, viscosity, pitot-static tube,	CLO 7	T2 : 6.7
41	Venturimeter and orifice meter, viscometers.	CLO 7	T2 : 6.7
42	Statement of Buckingham's π- theorem, similarity parameters. Reynolds number, Froude number	CLO 8	T2 : 12.4
43	Concepts Of geometric, kinematic and dynamic similarity	CLO 8	T2 : 12.6
44-45	Reynolds number as a very approximate measure of ratio of inertia force and viscous force	CLO 8	T2 : 12.8
46	Introductory concepts of boundary layer	CLO 9	T2 : 13.1
47	large Reynolds number flows and Prandtl's boundary layer hypothesis,	CLO 9	T2 :13.2 R3 : 10.5
48-49	Pressure drag and skin friction drag.	CLO 10	T2 : 13.3 R3 : 10.5

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
50	Reynolds experiment, Darcy's equation	CLO 11	T2 : 10.2 R3 : 7.1
51-52	Major and minor losses in pipes and numerical problems.	CLO 11	T2 : 11.4 R3 : 7.2
53	Exact Solutions of Naviers Stokes Equations.	CLO 6	T2 : 6.9
54	Flow between parallel plates, flow through long tubes –fully developed flow	CLO 11	T2 : 11.9 R3 : 10.2
55-56	Turbulent flow, variation of friction factor with Reynolds's Number	CLO 12	T2 : 10.1 R3 : 10.5
57	Moody's chart	CLO 13	T2 : 11.4.7
58-59	Introduction and classification of fluid machines:	CLO 14	T2 : 18.1
60	Turbo machinery analysis; The angular momentum principle;	CLO 14	T2 : 18.3
61-62	Euler turbo machine equation; Velocity triangles;	CLO 15	T2 : 18.6
63-64	Application to fluid systems - Working principle overview of turbines, fans, pumps and compressors.	CLO 15	T2 : 18.4

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

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Experimental determination of buoyancy	Seminars	PO 1, PO 2, PO 5	PSO 2
2	Introduction to vortex flows- forced and free vortex flows	Seminars / NPTEL	PO 1, PO 2, PO 5	PSO 3
3	Velocity triangles determination	NPTEL	PO 2, PO 3, PO 4	PSO 3

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