INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**FLUID MECHANICS AND MACHINES**				
Course Code	AMEB08				
Programme	B.Tech				
Semester	IV	ME			
Course Type	Core				
Regulation	IARE - R18				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	3	2
Chief Coordinator	Dr. CH.V.K.N.S.N Moorthy, Professor				
Course Faculty	Dr. CH.V.K.N.S.N Moorthy, Professor Mr. G. Sarath Raju, Assistant Professor				

I. COURSE OVERVIEW:

The aim of this course is to introduce basic principles of fluid mechanics and it is further extended to cover the application of fluid mechanics by the inclusion of fluid machinery. Nowadays the principles of fluid mechanics find wide applications in many situations. The course deals with the fluid machinery, like turbines, pumps in general and in power stations. This course also deals with the large variety of fluids such as air, water, steam, etc; however, the major emphasis is given for the study of water.

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AHS007	I	Applied Physics	4
UG	AME002	II	Engineering Mechanics	4
UG	AME003	III	Thermodynamics	4

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Fluid Mechanics and Hydraulic Machines	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 modules and each module 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 module. 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	20	5	5	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**: Capability to apply the knowledge of mathematics, science and engineering in the field of mechanical engineering.	3	Presentation on real-world problems
PO 2	**Problem analysis**: An ability to analyze complex engineering problems to arrive at relevant conclusion using knowledge of mathematics, science and engineering.	2	Seminar
PO 4	**Conduct investigations of complex problems**: To design and conduct research oriented experiments as well as to analyze and implement data using research methodologies.	1	Assignment

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	1	Seminar
PSO 2	**Problem solving skills:** An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	-	-
PSO 3	**Successful career and Entrepreneurship:** To build the nation, by imparting technological inputs and managerial skills to become technocrats.	1	Seminar

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES:

The course should enable the students to:	
I	Learn about the application of mass and momentum conservation laws for fluid flows.
II	Understand the importance of dimensional analysis.
III	Obtain the velocity and pressure variations in various types of simple flows.
IV	Analyze the flow in water pumps and turbines.

IX. COURSE OUTCOMES (COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO1	Discuss the basic concepts and methodologies of fluid statics	CLO 1	Define the properties of fluids and its characteristics.
		CLO 2	Explain the hydrostatic forces on submerged bodies.
		CLO 3	Define different types of manometers.
		CLO 4	Apply the law of conservation of mass and derive continuity equation.
CO2	Understand various laws for fluid kinematics and dynamics	CLO 5	Demonstrate practical understanding of friction losses in internal flows.
		CLO 6	Compare the results of analytical models introduced in lecture to the actual behavior of real fluid flows and draw correct and sustainable conclusions.
		CLO 7	Calculate the performance analysis in turbines can be used in power plants.
		CLO 8	Calculate the performance analysis in pumps.
CO3	Understand the concepts of boundary layer theory and closed conduit flow	CLO 9	Draw and analysis of performance characteristic curves of pumps.
		CLO 10	Draw and analysis of performance characteristic curves of turbines.
		CLO 11	Draw and analysis of characteristic curves of flow meters.
		CLO 12	Determine the coefficient of impact of different types of vanes.
		CLO 13	Determine the coefficient of discharge of different types of flow meters.
CO4	Explore the design, working and performance of turbines	CLO 14	Determine the friction factor of different types of cross section of pipes.
		CLO 15	Draw the characteristic curves of friction apparatus.
		CLO 16	Determine the friction factor using moody's chart.
		CLO 17	Applying the Darcy's Weisbach equation for the measurement of coefficient of friction.
		CLO 18	Evaluate the performance of hydraulic turbines.
CO5	Analyse the design, working, performance of pumps and dimensionality laws	CLO 19	Evaluate the performance of hydraulic pumps.
		CLO 20	Analyze flow in closed pipes, and design and selection of pipes including sizes.
		CLO 21	Explain the working principle of various types of hydro turbines and know their application range
		CLO 22	Demonstrate the various types of major and minor losses in pipes and explain flow between parallel plates.

X. 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
AMEB08.01	CLO 1	Define the properties of fluids and its characteristics.	PO 1	3
AMEB08.02	CLO 2	Explain the hydrostatic forces on submerged bodies.	PO 1, PO 3	3
AMEB08.03	CLO 3	Define different types of manometers.	PO 1, PO 3	3
AMEB08.04	CLO 4	Apply the law of conservation of mass and derive continuity equation.	PO 1, PO 2, PO 4	2
AMEB08.05	CLO 5	Demonstrate practical understanding of friction losses in internal flows.	PO 1, PO 3	2
AMEB08.06	CLO 6	Compare the results of analytical models introduced in lecture to the actual behavior of real fluid flows and draw correct and sustainable conclusions.	PO 1, PO 2, PO 4	2
AMEB08.07	CLO 7	Calculate the performance analysis in turbines can be used in power plants.	PO 1, PO 2, PO 3	1
AMEB08.08	CLO 8	Calculate the performance analysis in pumps.	PO 1, PO 2, PO 3	1
AMEB08.09	CLO 9	Draw and analysis of performance characteristic curves of pumps.	PO 1, PO 2	2
AMEB08.10	CLO 10	Draw and analysis of performance characteristic curves of turbines.	PO 1, PO 3	2
AMEB08.11	CLO 11	Draw and analysis of characteristic curves of flow meters.	PO 1, PO 3	3
AMEB08.12	CLO 12	Determine the coefficient of impact of different types of vanes.	PO 1, PO 2	3
AMEB08.13	CLO 13	Determine the coefficient of discharge of different types of flow meters.	PO 1, PO 3	3
AMEB08.14	CLO 14	Determine the friction factor of different types of cross section of pipes.	PO 1, PO 2	2
AMEB08.15	CLO 15	Draw the characteristic curves of friction apparatus.	PO 1, PO 3, PO 4	2
AMEB08.16	CLO 16	Determine the friction factor using moody's chart.	PO 1, PO 2	2
AMEB08.17	CLO 17	Applying the Darcy's Weisbach equation for the measurement of coefficient of friction.	PO 1, PO 2	3
AMEB08.18	CLO 18	Evaluate the performance of hydraulic turbines.	PO 1, PO 2	2
AMEB08.19	CLO 19	Evaluate the performance of hydraulic pumps.	PO 1, PO 3, PO 4	1
AMEB08.20	CLO 20	Analyze flow in closed pipes, and design and selection of pipes including sizes.	PO 1, PO 2	1
AMEB08.21	CLO 21	Explain the working principle of various types of hydro turbines and know their application range	PO 1, PO 2, PO 3, PO 4,	2
AMEB08.22	CLO 22	Demonstrate the various types of major and minor losses in pipes and explain flow between	PO 3, PO 4,	2

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
		parallel plates.		

3 = High; 2 = Medium; 1 = Low

XI. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUT COMES

Course Outcomes (COs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	2	3	2									1	2	
CO 2	2	2	2	2									1	2	
CO 3	3	3	3										1	2	
CO 4	2	2	2	2									1	2	
CO 5	1	2	2	2									1	2	

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XII. 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												1	2	
CLO 2	3		3										1		
CLO 3	3		3										1	2	
CLO 4	2	2		2									1	2	
CLO 5	2		2										1	2	
CLO 6	2	2		2										2	
CLO 7	1	1	1										1		
CLO 8	1	1	1											2	
CLO 9	2	2												2	
CLO 10	2		2										1		
CLO 11	3		3											2	
CLO 12	3	3											1		
CLO 13	3		3										1	2	

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 14	2	2											1		
CLO 15	2		2	2									1	2	
CLO 16	2	2											1		
CLO 17	3	3											1		
CLO 18	2	2											1	2	
CLO 19	1		1	1										2	
CLO 20	1	1												2	
CLO 21	2	2	2	2									1	2	
CLO 22			2	2									1	2	

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XIII. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1, PO 2 PO 3, PO 4, PSO1, PSO2	SEE Exams	PO 1, PO 2 PO 3, PO 4, PSO1, PSO2	Assignments	PO2	Seminars	PO4
Laboratory Practices	-	Student Viva	-	Mini Project	-	Certification	-
Term Paper	-						

XIV. ASSESSMENT METHODOLOGIES - INDIRECT

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

XV. SYLLABUS

MODULE-I	FLUID STATICS	Classes: 09
Definition of fluid, Newton's law of viscosity, Units and dimension -Properties of fluids, mass density, specific volume, specific gravity, viscosity, compressibility and surface tension, Control volume- application of continuity equation and momentum equation, Incompressible flow.		
MODULE-II	**FLUID KINEMATICS AND DYNAMICS**	**Classes: 09**
Fluid Kinematics: Kinematics of fluid flow- Eulerian and Lagrangian descriptions, Stream line, path line, streak line and stream tube, classification and description of flows for one and three dimensions. Fluid Dynamics: Euler's equation of motion, Bernoulli equation for flow along a stream line and applications, Measurement of flow.		
MODULE-III	**BOUNDARY LAYER CONCEPTS AND CLOSED CONDUIT FLOW**	**Classes: 09**

Concept of boundary layer, Definition, characteristics along thin plate, laminar, transition and turbulent boundary layers, separation of boundary layer, measures of boundary layer thickness. Closed conduit flow: Darcy Weisbach equation, friction factor, Head loss in pipe flow, Exact flow solutions in channels and ducts, Couette and Poisuielle flow, laminar flow through circular conduits and circular annuli.		
MODULE-IV	**FLUID MACHINES**	**Classes: 09**
Classification of water turbines, heads and efficiencies, velocity triangles- Axial, radial and mixed flow turbines- Pelton wheel, Francis turbine and Kaplan turbines, working principles draft tube- Specific speed, unit quantities, performance curves for turbines, governing of turbines.		
MODULE-V	**DIMENSIONAL ANALYSIS AND PUMPS**	**Classes: 09**
Dimensional Analysis: Need for dimensional analysis methods of dimension analysis, Similitude, types of similitude Dimensionless parameters application of dimensionless parameters, Model analysis. Pumps: Theory of Roto dynamic machines , various efficiencies , velocity components at entry and exit of the rotor, velocity triangles, Centrifugal pumps, working principle, work done by the impeller, performance curves Cavitation in pumps- Reciprocating pump working principle.		

Text Books:

1. Rajput, " Fluid Mechanics and Hydraulic Machines", S.Chand & Co, 6th Edition, 1998
2. H Modi, Seth, "Hydraulics, Fluid Mechanics and Hydraulic Machinery", Rajsons Publications, 20th Edition, 2013.
3. M. White, Fluid Mechanics, 8th Edition, Tata McGraw Hill, 2016.
4. V. Gupta and S. K. Gupta, Fundamentals of Fluid Mechanics, 4th Edition, New Age International 2011.
5. W. L. McCabe, J. C. Smith and P. Harriot, Unit Operations of Chemical Engineering, 7th Edition, McGraw Hill International Edition 2005.
6. O. Wilkes, Fluid Mechanics for Chemical Engineers, Prentice Hall of India, 2005.
7. R. W. Fox, P. J. Pritchard and A. T. McDonald, Introduction to Fluid Mechanics, 7th Edition, Wiley-India 2010.
8. R. Welty, C. E. Wicks, R. E. Wilson, G. Rorrer, Fundamentals of Momentum, Heat and Mass Transfer, 4th Edition, 2007.

Reference Books:

1. D.S. Kumar, "Fluid Mechanics and Fluid Power Engineering", Kotaria & Sons, 9th Edition 2013.
2. Dr. R K Bansal, " A Text Book of Fluid Mechanics and Hydraulic Machines", Laxmi Publications, 9th Edition, 2015.
3. B. R. Munson, D. F. Young, T. H. Okiishi and W. W. Huebsch, Wiley-India, 6th Edition, 2010.
4. R. L. Panton, Incompressible Flow, Wiley-India, 3rd Edition, 2005.
5. R. B. Bird, W. E. Stewart and E. N. Lightfoot, Transport Phenomena, 2nd Edition, Wiley- India 2002.

Web Reference:

1. https://nptel.ac.in/courses/112105171/

E-Book:

1. https://vscht.cz/uchi/ped/hydroteplo/materialy/introduction.fluid.mech.pdf

XVI. 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	**Module-I** Introduction, dimensions and units	CLO 1	T1:1.4 R1:1.2
3-5	Physical properties of fluids-specific gravity, viscosity, Surface tension, vapour pressure and their influence on fluid motion	CLO 2	T1:1.5 R1:2.4
6-7	Atmospheric, gauge and vacuum pressures	CLO 3	T1:2.5 R1:2.5

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
8-10	Measurement of pressure- piezometer, U-tube and differential manometers	CLO 4	T1:2.5 R1:2.6
11-12	**Module -II: Fluid Kinematics**: Stream line, path line, streak line and stream tube	CLO 5	T1:22.7
13-14	Classification of flows- steady and unsteady, uniform and non-uniform, laminar and turbulent, rotational and irrotational flows	CLO 5	T1:6.3 R1:5.3
15-16	Equation of continuity for one dimensional flow and three dimensional flows	CLO 6	T1:7.5 R1:6.3
17-18	**Fluid dynamics:** Surface and body forces	CLO 7	T1:8.5 R1:6.8
19-20	Euler's and Bernoulli's equations for flow along a stream line	CLO 8	T1:12.2 R1:13.1
21-22	**Module -III: BOUNDARY LAYER CONCEPTS:** Definition, thickness, characteristics along thin plate	CLO 8	T1:12.3 R1:13.2
23-24	Laminar and turbulent boundary layers (No derivation), boundary layer in transition	CLO 9	T1:12.10 R1:13.7
25-26	Separation of boundary layer, measures of boundary layer thickness.	CLO 10	T1:11.2 R1:10.2
27-28	**Closed conduit flow:** Darcy Weisbach equation, friction factor, Head loss in pipe flow	CLO 10	T1:16.3 R1:15.3
29-30	Exact flow solutions in channels and ducts	CLO 11	T1:17.5 R1:16.3
30-31	Couette and Poisuielle flow	CLO 12	T1:17.6 R1:16.8
32-33	Laminar flow through circular conduits and circular annuli.	CLO 12	T1:17.7 R1:16.9
34-35	**Module – IV: Hydraulic Turbines:** classification of turbines, heads and efficiencies, impulse and reaction turbines	CLO 13	T1:18.3 R1:17.2
36-39	Pelton wheel, Francis turbine and Kaplan turbine-working proportions, work done, efficiencies	CLO 14	T1:18.10 R1:17.7
40-41	Hydraulic design-draft tube theory –functions and efficiency	CLO 14	T1:18.4 R1:17.8
42-43	**Performance of hydraulic turbines:** Geometric similarity, unit and specific quantities, characteristic curves	CLO 15	T1:18.5 R1:17.9
44-45	Governing of turbines, selection of type of turbine	CLO 16	T1:18.6 R1:17.10
46-47	Cavitation, surge tank, water hammer	CLO 17	T1:18.7 R1:17.11
48-52	**Module -V: Dimensional Analysis:** Need for dimensional analysis methods of dimension analysis, Similitude, types of similitude Dimensionless parameters application of dimensionless parameters, Model analysis.	CLO 18	T1:19.2 R1:18.1
53-56	**Centrifugal pumps:** Classification, working, work done-barometric head losses and efficiencies	CLO 19	T1:19.3 R1:18.2
57-60	Specific speed – performance characteristic curves, NPSH.	CLO 20	T1:19.4 R1:18.3
61-64	**Reciprocating pumps:** working, discharge, slip, indicator diagrams	CLO 21	T1:19.5 R1:18.4

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

S NO	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	To explore Venturimeter and orifice meter	Seminars	PO 1, PO 4	PSO 1

2	To analyse the impact of jets	NPTEL	PO 4, PO3	PSO 1
3	Encourage students to prepare towards competitive exams.	NPTEL	PO 2	PSO 1

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