INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

COURSE DESCRIPTOR

Course Title	**MECHANICS OF FLUIDS AND HYDRAULIC MACHINES**				
Course Code	AME008				
Programme	B.Tech				
Semester	IV	ME			
Course Type	Core				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	3	2
Chief Coordinator	Mr. A. Somaiah, Assistant Professor				
Course Faculty	Dr. CH.V.K.N.S.N Moorthy, Professor Mr. A. Somaiah, 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

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Mechanics of Fluids 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 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	Seminar
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	Seminar
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	Term Paper

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.	2	Seminar
PSO 2	**Problem solving skills:** An ability to adopt and integrate current technologies in the design and manufacturing domain to enhance the employability.	2	Seminar
PSO 3	**Successful career and Entrepreneurship:** To build the nation, by imparting technological inputs and managerial skills to become technocrats.	1	Presentation on real-world problems

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES (COs):

The course should enable the students to:	
I	Understand the basic principles of fluid mechanics.
II	Understand boundary layer concepts and flow through pipes.
III	Evaluate the performance of hydraulic turbines.
IV	Understand the functioning and characteristic curves of pumps.

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
AME008.01	CLO 1	Define the properties of fluids and its characteristics, which will be used in aerodynamics, gas dynamics, marine engineering etc.	PO 1	3
AME008.02	CLO 2	Explain the hydrostatic forces on submerged	PO 1, PO 3	3

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
		bodies, variation with temperature and height with respect to different types of surfaces.		
AME008.03	CLO 3	Define different types of manometers and explain buoyancy force, stability of floating bodies by determining its metacenter height.	PO 1, PO 3	3
AME008.04	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 1, PO 2, PO 4	2
AME008.05	CLO 5	Explain one dimensional, two dimensional flows in wind tunnel with classification of both compressible and in compressible flows in continuity equation.	PO 1, PO 3	2
AME008.06	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 1, PO 2, PO 4	2
AME008.07	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 1, PO 2, PO 3	1
AME008.08	CLO 8	Demonstrate Buckingham's π theorem and explain similarity parameters used for scale down models and explain flow measurements with dimensionless parameters.	PO 1, PO 2, PO 3	1
AME008.09	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 1, PO 2	2
AME008.10	CLO 10	Distinguish the pressure drag and skin friction drag and state the relation between the frictions of both the drags.	PO 1, PO 3	2
AME008.11	CLO 11	Demonstrate the various types of major and minor losses in pipes and explain flow between parallel plates.	PO 1, PO 3	3
AME008.12	CLO 12	Discuss fully developed flow through pipes and variation with friction factor with Reynolds number and sketch the Moody's chart.	PO 1, PO 2	3
AME008.13	CLO 13	Describe the concepts of turbo machinery in the field of aerospace engineering and concepts of internal flows through engines.	PO 1, PO 3	3
AME008.14	CLO 14	Explain types of hydraulic pumps,the basic functions and features.	PO 1, PO 2	2
AME008.15	CLO 15	Design and select pumps (single or multiple) for different hydraulic applications.	PO 1, PO 3, PO 4	2
AME008.16	CLO 16	Understand pumps classification and be able to develop a system curve used in pump selection	PO 1, PO 2	2
AME008.17	CLO 17	Analyze flow in closed pipes, and design and selection of pipes including sizes.	PO 1, PO 2	3
AME008.18	CLO 18	Understand the basic elements of pump and turbine flow, and be able to analyze and select the pump needed for pressurizing situations.	PO 1, PO 2	2
AME008.19	CLO 19	Recognize and discuss today's and tomorrow's use of turbomachines for enabling a	PO 1, PO 3, PO 4	1

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
		sustainable society.		
AME008.20	CLO 20	Explain the working principle of various types of hydro turbines and know their application range	PO 1, PO 2	1
AME008.21	CLO 21	Determine the velocity triangles in turbomachinery stages operating at design and offdesign conditions.	PO 1, PO 2, PO 3, PO 4,	2

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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
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	
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	

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 21	2	2	2	2									1	2	

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES – DIRECT

CIE Exams	PO 1, PO 2 PO 3, PO 4	SEE Exams	PO 1, PO 2 PO 3, PO 4	Assignments	PO 1	Seminars	PO 2
Laboratory Practices	PO 3	Student Viva	-	Mini Project	-	Certification	-

XII. ASSESSMENT METHODOLOGIES - INDIRECT

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

XIII. SYLLABUS

UNIT-I	**FLUID STATICS**
Dimensions and units, Physical properties of fluids-specific gravity, viscosity, surface tension, vapour pressure and their influence on fluid motion, atmospheric, gauge and vacuum pressures, measurement of pressure, piezometer, U-tube and differential manometers.	
UNIT-II	**FLUID KINEMATICS, FLUID DYNAMICS**
Fluid Kinematics: Stream line, path line, streak line and stream tube, classification of flows- steady and unsteady, uniform and non uniform, laminar and turbulent, rotational and irrotational flows, equation of continuity for one dimensional flow and three dimensional flows; Fluid dynamics: Surface and body forces, Euler's and Bernoulli's equations for flow along a stream line, momentum equation and its application on force on pipe bend.	
UNIT-III	**BOUNDARY LAYER CONCEPTS, CLOSED CONDUIT FLOW**
Boundary layer Concepts: Definition, thickness, characteristics along thin plate, Laminar and turbulent boundary layers, boundary layer in transition, Separation of boundary layer, submerged objects- drag and lift. Closed Conduit flow: Reynolds's experiment, Darcy Weisbach equation, minor losses in pipes, Pipes in series and pipes in parallel, Total energy line, hydraulic gradient line, Measurement of flow, Pitot tube, venturi meter, and orifice meter, flow nozzle.	
UNIT-IV	**BASICS OF TURBO MACHINERY, HYDRAULIC TURBINES AND PERFORMANCE**
Basics of turbo machinery: Hydrodynamic force of jets on stationary and moving flat, inclined vanes, curved vanes, jet striking centrally and at tip, velocity diagrams, work done and efficiency, flow radial vanes; Hydraulic turbines: classification of turbines, heads and efficiencies, impulse and reaction turbines, Peloton Wheel, Francis turbine and Kaplan turbine-working proportions, work done, efficiencies, hydraulic design, draft tube theory, functions and efficiency; Performance of hydraulic turbines: Geometric similarity, unit and specific quantities, characteristic curves, governing of turbines, selection of type of turbine, cavitation, surge tank, water hammer.	
UNIT-V	**CENTRIFUGAL PUMPS AND RECIPROCATING PUMPS**
Centrifugal pumps: Classification, working, work done, barometric head losses and efficiencies, specific speed, performance characteristic curves, NPSH; Reciprocating pumps: working, discharge, slip, indicator diagrams.	

Text Books:
1. H Modi, Seth, "Hydraulics, Fluid Mechanics and Hydraulic Machinery", Rajsons Publications, 20th Edition, 2013. 2. Rajput, "Fluid Mechanics and Hydraulic Machines", S.Chand & Co, 6th Edition, 1998.
Reference Books:
1. Dr. R K Bansal, "A Text Book of Fluid Mechanics and Hydraulic Machines", Laxmi Publications, 9th Edition, 2015. 2. D.S. Kumar, "Fluid Mechanics and Fluid Power Engineering", Kotaria & Sons, 2013. 3. D. Rama Durgaiah, "Fluid Mechanics and Machinery", New Age International, 1st Edition, 2002. 4. Banga, Sharma, "Hydraulic Machines", Khanna Publishers, 6th Edition, 2001

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	Outline of various units	CLO 1	T1:1.4 R1:1.2
2-5	Explain the fluid properties	CLO 1	T1:1.5 R1:2.4
6-7	Distinguish various pressures	CLO 1	T1:2.5 R1:2.5
8-10	Determine the pressure with different instruments	CLO 1	T1:2.5 R1:2.6
11-12	Differentiate various flow lines	CLO 4	T1:22.7
13-14	Classify and describe various flows	CLO 6	T1:6.3 R1:5.3
15-16	Formulate continuity equation for 1 and 3-d flow	CLO 7	T1:6.6 R1:5.3.6
18	List various forces	CLO 7	R1:6.2
19-20	Formulate Euler's and Bernoulli's equations	CLO 7	T1:7.5 R1:6.3
21-22	Apply momentum equation for a pipe bend	CLO 7	T1:8.5 R1:6.8
23	Define boundary layer	CLO 7	T1:12.2 R1:13.1
24-25	Distinguish boundary layer of laminar, turbulent and transition	CLO 9	T1:12.3 R1:13.2
26-27	Explain separation of boundary layer	CLO 10	T1:12.10 R1:13.7
28	Demonstrate Reynold's experiment	CLO 11	T1:11.2 R1:10.2
29-30	Formulate the Darcy's equation	CLO 12	T1:11.5 R1:10.3
31-32	Discuss the series and parallel connections of pipes	CLO 12	T1:11.12 R1:11.9
33-35	Construct total energy and hydraulic gradient lines	CLO 12	T1:11.8 R1:11.5
36-38	Measurement the discharge	CLO 12	T1:9.9
39-41	Discuss the effect of hydrodynamic force on flat vanes	CLO 18	T1:20.3 R1:17.2
42-44	Draw the velocity triangles for curved vanes	CLO 19	T1:20.4 R1:17.4.4

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
45	Classify the turbines	CLO 20	T1:21.4 R1:18.5
46-48	Evaluate the performance of turbines	CLO 21	T1:22 R1:18.6.1
49	Describe the functions of draft tube	CLO 21	T1:21.12 R1:18.10
50-51	Define unit quantities and Draw characteristic curves	CLO 20	T1:22.5 R1:18.13
52	Illustrate the governing of turbines	CLO 21	T1:21.21 R1:18.14
54-55	Explain Cavitation, water hammer, surge tank	CLO 21	T1:21.23
56-57	Classify and Explain the working of centrifugal pump	CLO 14	T1:24.3 R1:19.2
58-59	Compare the characteristic curves of centrifugal pump	CLO 16	T1:24.16 R1:19.10
60	Describe and Evaluate the performance of reciprocating pumps	CLO 17	T1:23.4 R2:20.2

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, PO 4	PSO 1
2	Conditional probability, Sampling distribution, correlation, regression analysis and testing of hypothesis	Seminars / NPTEL	PO 4, PO3	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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