INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad - 500 043

AERONAUTICAL ENGINEERING

COURSE DESCRIPTION FORM

Course Title	**MECHANICS OF FLUIDS**			
Course Code	**R15-A30103**			
Regulation	**R13 – JNTUH**			
Course Structure	**Lectures**	**Tutorials**	**Practical's**	**Credits**
	4	-	-	4
Course Coordinator	Mr. C. Satya Sandeep Assistant Professor			
Team of Instructors	Mr C. Satya Sandeep Assistant Professor			

I. COURSE OVERVIEW:

The students will gain insight into a number of potentially useful phenomena involving movement of fluids. He/she will learn to do elementary calculations for engineering application of fluid motion. This course also prepares the student for more advanced courses such as aerodynamics I&II.

II. PREREQUISITE(S)

Level	Credits	Periods/ Week	Prerequisites
UG	4	4	Basic concepts of Engineering mechanics, Some mathematical concepts and Advanced solid mechanics

III MARKS DISTRIBUTION

Sessional Marks	University End Exam marks	Total marks
Mid Semester Test There shall be two midterm examinations. Each midterm examination consists of subjective type and objective type tests. The subjective test is for 10 marks of 60 minutes duration. Subjective test of shall contain 4 questions; the student has to answer 2 questions, each carrying 5 marks. The objective type test is for 10 marks of 20 minutes duration. It consists of 10 Multiple choice and 10 objective type questions, the student has to answer all the questions and each carries half mark. First midterm examination shall be conducted for the first two and half units of syllabus and second midterm examination shall be conducted for the remaining portion **Assignment** Five marks are earmarked for assignments. There shall be two assignments in every theory course. Marks shall be awarded considering the average of two assignments in each course.	75	100

IV. EVALUATION SCHEME

S. No	Component	Duration	Marks
1.	I Mid Examination	80 minutes	20
2.	I Assignment	-	5
3.	II Mid Examination	80 minutes	20
4.	II Assignment	-	5
5.	External Examination	3 hours	75

V. COURSE OBJECTIVES:

1. **Knowledge** about the basic properties of a fluid, hydrostatic forces on submerged bodies and different manometers.
2. **Discuss** on other fluid kinematics and classification flows.
3. **Derive** the basic equation of a fluid like continuity, momentum, Euler and Bernoulli's equation.
4. **Explain** the concept of boundary layer theory and importance of Prandtl's boundary layer theory.
5. **Impar**t the knowledge of boundary layer on velocity profile on a flat plate.
6. **Demonstrate** major and minor losses in pipes and diff explain equations regarding pipes.
7. **Derive** exact solutions of Naviers stokes equations and **knowledge** about turbulence flow.

VI. COURSE OUTCOMES:

At the end of the course the students are able to:

1. **Define** the properties of fluids and its characteristics and identify different types of fluid properties
2. **Explain** the hydrostatic forces on submerged bodies ,variation with temperature and height with respect to different types of surfaces
3. **Define** different types of nanometers and explain buoyancy force concept in fluid properties**.**
4. **Define** fluid kinematics and classification of flows, summary of stream function and velocity potential function.
5. **Explain** one dimensional, two dimensional flows in wind tunnel for classification of both compressible and in compressible flows.
6. **Recognize**the surface and body forces and explain types of derivatives
7. **Derive** Bernoulli's equation from Euler's equation and explain phenomenological basis of Naviers – strokes equation
8. **State** Buckingham's π theorem and explain similarity parameters and explain flow measurements
9. **State** the concepts of boundary layer and qualitative description of boundary layer thickness and velocity profile on a flat plate**.**
10. **Distinguish** the pressure drag and skin friction drag and state the relation between the friction of both the drags
11. **Demonstrate** the various types of major and minor losses in pipes and explain flow between parallel plates
12. **Outlining**fully developed flow and variation with friction factor with Reynolds number and sketch theMoody's chart.

VII. HOW PROGRAM OUTCOMES ARE ASSESSED

Program Outcomes		Level	Proficiency assessed by
A	Knowledge in fundamentals of mathematics, science and engineering.	S	
B	An ability to identify, formulate and solve problems in key areas of Aerodynamics, Structures, Propulsion, Flight Dynamics and Control, Design, Testing, Space and Missile Technologies and Aviation of Aeronautical Engineering discipline	H	
C	An ability to design and conduct experiments, analyze and interpret data related to various areas of Aeronautical Engineering.	H	
D	An ability in conducting investigations to solve problems using research based knowledge and methods to provide logical conclusions.	S	
E	Skills to use modern engineering and IT tools, software and equipment to analyze the problems in Aeronautical Engineering.	H	
F	Understanding of impact of engineering solutions on the society to assess health, safety, legal, and social issues in Aeronautical Engineering.	S	
G	The impact of professional engineering solutions in environmental context and to be able to respond effectively to the needs of sustainable development.	N	
H	The knowledge of Professional and ethical responsibilities.	N	
I	An ability to work effectively as an individual and as a team member/leader in multidisciplinary areas.	N	
J	An ability to critique writing samples (abstract, executive summary, project report), and oral presentations.	S	
K	Knowledge of management principles and apply these to manage projects in multidisciplinary environments.	S	
L	The need of self-education and ability to engage in life - long learning.	H	

N-None **S-Supportive** **H-Highly Related**

VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED

Program Specific Outcomes		Level	Proficiency Assessed by
PSO 1	**Professional skills:** Able to utilize the knowledge of aeronautical/aerospace engineering in innovative, dynamic and challenging environment for design and development of new products	H	Lectures and Assignments
PSO 2	**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	H	Discussions
PSO 3	**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	H	projects
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	S	Seminars and Projects

IX. 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.

UNIT II

Fluid Kinematics: 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: Surface and Body forces, substantive derivative, localderivative and convective derivative, momentum equation, Euler's and Bernoulli's equation, phenomenological basis of Naviers- stokes equation, introduction to vortex flows.

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 ,flow measurements : pressure ,velocity and mass flow rate ,viscosity ,pivot-static tube ,venture meter and orifice meter, viscometers.

UNIT IV

Boundary layer: introductory concepts of boundary layer, large Reynolds number flows and Prandtl's boundary layer hypothesis, qualitative description of boundary layer thickness and velocity profile on a flat plate and flow around submerged objects. Pressure drag and skin friction drag.

UNIT V

Pipe flow: Reynolds experiment, Darcy's equation, major and minor losses in pipes and numerical problems.

Exact Solutions of Naviers Stokes Equations. Flow between parallel plates, flow through long tubes – fully developed flow, Turbulent flow, variation of friction factor with Reynolds's Number ,Moody's chart.

Text Books:

1. Engineering Fluid mechanics - K.L.Kumar, S.Chand & co.
2. Fluid Mechanics and Hydraulic Machines – R.K.Bansal.
3. Introduction to Fluid Mechanics and Fluid Machines – S.K.Som and Biswas.

References

1. Fluid Mechanics – Frank M and White, McGraw-Hill.
2. Fluid Mechanics – Fox and M.C. Donald.

3. Fluid Mechanics – E.Rathakrishnan

X. COURSE PLAN:

At the end of the course, the students are able to achieve the following course learning outcomes.

Lecture No.	Course Learning Outcomes	Topics to be covered	Reference
2	**Define** Density, Specific weight, Specific gravity.	**UNIT-1 FLUID PROPERTIES** Density, Specific weight, Specific gravity.	T2
3-4	**Explain** surface tension and capillarity	surface tension and capillarity	T2
5-7	**Explain** Newton's law of viscosity, incompressible and compressible fluid, Solvenumerical problems.	Newton's law of viscosity, incompressible and compressible fluid, numerical problems.	T2
8-10	**Define** Hydrostatic forces on submerged bodies Pressure at a point, Pascal's law, pressure variation with temperature and height	**Hydrostatic forces on submerged bodies:** Pressure at a point, Pascal's law, pressure variation with temperature and height	T2
11-13	**Derive** Center of pressure plane, vertical and inclined surfaces.	Center of pressure plane, vertical and inclined surfaces.	T2
14-16	**Derive** Manometers: simple and differential Manometers, inverted manometers ,micro manometers	**Manometers**: simple and differential Manometers, inverted manometers ,micro manometers	T2
17-18	**Solve** Pressure gauges and numerical problems **Explain**.Buoyancy : Archimedes principle	Pressure gauges and numerical problems .Buoyancy : Archimedes principle	T2
19-20	**Calculate** Metacenter, meta centric height calculations.	Metacenter, meta centric height calculations.	T2
21	**Explain** Stream line, path line, streak line, stream surface ,stream tube	**UNIT-2 FLUID KINEMATICS** Stream line, path line, streak line, stream surface ,stream tube	T2
22-23	**Classify** flows steady, unsteady, uniform, non-uniform, laminar, turbulent flows	Classification of flows, steady, unsteady, uniform, non-uniform, laminar, turbulent flows	T2
24-25	**Explain**one dimensional approximation, examples of real 1-D flows, two dimensional approximations, and 2-D flow in wind tunnel.	one dimensional approximation, examples of real 1-D flows, two dimensional approximation ,2-D flow in wind tunnel	T1
26-27	**Derive** Continuity equations for 1-D and 2-D flows both compressible and incompressible, stream function for two dimensional incompressible flows.	Continuity equations for 1-D and 2-D flows both compressible and incompressible, stream function for two dimensional incompressible flows.	T1
28-29	**Explain** Vortices, irrotational flow	Vortices, irrotational flow, velocity	T1

	,velocity potential function	potential function.	
30-32	**State**Surface and Body forces, substantive derivative ,local derivative and convective derivative	**UNIT-3 FLUID DYNAMICS** Surface and Body forces, substantive derivative ,local derivative and convective derivative	T2
33-34	**Derive Momentum** equation, Euler's and Bernoulli's equation.	Momentum equation, Euler's and Bernoulli's equation.	T2
35-36	**Derive** Phenomenological basis of Naviers- stokes equation, **Define** introduction to vortex flows.	Phenomenological basis of Naviers- stokes equation, introduction to vortex flows.	T2
37-38	**Explain** Statement of Buckingham's π-theorem ,similarity parameters : Reynolds number ,Froude number	Statement of Buckingham's π-theorem ,similarity parameters : Reynolds number ,Froude number	T2
39-40	**Explain** Concepts Of geometric ,kinematic and dynamic similarity	Concepts Of geometric ,kinematic and dynamic similarity	T2
41-42	**Explain**Reynolds number as a very approximate measure of ratio of inertia force and viscous force	Reynolds number as a very approximate measure of ratio of inertia force and viscous force	T1
43-44	**Explain**Flow measurements:pressure, velocity and mass flow rate, viscosity, pitot-static tube.	Flow measurements : pressure ,velocity and mass flow rate ,viscosity ,pitot-static tube	T2
45-47	**Derive**Venture meter and orifice meter, viscometers	Venture meter and orifice meter, viscometers	T2
48-49	**Discuss**Introductory concepts of boundary layer,	**UNIT-4 BOUNDARY LAYER** Introductory concepts of boundary layer,	T2
50-51	**Explain**large Reynolds number flows and Prandtl's boundary layer hypothesis ,	large Reynolds number flows and Prandtl's boundary layer hypothesis ,	T1
52-53	**Describe**Qualitative description of boundary layer thickness and velocity profile on a flat plate	Qualitative description of boundary layer thickness and velocity profile on a flat plate	T2
54	**Explain** Flow around submerged objects.	Flow around submerged objects.	T2
55-56	**Derive** Pressure drag and skin friction drag.	Pressure drag and skin friction drag.	T1
57-59	**Explain** Reynolds experiment, derive Darcy's equation	**UNIT-5 PIPE FLOW** Reynolds experiment, Darcy's equation	T2
60-61	**Discuss** Major and minor losses in pipes and **solve** numerical problems.	Major and minor losses in pipes and numerical problems.	T2
62-63	**Derive** Exact Solutions of Naviers Stokes Equations.	Exact Solutions of Naviers Stokes Equations.	T1
64-65	**Derive**Flow between parallel plates, flow through long tubes –fully developed flow	Flow between parallel plates, flow through long tubes –fully developed flow	T2
66-67	**Explain**Turbulent flow, variation of friction factor with Reynolds's Number	Turbulent flow, variation of friction factor with Reynolds's Number	T2
68-69	**Discuss**Moody's chart.	Moody's chart	T2

XI. MAPPING COURSE OBJECTIVES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course objectives	Program Outcomes												Program specific outcomes			
	A	B	C	D	E	F	G	H	I	J	K	L	PSO1	PSO2	PSO3	PSO4
I	S	H	H	S	H	S			S	S		H			H	
II	H	S		S		S				S			H		S	
III	H	H	H	S			S			H		S		H		
IV	H	H	S							S			S			H
V	S	H	S	S					S			S		H		
VI	S	H	H	S				S		S		S	H			
VII	S	H	S	S		S		S	H			S				H

N = None S = Supportive H = Highly related

XII. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES:

Course Outcomes	Program Outcomes												Program specific outcomes			
	A	B	C	D	E	F	G	H	I	J	K	L	PSO1	PSO2	PSO3	PSO4
1	S	H	S	S						S		H		H		
2	S	H	S	H			S		S	S			S			
3	S	S	H	S			S			S		S			H	
4	H	S	S	H				S	H	S						
5	S	H	H	H	S	S	S	S	H	S		S		H		
6	H	H	S	S	S	H	S	H	S	S	S	S	H		S	
7	S	S	H	H	S	S	H	S	H	S		S				H
8	S	S	H	S	S	H	S	S	H	S		S				
9	H	H	S	S	S	S	H	S	S	H		S		H		
10	S	S	H	H	S	S	S	S	S	H		S				
11	H	H	S	S	H	S	H	S	S	H		S	H			
12	H	H	S	S	S	H	S	S	S	H		S				H

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Prepared by: Mr. C.Satya Sandeep, Assistant Professor

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