INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

CIVIL ENGINEERING

COURSE DESCRIPTION FORM

Course Title	**HYDRAULICS & HYDRAULIC MACHINERY**			
Course Code	A40111			
Regulation	R13			
Course Structure	**Lectures**	**Tutorials**	**Practicals**	**Credits**
	4	0	-	4
Course Coordinator	Dr. Venkata Ramana Gedela, Professor, Civil Department			
Team of Instructors	Dr. Venkata Ramana Gedela, Professor, Civil Department			

I. COURSE OVERVIEW:

This course is intended to introduce basic principles of fluid mechanics. It is further extended to cover the application of fluid mechanics by the inclusion of fluid machinery especially water turbine and water pumps. Now days the principles of fluid mechanics find wide applications in many situations directly or indirectly. The use of fluid machinery, turbines pumps in general and in power stations in getting as accelerated fill up. Thus there is a great relevance for this course for mechanical technicians. The Mechanical technicians have to deal with large variety of fluids like water, air, steam, ammonia and even plastics. The major emphasis is given for the study of water. However the principle dealt with in this course will be applicable to all incompressible fluids.

II. PREREQUISITES:

Level	Credits	Periods / Week	Prerequisites
UG	4	5	Fluid Mechanics, Thermodynamics, Engineering Mechanics

III. COURSE ASSESSMENT METHODS:

Session 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.	75	100

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.		

IV. EVALUATION SCHEME:

S. No	Component	Duration	Marks
1	I Mid Examination	90 minutes	20
2	I Assignment	-	5
3	II Mid Examination	90 minutes	20
4	II Assignment	-	5
5	External Examination	3 hours	75

V. COURSE OBJECTIVES:

The objectives of the course are to enable the student to:

1. **Understand** the importance of types of flows, types of channels, economical sections, specific energy, hydraulic jump, energy dissipation of an open channel flow.
2. **Perform** dimensional analysis, Rayleigh's method and Buckingham's pi theorem.
3. **Apply** Hydrodynamic force of jets on stationary and moving flat inclined and curved vanes.
4. **Understand** applications of radial flow turbines.
5. **Understand** non uniform flow-dynamic equation for G.V.F., mild, critical, steep, horizontal and adverse slopes, surface profiles.
6. **Generate** layout of a typical hydropower installation, governing of turbines, surge tanks, unit and specific turbines.

VI. COURSE OUTCOMES:

At the end of this course, a student will be able to:

1. Explain the concept of types of flows, type of channels, velocity distribution, energy and momentum correction factors, Chezy's, Manning's and Bazin formulae for uniform flow.
2. Perform analysis of Specific energy, critical depth, computation of critical depth, critical sub-critical and super critical flows can be understood.
3. Explain Non uniform flow-Dynamic equation for G.V.F., Mild, Critical, Steep, horizontal and adverse slopes, surface profiles, direct step method can be learnt.
4. Understand the Dimensional analysis, Rayleigh's method and Buckingham's pi theorem.
5. Demonstrate the formulation of velocity triangles at inlet and out let ,expressions for work done and efficiency, Angular momentum principle, applications to radial flow turbines.
6. Participate and succeed in competitive examinations like GATE, CEED, PSUs, etc.

VII. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Level	Proficiency assessed by
PO1	An ability to apply knowledge of computing, mathematical foundations, algorithmic principles, and civil engineering theory in design of computer-based systems to real-world problems	H	Assignments, Tutorials, Exams

PO2	The ability to practice civil engineering using up-to- date techniques, skills, and tools as a result of life – long learning ability to design and conduct experiments, as well as to analyze and interpret data.	N	--
PO3	An ability to design , implement, and evaluate a field program to meet desired needs, within realistic constraints such as economic, environmental, social, political, health and safety, manufacturability, and sustainability.	H	Assignments, Tutorials, Exams
PO4	An ability to design a system or component to satisfy stated or code requirements of Civil Engineering	N	--
PO5	An ability to analyze a problem, identify, formulate and use the appropriate computing and Civil engineering requirements for obtaining its solution.	H	Assignments, Tutorials, Exams
PO6	An understanding of professional, ethical, legal, security and social issues and responsibilities.	N	--
PO7	An ability to communicate effectively, both in writing and orally	N	--
PO8	The broad education necessary to analyze the local and global impact of computing and engineering solutions on individuals, organizations, and society	N	--
PO9	Recognition of the need for, and an ability to engage in continuing professional development and life-long learning	N	--
PO10	Knowledge of contemporary issues as they affect the professional and ethical practice of engineering.	N	--
PO11	An ability to use current techniques, skills, and tools necessary for computing and engineering practice	H	Assignments and Tutorials, Exams
P012	An ability to design and development principles in the construction of Civil Engineering of varying complexity.	N	--

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

VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program specific outcomes		Level	Proficiency Assessed By
PSO1	An ability to apply knowledge of computing, mathematical foundations, algorithmic principles, and civil engineering theory in design of computer-based systems to real-world problems	H	Lectures, Exercises and Assignments
PSO2	An ability to design , implement, and evaluate a field program to meet desired needs, within realistic constraints such as economic, environmental, social, political, health and safety, manufacturability, and sustainability.	H	Project
PSO3	An ability to use current techniques, skills, and tools necessary for computing and engineering practice	S	Guest lectures

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

IX. SYLLABUS:

UNIT – I:

OPEN CHANNEL FLOW - I: Types of flows, Type of channels, Velocity distribution, Energy and momentum correction factors, Chezy's, Manning's and Bazin formulae for uniform flow, Most Economical sections. Critical flow: Specific energy, critical depth, computation of critical depth, critical sub-critical and super critical flows.

Non uniform flow-Dynamic equation for G.V.F., Mild, Critical, Steep, horizontal and adverse slopes, surface profiles, direct step method, rapidly varied flow, hydraulic jump, energy dissipation.

UNIT – II:

DIMENSIONAL ANALYSIS AND SIMILITUDE: Dimensional analysis, Rayleigh's method and Buckingham's pi theorem, study of Hydraulic models, Geometric, kinematic and dynamic similarities, dimensionless numbers, model and prototype relations.

UNIT – III:

HYDRODYNAMIC FORCE ON JETS: Hydrodynamic force of jets on stationary and moving flat inclined and curved vanes, jet striking centrally and at tip, velocity triangles at inlet and outlet, expressions for work done and efficiency, Angular momentum principle, Applications to radial flow turbines. Layout of a typical Hydropower installation, Heads and efficiencies.

UNIT – IV:

Classification of turbines-pelton wheel, Francis turbine and Kaplan turbine working, working proportions, velocity diagram, hydraulic design, draft tube, theory and function efficiency.

Governing of turbines, surge tanks, unit and specific turbines, unit speed, unit quantity, unit power and specific speed performance characteristics, geometric similarity, cavitations.

UNIT – V:

CENTRAIFUGAL PUMPS: Pump installation details, classification, Manometric head, minimum starting speed, losses and efficiencies, specific speed multistage pumps, pumps in parallel, performance of pumps, characteristic curves, NPSH-cavitations.

Classification of hydro power plants –definition of terms –load factor, utilization factor, capacity factor, estimation of hydropower potential.

TEXT BOOKS:

1. Fluid mechanics and hydraulic machines by Dr.R.K.Bansal.
2. Open channel flow by k. subramanya. Tata Mc.Graw hill publishers.
3. Fluid mechanics, hydraulic and hydraulic machines by Modi & Seth, Standard book house.
4. Fluid mechanics & fluid machines by narayana pillai, Universities press.

REFERENCES:

1. Fluid mechanics & machinery , CSP OJHA, Oxford university press
2. Elements of open channel flow by rangaraju, Tata Mc.Graw hill, publications
3. Fluid mechanics & fluid machines by rajput , S.chand & co
4. Open channel flow by V.T. Chow, Mc.Graw.Hill book company
5. Fluid mechanics & machinery by D.Ramdurgaia by New Age Publications
6. Mechanics of fluid by Merle C.Potter , David C , Wiggert, bassem H. ramdan, cengage learning.

X. COURSE PLAN:

The course plan is meant as a guideline. There may probably be changes.

Unit	Lecture Number	Topics Planned to cover	Learning Objectives
Course Content Delivery --- Lecture Wise Break-up of Topics I SPELL			
I	1&2	To understand the Basics of Open Channel Flow	Introduction to Open Channel Flow
	3&4	To know the types of flows, Type of channels, Velocity distribution	Types of flows, Type of channels, Velocity distribution
	5&6	To derive the derivation of Energy and momentum correction factors, Chezy's, Manning's and Bazin formulae for uniform flow.	Derivation of Energy and momentum correction factors, hezy's, Manning's and Bazin formulae for uniform flow,
	7&8	Ability to solve the problems on Energy and momentum correction factors, Chezy's, Manning's and Bazin formulae for uniform flow	problems on Energy and momentum correction factors, Chezy's, Manning's and Bazin formulae for uniform flow,
	9&11	Ability to know the Most Economical sections	Most Economical sections
	12&13	To understand the Basics of Critical Flow	Introduction to critical flow
	14&15	To know the Specific energy, critical depth, computation of critical depth	Specific energy, critical depth, computation of critical depth
	16	To know the critical sub-critical and super critical flows	critical sub-critical and super critical flows
	17&18	Ability to solve the problems on Specific energy, critical depth, computation of critical depth	problems on Specific energy, critical depth, computation of critical depth
	19	Ability to understand Non uniform flow-Dynamic equation for G.V.F., Mild, Critical, Steep.	Non uniform flow-Dynamic equation for G.V.F., Mild, Critical, Steep
	20&21	Ability to understand Non uniform flow-Dynamic equation for horizontal and adverse slopes, surface profiles, direct step method	Non uniform flow-Dynamic equation for horizontal and adverse slopes, surface profiles, direct step method
	22	Ability to understand Rapidly varied flow, hydraulic jump, energy dissipation	Rapidly varied flow, hydraulic jump, energy dissipation
	23&24	Ability to solve the problems on Non uniform flow-Dynamic equation for G.V.F., Mild, Critical, Steep.	problems on Non uniform flow-Dynamic equation for G.V.F., Mild, Critical, Steep
	25&26	Ability to solve the problems on Rapidly varied flow, hydraulic jump, energy dissipation	problems on Rapidly varied flow, hydraulic jump, energy dissipation
II	27&28	To understand the Dimensional analysis, Rayleigh's method and Buckingham's pi theorem	Introduction to Dimensional analysis, Rayleigh's method and Buckingham's pi theorem
	29&30	To study of Hydraulic models, Geometric, kinematic and dynamic similarities	study of Hydraulic models, Geometric, kinematic and dynamic similarities
	30&31	To know dimensionless numbers, model and prototype relations	Dimensionless numbers, model and prototype relations
	32&33	Ability to solve the problems Rayleigh's method and Buckingham's pi theorem	Problems solving on Rayleigh's method and Buckingham's pi theorem
	34&35	Ability to solve the problems on	Problems solving on kinematic and dynamic

		kinematic and dynamic similarities	similarities
	36&37	Ability to solve dimension less numbers , model and prototype relations	
III	38	To understand the Basics of Basics of Turbo Machinery	Introduction to Basics of Turbo Machinery
	39&40	To know the Hydrodynamic force of jets on stationary and moving flat inclined and curved vanes	Hydrodynamic force of jets on stationary and moving flat inclined and curved vanes
	41&42	Ability to solve the problems on Hydrodynamic force of jets on stationary and moving flat inclined and curved vanes	Problems solving on Hydrodynamic force of jets on stationary and moving flat inclined and curved vanes
	43	To know the jet striking centrally and at tip, velocity triangles at inlet and outlet	The jet striking centrally and at tip, velocity triangles at inlet and outlet
III	44&45	Ability to solve the problems jet striking centrally and at tip, velocity triangles at inlet and outlet	Problems solving on jet striking centrally and at tip, velocity triangles at inlet and outlet
	46	To know the concept of the Angular momentum principle, applications to radial flow turbines.	The concept Angular momentum principle, Applications to radial flow turbines.
	47&48	Ability to solve the problems on Angular momentum principle	Problems solving on Angular momentum principle
	49&50	To know Layout of a typical Hydropower installation, Heads and efficiencies	Layout of a typical Hydropower installation, Heads and efficiencies
IV	51	To know about the Hydraulic Turbines	Introduction to Hydraulic Turbines
	52&53	To know classification of turbines- pelton wheel, Francis turbine and Kaplan turbine working, working proportions	classification of turbines- pelton wheel, Francis turbine and Kaplan turbine working, working proportions
	54	Ability to solve the problems on pelton wheel, Francis turbine and Kaplan turbine	Problems on pelton wheel, Francis turbine and Kaplan turbine
	55&56	To know velocity diagram, hydraulic design, draft tube, theory and function efficiency.	velocity diagram, hydraulic design, draft tube, theory and function efficiency.
	57&58	Ability to know Governing of turbines, surge tanks, unit and specific turbines, unit speed, unit quantity, unit power and specific speed performance characteristics, geometric similarity, cavitations	Governing of turbines, surge tanks, unit and specific turbines, unit speed, unit quantity, unit power and specific speed performance characteristics, geometric similarity, cavitations
V	59	To know the centrifugal pumps	Introduction to centrifugal pumps
	60	To study the Pump installation details, classification, Manometric head, minimum starting speed	Pump installation details, classification, Manometric head, minimum starting speed
	61&62	To know Losses and efficiencies, specific speed multistage pumps, pumps in parallel, performance of pumps, characteristic curves, NPSH-cavitations.	Losses and efficiencies, specific speed multistage pumps, pumps in parallel, performance of pumps, characteristic curves, NPSH-cavitations.
	63	Ability to solve problems on specific speed , multi stage pumps , pumps in parallel	Problems on specific speed , multi stage pumps , pumps in parallel

	64&65	Ability to solve the problems on performance of pumps , characteristic curves –NSPH cavitation and classification of hydro power plants –definition of terms : load factor , utilization factor , capacity factor , estimation of hydro power potential.	Problems on performance of pumps ,characteristic curves , NSPH curves. Classification of hydro power plants – definition of terms such as load factor , utilization factor , capacity factor , estimation of hydro power potential.

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

Course Objectives	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
I	H	H				H						S	H	S	
II	H	H	S			H	S						H	S	
III	H	H	S	S		H	S	S		H			S	H	
IV	H	S								H	S		H	S	
V		H			S					H	S	S	H		
VI	H			S						S		H	S		

S= Supportive **H = Highly Related**

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

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	H	S	S										H	S	
2	H			S			H						S	H	
3		H			S	H	H						H	S	
4	H	H				H	S						H		
5	H	S				H							S		
6	H					S						S	H	S	
7	S					S	H						S		
8	S	H				S	H			S			H	S	
9	S	H				S	H			H		S	H		
10	S	H				S	H		S	H		S	H		
11	S	H				S	H		S	H		S	H		
12	S	H				S	H		S	H		S	H		

S= Supportive **H = Highly Related**

Prepared by: Dr. Venkata Ramana Gedela, Professor

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