# **2- Course Specification of Advanced Hydraulics**

## Course Code (CE543)

III.	III. General Information About the Course:							
13.	Course Title:		Advan	ced Hydraulics				
14.	<b>Course Code and Number:</b>	CE543						
			Credit	Hours	Tatal			
15.	Credit Hours:	Lecture	Practical	Seminar/Tutorial	Total			
		2		2	3			
16.	Study Level and Semester:		1 <sup>st</sup> semest	er – MSc. Program				
17.	Pre-requisites (if any):		Hydra	ulics Engineering				
18.	Co-requisites (if any):			None				
19.	Program (s) in which the course is offered:	MSc. I	n Civil Engir Environ	eering Program – Wa mental Engineering	ter and			
20.	Language of teaching the course:	English						
21.	Study System:	Courses						
22.	Prepared By:	Dr. Adnan Moharam						
23.	Reviewed by:	Dr. Manso	Dr. Mansour Haidrah					
24.	Date of Approval:							

### **IV. Course Description:**

Advanced Hydraulics course develop understanding the fluid mechanics principles to analyze, design and construct open channel and closed conduit systems.

This course focus on the advance topics in hydraulics and employs theories of continuity, momentum, and energy equations to solve problems involving hydraulic jump, specific energy, critical depth, and water surface profiles of gradually and rapidly varied unsteady flow in open channels, in addition solve complex technical problems of unsteady flow in pipelines.

### III. Course Intended Learning Outcomes (CILOs):

Upon successful completion of Advanced Hydraulics Course, the graduates will be able to:

- a.1.1 Identify the discharge in open channels have simple and compound cross sections.
- a.1.2 Define specific energy, occurrence of critical depth and hydraulic jump in open channels.
- a.1.3 Describe the advanced hydraulic theories in non-uniform and unsteady flow in open channels.
- a.2.1 Identify standard energy approaches and formulas of water surface profiles for gradually and rapidly varied unsteady flow.
- a.2.2 Define the continuity, momentum and energy equations for unsteady flow in pipelines.
- a3. Explain the non-uniform and unsteady flow problems occur in pipelines.
- b1. Inspect and categorize water surface profiles for gradually and rapidly varied unsteady flows.
- b2. Evaluate water hammer problem and other unsteady flow problems in pipelines.
- b3. Apply the concept of specific energy to solve problems involving critical depth.
- b4. Determine the best hydraulic sections and design earthen and lined open channels.

c1. Analyze open channel flow problems and design open channels using modern software.

- c2. Solve complex technical problems of unsteady flow in pipelines.
- c4. Prepare design project of earthen and lined open channels.
- d1. Conduct thesis in hydraulic engineering to achieve the engineering solutions.
- d2. Work effectively within the team and use the rules of practice and professional ethics in hydraulic applications.
- d3. Conduct and discuss scientific researches/technical reports in hydraulic engineering to achieve engineering solutions and their impact on society and environment.

#### XII. Alignment of Course Intended Learning Outcomes (CILOs) to **Program Intended Learning Outcomes (PILOs ) CILOs PILOs** E. Knowledge and Understanding: Upon e. Knowledge and **Understanding:** Upon successful completion of the MSc. in Water successful completion of the Advanced Hydraulics Course, the graduates will be able Environmental and Engineering **Program**, the graduates will be able to: to: Identify the discharge in open channels A1. Demonstrate in-depth understanding of the a.1.1 have simple and compound cross sections. theory and practice of modern water and environmental systems identification, design Define specific energy, occurrence of a.1.2 critical depth and hydraulic jump in open and operation. channels. **a.1.3** Describe the advanced hydraulic theories in non-uniform and unsteady flow in open channels. a.2.1 Identify standard energy approaches and A2. Demonstrate understanding of formulas of water surface profiles for methodology, research planning, and analysis gradually and rapidly varied unsteady techniques. flow. a.2.2 Define the continuity, momentum and energy equations for unsteady flow in pipelines. a3. Explain the non-uniform and unsteady A3. Explain in details the key considerations flow problems occur in pipelines. and challenges of sustainable development of modern water and environmental systems. f. Cognitive/ F. Cognitive/ Intellectual Skills: Intellectual Skills: Upon Upon successful completion of the Advanced successful completion of the MSc. in Water Hydraulics Course, the graduates will be able Environmental Engineering and **Program**, the graduates will be able to: to: Identify, formulate and solve complex **b1**. Inspect and categorize water surface B1. Water and Environmental Engineering by profiles for gradually and rapidly varied selecting and applying appropriate tools and unsteady flows. techniques. b2. **B2.** Critically review the scientific literature for Evaluate water hammer problem and other effective justification and support of results and unsteady flow problems in pipelines. decisions.

<ul> <li>b3. Apply the concept of specific energy to solve problems involving critical depth.</li> <li>b4. Determine the best hydraulic sections and design earthen and lined open channels.</li> <li>g. Professional and Practical Skills: Upon successful completion of the Advanced Hydraulics Course, the graduates will be able to:</li> <li>c1. Analyze open channel flow problems and design open channels using modern software.</li> <li>c2. Solve complex technical problems of unsteady flow in pipelines.</li> <li>c3.</li> <li>c4. Prepare design project of carthen and lined open channels.</li> <li>c4. Prepare design project of carthen and lined open channels.</li> <li>c5.</li> <li>c6.</li> <li>c6.</li> <li>c7. Solve complex technical problems of unsteady flow in pipelines.</li> <li>c6.</li> <li>c7. Solve complex technical problems of unsteady flow in pipelines.</li> <li>c6.</li> <li>c7. Prepare design project of carthen and lined open channels.</li> <li>c6.</li> <li>c6.</li> <li>c7. Prepare design project of carthen and lined open channels.</li> <li>c6.</li> <li>c7. Conduct thesis in hydraulic engineering to achieve the engineering solutions.</li> <li>c7. Conduct thesis in hydraulic engineering technical professional and technical professional ethics in hydraulic applications.</li> <li>c7. Conduct and discuss scientific researches/technical reports in hydraulic engineering to achieve the engineering solutions.</li> <li>c7. Conduct and discuss scientific researches/technical reports in hydraulic engineering to achieve engineering solutions.</li> <li>c7. Conduct and discuss scientific researches/technical reports in hydraulic engineering to achieve engineering solutions.</li> <li>c7. Conduct and discuss scientific researches/technical reports in hydraulic engineering to achieve engine</li></ul>							
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<ul> <li>h. Transferable Skills: Upon successful completion of the Advanced Hydraulics Course, the graduates will be able to:</li> <li>d1. Conduct thesis in hydraulic engineering to achieve the engineering solutions.</li> <li>d2. Work effectively within the team and use the rules of practice and professional ethics in hydraulic applications.</li> <li>d3. Conduct and discuss scientific researches/technical reports in hydraulic engineering data discuss scientific researches/technical reports in hydraulic engineering data discuss engineering data discus engineering data discuss engineering data discus engineering data data discus engineering data discus engineering data discus engineering data data discus engineering data discus engineering data discus engineering data discus engineering data data data di</li></ul>		-	Water and Environmental Engineering areas.				
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d1.Conduct thesis in hydraulic engineering to achieve the engineering solutions.D1. Prepare, present and defined a thesis.d2.Work effectively within the team and use the rules of practice and professional ethics in hydraulic applications.D2. Incorporate professional with ethical responsibilities including contemporary issues and environmental awareness.d3.Conduct and discuss scientific researches/technical reports in hydraulic engineering to achieve engineeringD3. Conduct research and communicate to advance knowledge in related fields.			graduates will be able to:				
<ul> <li>achieve the engineering solutions.</li> <li>d2. Work effectively within the team and use the rules of practice and professional ethics in hydraulic applications.</li> <li>d3. Conduct and discuss scientific researches/technical reports in hydraulic application in hydraulic application achieve engineering to achieve engineering to achieve engineering</li> </ul>	d1.	Conduct thesis in hydraulic engineering to	D1. Prepare, present and defined a thesis.				
<ul> <li>d2. Work effectively within the team and use the rules of practice and professional ethics in hydraulic applications.</li> <li>d3. Conduct and discuss scientific researches/technical reports in hydraulic application in hydraulic application achieve engineering to achieve engineering to achieve engineering</li> </ul>		achieve the engineering solutions.					
the rules of practice and professional ethics in hydraulic applications.responsibilities including contemporary issues and environmental awareness.d3.Conduct researches/technical reports in hydraulic engineeringD3.Conduct research and communicate to advance knowledge in related fields.	d2.	Work effectively within the team and use	D2. Incorporate professional with ethical				
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<b>d3.</b> Conduct and discuss scientific <b>D3.</b> Conduct research and communicate to advance knowledge in related fields.		ethics in hydraulic applications.	and environmental awareness.				
researches/technical reports in hydraulic advance knowledge in related fields.	d3.	Conduct and discuss scientific	D3. Conduct research and communicate to				
engineering to achieve engineering		researches/technical reports in hydraulic	advance knowledge in related fields.				
engineering to achieve engineering		engineering to achieve engineering					
solutions and their impact on society and		solutions and their impact on society and					
environment.		environment.					

XIII.	Alignment	of C	CILOs	to	Teaching	and	Assessment
Strate	egies						
e. Alignment of Knowledge and Understanding CILOs:							
Knowledg	e and Understanding	CILOs	Т	eaching	g Strategies	Asses	ssment Strategies

a.1.1	Identify the discharge in open channels have simple and compound cross sections.	<ul> <li>Lectures</li> <li>Seminars</li> <li>Self-Learning</li> <li>Problems studies</li> <li>Case study</li> <li>Active learning</li> </ul>	<ul> <li>Written exam</li> <li>Written assignment</li> <li>Quizzes</li> <li>Student presentation</li> </ul>
a.1.2	Define specific energy, occurrence of critical depth and hydraulic jump in open channels.	<ul> <li>Lectures</li> <li>Seminars</li> <li>Self-Learning</li> <li>Problems studies</li> <li>Case study</li> <li>Active learning</li> </ul>	<ul> <li>Written exam</li> <li>Written assignment</li> <li>Quizzes</li> <li>Student presentation</li> </ul>
a.1.3	Describe the advanced hydraulic theories in non-uniform and unsteady flow in open channels.	<ul> <li>Lectures</li> <li>Seminars</li> <li>Self-Learning</li> <li>Problems studies</li> <li>Case study</li> <li>Active learning</li> </ul>	<ul> <li>Written exam</li> <li>Written assignment</li> <li>Quizzes</li> <li>Student presentation</li> </ul>
a.2.1	Identify standard energy approaches and formulas of water surface profiles of gradually and rapidly varied unsteady flow.	<ul> <li>Lectures</li> <li>Seminars</li> <li>Self-Learning</li> <li>Problems studies</li> <li>Case study</li> <li>Active learning</li> </ul>	<ul> <li>Written exam</li> <li>Written assignment</li> <li>Quizzes</li> <li>Student presentation</li> </ul>
a.2.2	Define the continuity, momentum and energy equations for unsteady flow in pipelines.	<ul> <li>Lectures</li> <li>Seminars</li> <li>Self-Learning</li> <li>Problems studies</li> <li>Case study</li> <li>Active learning</li> </ul>	<ul> <li>Written exam</li> <li>Written assignment</li> <li>Quizzes</li> <li>Student presentation</li> </ul>
a3.	Explain the non-uniform and unsteady flow problems occur in pipelines.	<ul> <li>Lectures</li> <li>Seminars</li> <li>Self-Learning</li> <li>Problems studies</li> <li>Case study</li> <li>Active learning</li> </ul>	<ul> <li>Written exam</li> <li>Written assignment</li> <li>Quizzes</li> <li>Student presentation</li> </ul>
I. All	Intellectual Skills CILOs	JS: Teaching Strategies	Assessment Strategies
b1.	Inspect and categorize water surface profiles for gradually and rapidly varied unsteady flows.	<ul> <li>Lectures</li> <li>Self-Learning</li> <li>Case Study</li> <li>Simulation Exercises</li> <li>Independent Study</li> <li>Analysis and Problem Solving</li> <li>Brainstorming</li> <li>Presentations</li> </ul>	<ul> <li>Written exam</li> <li>Written assignment</li> <li>Quizzes</li> <li>Student presentation</li> </ul>

b2.	Evaluate water hammer problem and other unsteady flow problems in pipelines.	<ul> <li>Lectures</li> <li>Self-Learning</li> <li>Case Study</li> <li>Simulation Exercises</li> <li>Independent Study</li> <li>Analysis and Problem Solving</li> <li>Brainstorming</li> <li>Presentations</li> </ul>	<ul> <li>Written exam</li> <li>Written assignment</li> <li>Quizzes</li> <li>Student presentation</li> </ul>
b3.	Apply the concept of specific energy to solve problems involving critical depth.	<ul> <li>Lectures</li> <li>Self-Learning</li> <li>Case Study</li> <li>Simulation Exercises</li> <li>Independent Study</li> <li>Analysis and Problem Solving</li> <li>Brainstorming</li> <li>Presentations</li> </ul>	<ul> <li>Written exam</li> <li>Written assignment</li> <li>Quizzes</li> <li>Student presentation</li> </ul>
b4.	Determine the best hydraulic sections and design earthen and lined open channels.	<ul> <li>Lectures</li> <li>Self-Learning</li> <li>Case Study</li> <li>Simulation Exercises</li> <li>Analysis and Problem Solving</li> <li>Group/Individual Projects</li> <li>Brainstorming</li> <li>Presentations</li> </ul>	<ul> <li>Written exam</li> <li>Written assignment</li> <li>Quizzes</li> <li>Student presentation</li> </ul>
g. Al	ignment of Professional and Pract	ical Skills CILOs:	
Pro	fessional and Practical Skills CILOs	Teaching Strategies	Assessment Strategies
c1.	Analyze open channel flow problems and design open channels using modern software.	<ul> <li>Lectures</li> <li>Self-Learning</li> <li>Case Study</li> <li>Simulation Exercises</li> <li>Independent Study</li> <li>Analysis and Problem Solving</li> <li>Brainstorming</li> <li>Presentations</li> </ul>	<ul> <li>Written exam</li> <li>Seminar Report</li> <li>Written Research Proposal</li> <li>Student presentation</li> </ul>
c2.	Solve complex technical problems of unsteady flow in pipelines.	<ul> <li>Lectures</li> <li>Self-Learning</li> <li>Case Study</li> <li>Simulation Exercises</li> <li>Independent Study</li> <li>Analysis and Problem Solving</li> <li>Brainstorming</li> <li>Presentations</li> </ul>	<ul> <li>Written exam</li> <li>Seminar Report</li> <li>Written Research Proposal</li> <li>Student presentation</li> </ul>

c4.	Prepare design project of earthen and lined open channels.	<ul> <li>Lectures</li> <li>Dissertation Defenses and Presentation</li> <li>Independent Study</li> <li>Presentation</li> <li>Brainstorming</li> <li>Group/Individual Projects</li> <li>Presenting Researches</li> </ul>	<ul> <li>Seminar Report</li> <li>Written exam</li> <li>Seminar Report</li> <li>Project evaluation</li> <li>Student presentation</li> </ul>
h. A	lignment of Transferable (General)	) Skills CILOs:	
]]	Transferable (General) Skills CILOs	Teaching Strategies	Assessment Strategies
d1. d2.	Conduct thesis in hydraulic engineering to achieve the engineering solutions. Work effectively within the team and use the rules of practice and professional ethics in hydraulic applications.	<ul> <li>Dissertation Defenses and Presentation</li> <li>Independent Study</li> <li>Presentation</li> <li>Brainstorming</li> <li>Project</li> <li>Presenting Researches</li> <li>Dissertation Defenses and Presentation</li> <li>Independent Study</li> <li>Presentation</li> <li>Brainstorming</li> <li>Project</li> <li>Project</li> <li>Presenting Researches</li> </ul>	<ul> <li>Written Research Proposal and Thesis</li> <li>Student presentation</li> <li>Written Report</li> <li>Project evaluation</li> <li>Written Research Proposal.</li> <li>Student presentation</li> <li>Written Report</li> <li>Project evaluation</li> </ul>
d3.	Conduct and discuss scientific researches/technical reports in hydraulic engineering to achieve engineering solutions and their impact on society and environment.	<ul> <li>Dissertation Defenses and Presentation</li> <li>Independent Study</li> <li>Presentation</li> <li>Brainstorming</li> <li>Project</li> <li>Presenting Researches</li> </ul>	<ul> <li>Written Research Proposal.</li> <li>Student presentation</li> <li>Written Report</li> <li>Project evaluation</li> </ul>

XIV	XIV. Course Content							
2. Th	eoretical Aspect							
Order	Topic List / Units	Sub -Topics List	Number of Weeks	Contact Hours	Course ILOs			
1		<ul> <li>Introduction in open channel flow + Discharge in simple and compound channels.</li> </ul>	1	3	a.1.1, d1., d3.			
2	Open-Channel	<ul> <li>The best efficiency cross-section for different shapes of channels.</li> </ul>	2	3	b1., b4., c1., c4.,			
3	Flow	<ul> <li>Design of earthen and lined channels.</li> </ul>	3	3	d2.			
4		<ul> <li>Specific energy, critical depth and Hydraulic jump.</li> </ul>	4	3	a.1.2, b3., d1., d3.			
5		<ul> <li>Gradually varied unsteady flow.</li> </ul>	5	3	a.2.1, b1.,			
6		<ul> <li>Rapidly varied unsteady flow.</li> </ul>	6	3	d1., d3.			

7		Midterm exam	7	3	
8	Open-Channel Flow	<ul> <li>Non-uniform and unsteady flow in channels (Structure of characteristics upstream and downstream of the gate and Riemann invariants).</li> </ul>	8	3	a.1.3, a3., d1., d3.
9		<ul> <li>Continuity, momentum and Energy equations for unsteady flow.</li> </ul>	9	3	a.2.2, c2., d1., d3.
10		<ul> <li>Non- uniform and unsteady flow in pipes for incompressibility fluids.</li> </ul>	10	3	c2., d1., d3.
11	Pipe Flow	<ul> <li>Pressure wave celerities in pipelines + Water hammer in pipelines.</li> </ul>	11	3	b2., c2., d1., d3.
12		<ul> <li>Instantaneous and rapidly closures of valves in pipelines</li> </ul>	12	3	c2., d1., d3.
13		<ul> <li>Reservoir evacuation and pipe networks</li> </ul>	13	3	c2., d1., d3.
14		14	3		
	Number of Weeks	s /and Contact Hours Per Semester			

2. Tutorial Aspect:							
No.	Tutorial	Number of Weeks	Contact Hours	Learning Outcomes ( <u>C</u> ILOs)			
1	Discharge in simple and compound channels	2	2	a.1.1, d1., d3.			
2	The best efficiency section for different shapes of channels	3	2	b1., b4., c1., c4., d2.			
3	Design of earthen and lined channels	4	2	b1., b4., c1., c4., d2.			
4	Specific energy, critical depth and Hydraulic jump	5	2	a.1.2, b3., c1., d1., d3.			
5	Gradually varied flow in open channels	6	2	a.2.1, d1., d3.			
6	Rapidly varied flow in open channels	7	2	a.2.1, d1., d3.			
7	Structure of characteristics upstream and downstream of the gate and Riemann invariants	9	2	a.1.3, d1., d3.			
8	Continuity, momentum and energy equations of unsteady flow	10	2	a.2.2, d1., d3.			
9	Pressure wave celerities in pipelines + Water hammer in pipelines.	11	2	a3., b2., d1., d3.			
10	Instantaneous and rapidly closures of valves in pipelines	12	2	c2., d1., d3.			
11	Reservoir evacuation and pipe networks	13	2	c2., d1., d3.			
	Number of Weeks /and Units Per Semester	11	22				

3 - Practical Aspect:						
Order	Tasks	Number of Weeks	contact hours	Learning Outcomes		

Number of Weeks /and Units Per Semester				
XV. Teaching Strategies:				
<ul> <li>Discussion</li> </ul>				
<ul> <li>Cooperative learning</li> </ul>				
<ul> <li>Demonstration</li> </ul>				
<ul> <li>Lectures</li> </ul>				
<ul> <li>Self-Learning</li> </ul>				
<ul> <li>Simulation Exercises</li> </ul>				
<ul> <li>Independent Study</li> </ul>				
<ul> <li>Analysis and Problem Solving</li> </ul>				
<ul> <li>Brainstorming</li> </ul>				
<ul> <li>Dissertation Defenses and Presentation</li> </ul>				
<ul> <li>Presenting Researches</li> </ul>				
<ul> <li>Group/Individual Projects</li> </ul>				
Presentations				

# XVI. Assessment Methods of the Course:

- Written exam
- Written assignment
- Quizzes
- Student presentation
- Written Research Proposal and Thesis
- Project evaluation

Χ	VII. Tasks and Assignments:				
No	Assignments/ Tasks	Individual/ Group	Mark	Week Due	CILOs (symbols)
1	<b>Assignment 1:</b> Discharge in simple and compound channels + The best efficiency section for different shapes of channels	Individual	15 %	Week 3	a.1.1, b1., b4., c1., c4., d2.
2	<b>Project 1:</b> Design of earthen and lined channels + Specific energy, critical depth and Hydraulic jump.	Individual	15 %	Week 5	a.1.2, b1., b3., b4., c1., c4., d2.
3	<b>Assignment 2:</b> Gradually varied flow in open channels + Rapidly varied flow in open channels	Individual	15 %	Week 7	a.2.1, d1., d3
4	<b>Assignment 3:</b> Structure of characteristics upstream and downstream of the gate and Riemann invariants.	Individual	15 %	Week 9	a.1.3, d1., d3
5	Assignment 4: Continuity, momentum and energy equations for unsteady flow	Individual	10 %	Week 10	a.2.2, d1., d3.
6	<b>Assignment 5:</b> Pressure wave celerities in pipelines + Water hammer in pipelines.	Individual	15 %	Week 12	a3., b2., d1., d3.

7	Assignment 6: Instantaneous and rapidly closures of valves in pipelines + Reservoir evacuation and pipe networks	Individual	15 %	Week 14	c2, d1., d3.
	Total Score		100 %		

X	XVIII. Learning Assessment:						
No.	Assessment Tasks	Week due	Mark	Proportion of Final Assessment	CILOs		
1	Tasks and Assignments	Weeks 3, 8, 12	10	10 %	a.1.1, a.1.2, a.1.3, a.2.1, a.2.2, a3., b1., b2., b3., b4., c1., c2., c4., d1., d2., d3.		
2	Quizzes	Two times randomly	5	5 %	a.1.1, a.1.2, a.1.3, a.2.1, a.2.2, a3., b1., b2., b3. b4., c1., c2., c4., d1., d2., d3.		
3	Project	Week 9	5	5 %	a.1.1, a.1.2, a.1.3, a.2.1, a.2.2, a3., b1., b2., b3. b4., c1., c2., c4., d1., d2., d3.		
4	Midterm Exam	Week 8	20	20 %	a.1.1, a.1.2, a.1.3, a.2.1, a.2.2, a3., b1., b3., b4., c1., c2., c4., d1., d2., d3.		
5	Participation and attendance	All lectures	10	10 %	a.1.1, a.1.2, a.1.3, a.2.1, a.2.2, a3., b1., b2., b4., c1., c2., c4., d1., d2., d3.		
6	Final Exam	Week 16	50	50 %	a.1.2, a.1.3, a.2.1, a.2.2, a3., b1., b2., b3., b4., c1., c2., c4., d1., d2., d3.		
	Total		100	100%			

### XIX. Learning Resources :

#### 2. Required Textbook(s) :

- 1. Robert L. Daugherty and Joseph B. Franzini (1985). "Fluid Mechanics with Engineering Applications". Arabic Edition, McGraw-Hill Book Company, Cairo, Egypt.
- **2.** Ven Te Chow (2009), ' Open-Channel Hydraulics", International Student Edition, McGraw-Hill International Book Company, Tokyo, Japan.

### 3. Essential References:

- 4. Vennard, J.K. and Street, R.L. (1995), Elementary Fluid Mechanics", Seventh Edition, John Wiley and Sons, New York, USA
- **5.** Victor L. Streeter and E. Benjamin Wylie (1998), Fluid Mechanics", Ninth Edition, McGraw-Hill Book Company, New York, USA
- **6.** Featherstone, R.E. and Nalluri C. (2007), "Civil Engineering Hydraulics, Backwell Science Limited", Fifth Edition, London, England

4. Electronic Materials and Web Sites etc.

None

XII . الضوابط والسياسات المتبعة في المقرر Course Policies

بعد الرجوع للوائح الجامعة يتم كتابة السياسة العامة للمقرر فيما يتعلق بالآتى:

سياسة حضور الفعاليات التعليمية Class Attendance:

1

- يلتزم الطالب بحضور 75% من المحاضرات ويحرم في حال عدم الوفاء بذلك. - يقدم أستاذ المقرر تقريرا بحضور وغياب الطلاب للقسم ويحرم الطالب من دخول الامتحان في حال تجاوز الغياب 25% ويتم	
القرار الحرمان من مجلس القسم. الحضور المتأخر Tardy: - يسمح للطالب حضور المحاضرة إذا تأخر لمدة ربع ساعة لثلاث مرات في الفصل الدراسي، وإذا تأخر زيادة عن ثلاث مرات	2
يُحذر شفويا من أستاذ المقرر، وعُذ عدم الالتزام يمنع من دخول المحاضرة. ضوابط الامتحان Exam Attendance/Punctuality:	3
- لا يسمح للطالب دخول الامتحان النهائي إذا تأخر مقدار (20) دقيقة من بدء الامتحان - إذا تغيب الطالب عن الامتحان النهائي تطبق اللوائح الخاصة بنظام الامتحان في الكلية.	
التعيينات والمشاريع Assignments & Projects: - يحدد أستاذ المقرر نوع التعيينات في بداية الفصل ويحدد مواعيد تسليمها وضوابط تنفيذ التكليفات وتسليمها. - إذا تأخر الطالب في تسليم التكليفات عن الموعد المحدد يحرم من درجة التكليف الذي تأخر في تسليمه.	4
<u>الغش Cheating:</u> - في حال ثبوت قيام الطالب بالغش في الامتحان النصفي أو النهائي تطبق عليه لائحة شوّون الطلاب. - في حال ثبوت قيام الطالب بالغش او النقل في التكليفات والمشاريع يحرم من الدرجة المخصصة للتكليف.	5
الانتحال Plagiarism: - في حالة وجود شخص ينتحل شخصية طالب لأداء الامتحان نيابة عنه تطبق اللائحة الخاصة بذلك	6
سياسات أخرى Other policies: - أي سياسات أخرى مثل استخدام الموبايل أو مواعيد تسليم التكليفات الخ	7

#### Academic Year: .....

### **Course Plan (Syllabus):** Advanced Hydraulics

V. Information about Faculty Member Responsible for the Course:							
Name		Office Hours					
Location & Telephone No.		SAT	SUN	MON	TUE	WED	THU
E-mail							

V.	7. General information about the course:						
10	<b>Course Title</b>	Advanced Hydraulics					
11	<b>Course Code and Number</b>	CE543					
		Credit Hours					
12	<b>Credit Hours</b>	Lecture	Practical	Seminar/Tutorial	Totai		
		2		2	3		
13	<b>Study Level and Semester</b>	1 <sup>st</sup> semester – MSc. Program					
14	Pre-requisites		Hydrau	lics Engineering			
15	Co –requisite			None			
16	Program (s) in which the course is offered	MSc. In Civil Engineering Program – Water and Environmental Engineering					
17	Language of teaching the course	English					
18	Location of teaching the course	Fa	culty of Engine	ering – Sana'a Universi	ty		

### VI. Course Description:

Advanced Hydraulics course develop understanding the fluid mechanics principles to analyze, design and construct open channel and closed conduit systems.

This course focus on the advance topics in hydraulics and employs theories of continuity, momentum, and energy equations to solve problems involving hydraulic jump, specific energy, critical depth, and water surface profiles of gradually and rapidly varied unsteady flow in open channels, in addition solve complex technical problems of unsteady flow in pipelines.

### IV. Course Intended Learning Outcomes (CILOs):

Upon successful completion of Advanced Hydraulics Course, the graduates will be able to:

- a.1.1 Identify the discharge in open channels have simple and compound cross sections.
- a.1.2 Define specific energy, occurrence of critical depth and hydraulic jump in open channels.
- a.1.3 Describe the advanced hydraulic theories in non-uniform and unsteady flow in open channels.
- a.2.1 Identify standard energy approaches and formulas of water surface profiles for gradually and rapidly varied unsteady flow.
- a.2.2 Define the continuity, momentum and energy equations for unsteady flow in pipelines.
- a3. Explain the unsteady flow problems occur in pipelines.

- b1. Inspect and categorize water surface profiles for gradually and rapidly varied unsteady flows.
- b2. Evaluate water hammer problem and other unsteady flow problems in pipelines.
- b3. Apply the concept of specific energy to solve problems involving critical depth.
- b4. Determine the best hydraulic sections and design earthen and lined open channels.
- c1. Analyze open channel flow problems and design open channels using modern software.
- c2. Solve complex technical problems of unsteady flow in pipelines.
- c4. Prepare design project of earthen and lined open channels.
- d1. Conduct thesis in hydraulic engineering to achieve the engineering solutions.
- d2. Work effectively within the team and use the rules of practice and professional ethics in hydraulic applications.
- d3. Conduct and discuss scientific researches/technical reports in hydraulic engineering to achieve engineering solutions and their impact on society and environment.

V. Co	V. Course Content						
<b>1.</b> T	heoretical Aspect						
Order	<b>Topic List / Units</b>	Sub -Topics	Number of Weeks	<b>Contact Hours</b>			
1		<ul> <li>Introduction in open channel flow + Discharge in simple and compound channels.</li> </ul>	1	3			
2	Open-Channel	<ul> <li>The best efficiency cross-section for different shapes of channels.</li> </ul>	2	3			
3	Flow	• Design of earthen and lined channels.	3	3			
4	110W	<ul> <li>Specific energy, critical depth and Hydraulic jump.</li> </ul>	4	3			
5		<ul> <li>Gradually varied unsteady flow.</li> </ul>	5	3			
6		<ul> <li>Rapidly varied unsteady flow.</li> </ul>		3			
7	Midterm exam		7	3			
8	Open-Channel Flow	<ul> <li>Non-uniform and unsteady flow in channels (Structure of characteristics upstream and downstream of the gate and Riemann invariants)</li> </ul>	8	3			
9		<ul> <li>Continuity, momentum and Energy equations for unsteady flow</li> </ul>	9	3			
10		<ul> <li>Non-uniform and unsteady flow in pipes for incompressibility fluids.</li> </ul>	10	3			
11		<ul> <li>Pressure wave celerities in pipelines + Water hammer in pipelines.</li> </ul>	11	3			
12	Pipe Flow• Instantaneous and rapidly closures of valves in pipelines		12	3			
13		<ul> <li>Reservoir evacuation and pipe networks</li> </ul>	13	3			
14	Final exam		14	3			

Number of Weeks /and Contact Hours Per Semester	
	<u> </u>

2. Tu	2. Tutorial Aspect:					
No.	Tutorial	Number of Weeks	<b>Contact Hours</b>			
1	Discharge in simple and compound channels	2	2			
2	The best efficiency section for different shapes of channels	3	2			
3	Design of earthen and lined channels	4	2			
4	Specific energy, critical depth and Hydraulic jump	5	2			
5	Gradually varied flow in open channels	6	2			
6	Rapid varied flow in open channels	7	2			
7	Structure of characteristics upstream and downstream of the gate and Riemann invariants	9	2			
8	Continuity, momentum and Energy equations of unsteady flow	10	2			
9	Pressure wave celerities in pipelines + Water hammer in pipelines.	11	2			
10	Instantaneous and rapidly closures of valves in pipelines	12	2			
11	Reservoir evacuation and pipe networks	13	2			
	Number of Weeks /and Units Per Semester	11	22			

3 - Practical	3 - Practical Aspect:						
Order	Tasks	Number of Weeks	contact hours	Learning Outcomes			
	Number of Weeks /and Units Per Semester						
VI. Teaching Strategies:							

- Discussion
- Cooperative learning
- Demonstration
- Lectures
- Self-Learning
- Simulation Exercises
- Independent Study
- Analysis and Problem Solving
- Brainstorming
- Dissertation Defenses and Presentation
- Presenting Researches
- Group/Individual Projects
- Presentations

## VII. Assessment Methods of the Course:

- Written exam
- Written assignment
- Quizzes
- Student presentation
- Written Research Proposal and Thesis
- Project evaluation

V	VI. Tasks and Assignments:						
No	Assignments/ Tasks	Individual/ Group	Mark	Week Due			
1	<b>Assignment 1:</b> Discharge in simple and compound channels + The best efficiency section for different shapes of channels	Individual	15 %	Week 3			
2	<b>Project 1:</b> Design of earthen and lined channels + Specific energy, critical depth and hydraulic jump	Individual	15 %	Week 5			
3	Assignment 2: Gradually varied flow in open channels + Rapidly varied flow in open channels	Individual	15 %	Week 7			
4	Assignment 3: Structure of characteristics upstream and downstream of the gate and Riemann invariants	Individual	15 %	Week 9			
5	Assignment 4: Continuity, momentum and Bernoulli equations of unsteady flow	Individual	10 %	Week 10			
6	<b>Assignment 5:</b> Pressure wave celerities in pipelines + Water hammer in pipelines.	Individual	15 %	Week 12			
7	<b>Assignment 6:</b> Instantaneous and rapid closures of valves in pipelines + Reservoir evacuation and pipe networks	Individual	15 %	Week 14			
	Total Score		100%				

VI	VII. Learning Assessment:						
No.	Assessment Tasks	Week due	Mark	<b>Proportion of Final Assessment</b>			
1	Tasks and Assignments	Weeks 3, 8, 12	10	10 %			
2	Quizzes	Two times randomly	5	5 %			
3	Project	Week 9	5	5 %			
4	Midterm Exam	Week 8	20	20 %			
5	Participation and attendance	All lectures	10	10 %			
6	Final Exam	Week 16	50	50 %			
	Total			100%			

### X. Learning Resources :

#### 3. Required Textbook(s) :

- 1. Robert L. Daugherty and Joseph B. Franzini (1985). "Fluid Mechanics with Engineering Applications". Arabic Edition, McGraw-Hill Book Company, Cairo, Egypt.
- 2. Ven Te Chow (2009), ' Open-Channel Hydraulics", International Student Edition, McGraw-Hill International Book Company, Tokyo, Japan.

#### 4. Essential References:

- 1. Vennard, J.K. and Street, R.L. (1995), Elementary Fluid Mechanics", Seventh Edition, John Wiley and Sons, New York, USA
- 2. Victor L. Streeter and E. Benjamin Wylie (1998), Fluid Mechanics", Ninth Edition, McGraw-Hill Book Company, New York, USA
- 3. Featherstone, R.E. and Nalluri C. (2007), "Civil Engineering Hydraulics, Backwell Science Limited", Fifth Edition, London, England

#### 3. Electronic Materials and Web Sites etc.

None

<ul> <li>۲. الضوابط والسياسات المتبعة في المقرر Course Policies</li> </ul>	XI
بعد الرجوع للوائح الجامعة يتم كتابة السياسة العامة للمقرر فيما يتعلق بالآتي:	!
سياسة حضور الفعاليات التعليمية Class Attendance: - يلتزم الطالب بحضور 75% من المحاضرات ويحرم في حال عدم الوفاء بذلك. - يقدم أستاذ المقرر تقريرا بحضور وغياب الطلاب للقسم ويحرم الطالب من دخول الامتحان في حال تجاوز الغياب 25% ويتم اقرار الحرمان من مجلس القسم.	1
<u>الحضور المتأخر Tardy:</u> - يسمح للطالب حضور المحاضرة إذا تأخر لمدة ربع ساعة لثلاث مرات في الفصل الدراسي، وإذا تأخر زيادة عن ثلاث مرات يحذر شفويا من أستاذ المقرر، وعند عدم الالتزام يمنع من دخول المحاضرة.	2
ضوابط الامتحان Exam Attendance/Punctuality: - لا يسمح للطالب دخول الامتحان النهائي إذا تأخر مقدار (20) دقيقة من بدء الامتحان - إذا تغيب الطالب عن الامتحان النهائي تطبق اللوائح الخاصة بنظام الامتحان في الكلية.	3

4	التعيينات والمشاريع Assignments & Projects:
	- يحدد أستاذ المقرر نوع التعيينات في بداية الفصل ويحدد مواعيد تسليمها وضوابط تنفيذ التكليفات وتسليمها.
	<ul> <li>إذا تأخر الطالب في تسليم التكليفات عن الموعد المحدد يحرم من درجة التكليف الذي تأخر في تسليمة.</li> </ul>
5	الغش Cheating:
	- في حال تُبوت قيام الطالب بالغش في الامتحان النصفي أو النهائي تطبق عليه لائحة شؤون الطلاب.
	<ul> <li>في حال تُبوت قيام الطالب بالغش او النقل في التكليفات والمشاريع يحرم من الدرجة المخصصة للتكليف.</li> </ul>
6	الانتحال Plagiarism:
	– في حالة وجود شخص ينتحل شخصية طالب لأداء الامتحان نيابة عنه تطبق اللائحة الخاصة بذلك
7	سیاسات آخری Other policies:
	<ul> <li>أي سياسات أخرى مثل استخدام الموبايل أو مواعيد تسليم التكليفات الخ</li> </ul>