10- Course Specification of Advanced Fluid Mechanics Course Code (ME522)

• General Information About the Course:

1.	**Course Title:**	Advanced Fluid Mechanics			
2.	**Course Code and Number:**	ME 522			
3.	**Credit Hours:**	**Credit Hours**			**Total**
		Lecture	Practical	Seminar/Tutorial	
		3	--	--	**3**
4.	**Study Level and Semester:**	1st Level / 1st Semester			
5.	**Pre-requisites (if any):**	Fluid Mechanics2 (ME242), Engineering Mathematics (BR231)			
6.	**Co-requisites (if any):**	None			
7.	**Program (s) in which the course is offered:**	MSc. In Mechanical Engineering Program			
8.	**Language of teaching the course:**	English			
9.	**Study System:**	Courses & Thesis			
10.	**Prepared By:**	Dr. Hamoud A. Al-Nahari			
11.	**Reviewed by:**	Dr. ……			
12.	**Date of Approval:**				

• Course Description:

The aim of this course is to develop an advanced understanding of the laws of fluid mechanics, with ability to utilize the appropriate theoretical models to approach problems involving laminar and turbulent viscous flows. Course topics: review of engineering mathematics, kinematics of fluid motion, conservation laws, continuity and momentum equations, Navier-Stokes equation, viscous flow theory, simple flows, and low Reynolds number flows. Introduction to computational fluid dynamics. Asymptotic methods, perturbation methods, singular perturbation, and matched asymptotic expansion. Boundary layer theory, similarity solutions, and integral method. Review of the instability of viscous flows. Origin of turbulence. Phenomenological theories of turbulence. Reynolds' equation, energy and vorticity transport in turbulence. Introduction to turbulence modeling.

• Course Intended Learning Outcomes (CILOs):

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

a1.	Explain the concept and models of fluids and the physical meaning of general equations.
a2.	Characterize the computational modeling of fluid flows.
a3.	Describe the boundary layer concepts and the basics of turbulent flows.
b1.	Solve analytically and numerically some complex laminar flow problems in internal and external flow geometries under steady and unsteady conditions.
b2.	Formulate the equation for viscous flow, including laminar and turbulent flows.
b3.	Derive the governing equations in Cartesian coordinates and write governing equations in tensor form.
c1.	Employ the CFD code for solving laminar and turbulent flows.
c2.	Apply the fundamentals of kinematics and conservation laws to fluid flow systems**.**

c3.	Compute the exact solutions of Navier-Stokes equations and calculate the potential flows and stability theory in fluid flows.
d1	Review IT capabilities and other resources to develop scientific research in fluid mechanics.
d2.	Communication effectively in both orally and writing forms for different audiences.
d3.	Undertake lifelong learning of the developments in the field of advanced fluid mechanics.
d4.	Cooperate effectively in team work to reach to a professional context.

• Alignment of Course Intended Learning Outcomes (CILOs) to Program Intended Learning Outcomes (PILOs)

CILOs		PILOs
• **Knowledge and Understanding:** Upon successful completion of **Advanced Solid Mechanics and Engineering Materials Course**, the graduates will be able to:		• **Knowledge and Understanding:** Upon successful completion of the **MSc. In Mechanical Engineering Program**, the graduates will be able to:
a1.	Explain the concept and models of fluids and the physical meaning of general equations.	**A1.** Acquire advanced concepts and knowledge of mathematics, scientific, mechanical engineering and associated technologies as well as across the boundaries of interdisciplinary disciplines.
a2.	Characterize the computational modeling of fluid flows.	**A2.** Identify and critically evaluate contemporary engineering technologies, current developments and emerging trends within the mechanical engineering contexts.
a3.	Describe the boundary layer concepts and the basics of turbulent flows.	**A3.** Provide a holistic description of principles, concepts, approaches, techniques and analysis tools to design and development of existing and novel mechanical systems, while taking a sustainable and environmentally-friendly approach.
• **Cognitive/ Intellectual Skills:** Upon successful completion of the **Advanced Solid Mechanics and Engineering Materials Course,** the graduates will be able to:		• **Cognitive/ Intellectual Skills:** Upon successful completion of the **MSc. In Mechanical Engineering Program,** the graduates will be able to:
b1.	Solve analytically and numerically some complex laminar flow problems in internal and external flow geometries under steady and unsteady conditions.	**B1.** Identify and apply specialized knowledge and skills to solve problems that are critical to future growth of industry and business.
b2.	Formulate the equation for viscous flow, including laminar and turbulent flows.	**B2.** Creatively thinking and apply analysis tools to formulate and solve complex engineering problems in the mechanical engineering context using modern techniques and tools.
b3.	Derive the governing equations in Cartesian coordinates and write governing equations in tensor form.	**B3.** Design and optimize mechanical components, systems and process to meet desired needs within realistic constraints.

• **Professional and Practical Skills:** Upon successful completion of the **Advanced Solid Mechanics and Engineering Materials Course,** the graduates will be able to:		• **Professional and Practical Skills:** Upon successful completion of the **MSc. In Mechanical Engineering Program,** the graduates will be able to:
c1.	Employ the CFD code for solving laminar and turbulent flows.	**C1.** Use modern manufacturing processes and materials, experimental tests, appropriate software packages and other modern tools for the design analysis and manufacture of mechanical components and systems.
c2.	Apply the fundamentals of kinematics and conservation laws to fluid flow systems.	**C2.** Perform mechanical engineering studies professionally, ethically and responsibly within realistic constraints.
c3.	Compute the exact solutions of Navier-Stokes equations and calculate the potential flows and stability theory in fluid flows.	
• **Transferable Skills:** Upon successful completion of the **Advanced Solid Mechanics and Engineering Materials Course,** the graduates will be able to:		• **Transferable Skills:** Upon successful completion of the **MSc. In Mechanical Engineering Program,** the graduates will be able to:
D1	Review IT capabilities and other resources to develop scientific research in fluid mechanics.	**D1.** Adopt effectively IT capabilities and other different resources of information to develop scientific research in mechanical engineering fields.
D2.	Communication effectively in both orally and writing forms for different audiences.	**D2.** Communicate, present, challenge and defend research ideas, results and conclusions in both orally and writing forms to different audiences in contexts.
D3.	Undertake lifelong learning of the developments in the field of advanced fluid mechanics.	**D3.** Identify a need for the latest relevant knowledge and technologies and undertake life-long learning.
D4.	Cooperate effectively in team work to reach to a professional context.	**D4.** Collaborate effectively within multidisciplinary teams and lead them in different professional contexts

• Alignment of CILOs to Teaching and Assessment Strategies

• Alignment of Knowledge and Understanding CILOs:

Knowledge and Understanding CILOs		Teaching Strategies	Assessment Strategies
a1.	Explain the concept and models of fluids and the physical meaning of general equations.	▪ Lectures, ▪ Self-Learning ▪ Problems/Studies, ▪ Case study, ▪ Individual/Group Projects and Studies, ▪ Active learning	▪ Oral & Writing Exams ▪ Individual Projects and Studies Reports, ▪ Assignments
a2.	Characterize the computational modeling of fluid flows.	▪ Lectures, ▪ Self-Learning Problems/Studies,	▪ Oral & Writing Exams ▪ Individual Projects and Studies Reports,

		▪ Case study, ▪ Individual/Group Projects and Studies, ▪ Active learning, ▪ Computer hands-on sessions	▪ Assignments
a3.	Describe the boundary layer concepts and the basics of turbulent flows.	▪ Lectures, ▪ Self-Learning Problems/Studies, ▪ Case study, ▪ Individual/Group Projects and Studies, ▪ Active learning	▪ Oral & Writing Exams ▪ Individual Projects and Studies Reports, ▪ Assignments

- **Alignment of Intellectual Skills CILOs:**

Intellectual Skills CILOs		Teaching Strategies	Assessment Strategies
b1.	Solve analytically and numerically some complex laminar flow problems in internal and external flow geometries under steady and unsteady conditions.	▪ Lectures, ▪ Self-Learning ▪ Problems/Studies, ▪ Case study, ▪ Individual/Group Projects and Studies ▪ Active learning, ▪ Computer hands-on sessions.	▪ Oral & Writing Exams ▪ Individual Projects and Studies Reports, ▪ Assignments
b2.	Formulate the equation for viscous flow, including laminar and turbulent flows.	▪ Lectures, ▪ Self-Learning ▪ Problems/Studies, ▪ Case study, ▪ Individual/Group Projects and Studies, ▪ Active learning	▪ Oral & Writing Exams ▪ Individual Projects and Studies Reports, ▪ Assignments
b3.	Derive the governing equations in Cartesian coordinates and write governing equations in tensor form.	▪ Lectures, ▪ Self-Learning ▪ Problems/Studies, ▪ Case study, ▪ Individual/Group Projects and Studies, ▪ Active learning	▪ Oral & Writing Exams ▪ Individual Projects and Studies Reports, ▪ Assignments

- **Alignment of Professional and Practical Skills CILOs:**

Professional and Practical Skills CILOs		Teaching Strategies	Assessment Strategies
c1.	Employ the CFD code for solving laminar and turbulent flows.	▪ Lectures, ▪ Self-Learning ▪ Problems/Studies, ▪ Case study, ▪ Individual/Group Projects and Studies, ▪ Active learning, ▪ Computer hands-on sessions.	▪ Oral & Writing Exams ▪ Individual Projects and Studies Reports, ▪ Assignments

c2.	Apply the fundamentals of kinematics and conservation laws to fluid flow systems**.**	▪ Lectures, ▪ Self-Learning ▪ Problems/Studies, ▪ Case study, ▪ Individual/Group Projects and Studies, ▪ Active learning	▪ Oral & Writing Exams ▪ Individual Projects and Studies Reports, ▪ Assignments
c3.	Compute the exact solutions of Navier-Stokes equations and calculate the potential flows and stability theory in fluid flows.	▪ Lectures, ▪ Self-Learning ▪ Problems/Studies, ▪ Case study, ▪ Individual/Group Projects and Studies, ▪ Active learning	▪ Oral & Writing Exams ▪ Individual Projects and Studies Reports, ▪ Assignments

- **Alignment of Transferable (General) Skills CILOs:**

Transferable (General) Skills CILOs		Teaching Strategies	Assessment Strategies
d1.	Review IT capabilities and other resources to develop scientific research in fluid mechanics.	▪ Independent Study, ▪ Individual/Group Projects and Studies, ▪ Presentation	▪ Presentation, ▪ Written Report
d2.	Communication effectively in both orally and writing forms for different audiences.	▪ Independent Study, ▪ Individual/Group Projects and Studies	▪ Presentation, ▪ Written Report.
d3.	Undertake lifelong learning of the developments in the field of advanced fluid mechanics.	▪ Independent Study, ▪ Individual/Group Projects and Studies	▪ Presentation, ▪ Written Report.
d4.	Cooperate effectively in team work to reach to a professional context.	▪ Independent Study, ▪ Individual/Group Projects and Studies	▪ Presentation, ▪ Written Report.

• Course Content

- **Theoretical Aspect**

Order	Topic List / Units	Sub -Topics List	Number of Weeks	Contact Hours	Course ILOs
13.	**Review of Engineering Mathematics**	- Review of differential equations - Review Partial Differential Equations - Indicial notation	1	3	a1
14.	**Continuum Fluid Mechanics**	- Kinematics - Conservation Laws - Review of Continuum Thermodynamics - Constitutive Equations	1	3	a1, b2,

15.	**Navier- Stoke Equation**	- Exact Solutions - Viscous Flows	1	3	a1, a2, a3, b1, b2, b3, c1, c2, c3,
16.	**Low Reynolds Number Flows**	- Creeping Flows - Lubrication Theory - Squeeze Film - Flow around a Sphere	1	3	a1, a2, a3, b1, b2, b3, c1, c2, c3,
17.	**Introduction to Computational Fluid Mechanics**	- Finite Difference and Finite Volume Methods - Introduction to CFD - ANSYS-Fluent Code	1	3	a1, a2, a3, b1, b2, b3, c1, c2, c3, d1
18.	**Asymptotic Methods**	- Perturbation Theory - Singular Perturbation Theory - Matched Asymptotic Expansion	2	3	a1, a2, a3, b1, b2, b3, c1, c2, c3,
19.	**Midterm Exam**	- All previous topics	1	2	a1, a2, a3, b1, b2, b3, c1, c2, c3,
20.	**Boundary Layer Theory**	- Boundary Layer Theory - Self-Similar Solutions - Integral methods - Jets and Wake Flows	3	3	a1, a2, a3, b1, b2, b3, c1, c2, c3,
21.	**Stability of Fluid Motion**	- Theory of Small Perturbation - The Orr-Sommerfeld Equation	1	3	a1, a2, a3, b1, b2, b3, c1, c2, c3,
22.	**Turbulent Flows**	- Reynolds Equation and Turbulence Stresses - Phenomenological Theories	1	3	a1, a2, a3, b1, b2, b3, c1, c2, c3,
23.	**Final projects**	Follow up on final projects	1	3	a1, a2, a3, b1, b2, b3, c1, c2, c3, d1, d2, d3, d4

24.	**Final projects**	Presentation of final projects	1	3	a1, a2, a3, b1, b2, b3, c1, c2, c3, d1, d2, d3, d4
25.	**Final Theoretical Exam**	All Previous Topics	1	3	a1, a2, a3, b1, b2, b3, c1, c2, c3
Number of Weeks /and Contact Hours Per Semester			**16**	**48**	

- **Practical Aspect**

Order	Practical / Tutorials topics	Number of Weeks	Contact Hours	Course ILOs
1	▪ **None**			
Number of Weeks /and Contact Hours Per Semester				

- **Tutorial Aspect:**

No.	Tutorial	Number of Weeks	Contact Hours	Learning Outcomes (CILOs)
1	• **None**			
Number of Weeks /and Units Per Semester				

• Teaching Strategies:

- Lectures,
- Self-Learning Problems/Studies,
- Case study,
- Individual Projects and Studies,
- Active learning,
- Computer hands-on sessions.
- Independent Study, and
- Presentation

• Assessment Methods of the Course:

- Oral & Writing Exams
- Individual/Group Projects and Studies Reports,
- Presentation,
- Assignments

• Tasks and Assignments:

No	Assignments/ Tasks	Individual/ Group	Mark	Week Due	CILOs (symbols)

1	Homework and Assignments.	Individual	10	3rd , 6th , 9th , 12th	a1, a2, a3, b1, b2, b3, c1, c2, c3, d1, d2, d3, d4
2	Mini/Major Project	Group	10	7th , 10th	a1, a2, a3, b1, b2, b3, c1, c2, c3, d1, d2, d3, d4
3	Case study	Group	10	13th	a1, a2, a3, b1, b2, b3, c1, c2, c3, d1, d2, d3, d4
	Total Score		**30**	==	===

• Learning Assessment:

No.	Assessment Tasks	Week due	Mark	Proportion of Final Assessment	CILOs
1	**Tasks and Assignments**	3rd , 6th , 9th , 12th	**30**	**20%**	a1, a2, a3, b1, b2, b3, c1, c2, c3, d1, d2, d3, d4
2	**Quizzes**	**3rd , 8th , 13th**	**10**	**6.7%**	a1, a2, a3, b1, b2, b3, c1, c2, c3
3	**Midterm Exam (Theoretical)**	**8th**	**30**	**20%**	a1, a2, a3, b1, b2, b3, c1, c2, c3
4	**Final Exam (Theoretical)**	**16th**	**80**	**53.3%**	a1, a2, a3, b1, b2, b3, c1, c2, c3
Total			**150**	**100%**	**===**

• Learning Resources :

1. Required Textbook(s):

1. William Graebel, 2007, Advanced Fluid Mechanics, 1st Edition, Academic Press.
2. Muralidhar K. and Biswas G., 2015, Advanced Engineering Fluid Mechanics, 3rd Edition, Alpha Science International Ltd.

2. Essential References:

1. F. Moukalled • L. Mangani M. Darwish,2016, The Finite Volume Method in Computational Fluid Dynamics, Springer.
2. H. Schlichting, 1979, Boundary Layer Theory, McGraw Hill
3. H. Tennekes and J.L. Lumley, 1981, A First Course in Turbulence, MIT Press.
4. A. J. Raudkivi , R. A. Callander , 1975, Advanced Fluid Mechanics: An Introduction, John Wiley & Sons.

3. Electronic Materials and Web Sites *etc.*

1. https://webspace.clarkson.edu/projects/fluidflow/public_html/courses/me527/index.html
2. https://sites.clarkson.edu/gahmadi/courses/me527/
3. https://ocw.mit.edu/courses/mechanical-engineering/2-25-advanced-fluid-mechanics-fall-2013/
4. https://www.kth.se/student/kurser/kurs/FSG3134?l=en
5. https://handbook.unimelb.edu.au/2017/subjects/mcen90018
6. https://cust.edu.pk/advanced-fluid-mechanics-ce2523/
7. https://www.edx.org/course/advanced-fluid-mechanics-1
8. https://nptel.ac.in/courses/112/105/112105218/
9. https://www.elsevier.com/books/advanced-fluid-mechanics/graebel/978-0-12-370885-4
10. https://www.udemy.com/course/fundamentals-of-fluid-mechanics-part-2/
11. https://www.springer.com/gp/book/9789400744875
12. https://www.amazon.com/Viscous-Fluid-MCGRAW-MECHANICALENGINEERING/dp/0072402318
13. https://www.springer.com/gp/book/9789024728770
14. https://link.springer.com/book/10.1007%2F978-3-662-52919-5
15. https://www.amazon.com/Turbulence-McGraw-Hill-mechanical-engineeringHinze/dp/0070290377
16. https://mitpress.mit.edu/books/first-course-turbulence

• **الضوابط والسياسات المتبعة في المقرر Course Policies**	
بعد الرجوع للوائح الجامعة يتم كتابة السياسة العامة للمقرر فيما يتعلق بالآتي:	
1	**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.**
2	**الحضور المتأخر Tardy:** **- 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.**
3	**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.**
4	**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.**
5	**الغش Cheating:** **- في حال ثبوت قيام الطالب بالغش في الامتحان النصفي أو النهائي تطبق عليه لائحة شؤون الطلاب.** **- في حال ثبوت قيام الطالب بالغش او النقل في التكليفات والمشاريع يحرم من الدرجة المخصصة للتكليف.**
6	**الانتحال Plagiarism:** **– في حالة وجود شخص ينتحل شخصية طالب لأداء الامتحان نيابة عنه تطبق اللائحة الخاصة بذلك**
7	**سياسات أخرى Other policies:** **- أي سياسات أخرى مثل استخدام الموبايل أو مواعيد تسليم التكليفات ..... الخ**

Academic Year: ……....

Course Plan (Syllabus) Advanced Heat Transfer

Course Code (ME 522)

• Information about Faculty Member Responsible for the Course:

Name	**Dr. Hamoud A. Al-Nahari**	**Office Hours**					
Location &Telephone No.	772223240	**SAT**	**SUN**	**MON**	**TUE**	**WED**	**THU**
E-mail	H_nahary@hotmail.com						

• General information about the course:

	Course Title	Advanced Fluid Mechanics			
2.	**Course Code and Number**	ME 522			
3.	**Credit Hours**	**Credit Hours**			**Total**
		Lecture	**Practical**	**Seminar/Tutorial**	
		3	--	--	**3**
4.	**Study Level and Semester**	1st Level / 1st Semester			
5.	**Pre-requisites**	Fluid Mechanics2 (ME242), Engineering Mathematics (BR231)			
6.	**Co –requisite**	None			
7.	**Program (s) in which the course is offered**	MSc. In Mechanical Engineering Program			
8.	**Language of teaching the course**	English			
9.	**Location of teaching the course**	Faculty Buildings			

• Course Description:

The aim of this course is to develop an advanced understanding of the laws of fluid mechanics, with ability to utilize the appropriate theoretical models to approach problems involving laminar and turbulent viscous flows. Course topics: review of engineering mathematics, kinematics of fluid motion, conservation laws, continuity and momentum equations, Navier-Stokes equation, viscous flow theory, simple flows, and low Reynolds number flows. Introduction to computational fluid dynamics. Asymptotic methods, perturbation methods, singular perturbation, and matched asymptotic expansion. Boundary layer theory, similarity solutions, and integral method. Review of the instability of viscous flows. Origin of turbulence. Phenomenological theories of turbulence. Reynolds' equation, energy and vorticity transport in turbulence. Introduction to turbulence modeling.

• Course Intended Learning Outcomes (CILOs):

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

a1.	Explain the concept and models of fluids and the physical meaning of general equations.
a2.	Characterize the computational modeling of fluid flows.
a3.	Describe the boundary layer concepts and the basics of turbulent flows.
b1.	Solve analytically and numerically some complex laminar flow problems in internal and external flow geometries under steady and unsteady conditions.
b2.	Formulate the equation for viscous flow, including laminar and turbulent flows.
b3.	Derive the governing equations in Cartesian coordinates and write governing equations in tensor form.
c1.	Employ the CFD code for solving laminar and turbulent flows.
c2.	Apply the fundamentals of kinematics and conservation laws to fluid flow systems**.**
c3.	Compute the exact solutions of Navier-Stokes equations and calculate the potential flows and stability theory in fluid flows.
D1	Review IT capabilities and other resources to develop scientific research in fluid mechanics.
D2.	Communication effectively in both orally and writing forms for different audiences.
D3.	Undertake lifelong learning of the developments in the field of advanced fluid mechanics.
D4.	Cooperate effectively in team work to reach to a professional context.

- **Course Content**
  - **Theoretical Aspect**

Order	Topic List / Units	Sub -Topics List	Number of Weeks	Contact Hours
15.	**Review of Engineering Mathematics**	- Review of differential equations - Review Partial Differential Equations - Indicial notation 1.6	1	3
16.	**Continuum Fluid Mechanics**	- Kinematics - Conservation Laws - Review of Continuum Thermodynamics - Constitutive Equations	1	3
17.	**Navier- Stoke Equation**	- Exact Solutions - Viscous Flows 4.1	1	3
18.	**Low Reynolds Number Flows**	- Creeping Flows - Lubrication Theory - Squeeze Film - Flow around a Sphere	1	3
19.	**Introduction to Computational Fluid Mechanics**	- Finite Difference and Finite Volume Methods - Introduction to CFD - ANSYS-Fluent Code	1	3
20.	**Asymptotic Methods**	- Perturbation Theory - Singular Perturbation Theory - Matched Asymptotic Expansion **5.6**	2	3
21.	**Midterm Exam**	7.9 All previous topics	1	2
22.	**Boundary Layer Theory**	- Boundary Layer Theory - Self-Similar Solutions - Integral methods - Jets and Wake Flows	3	3
23.	**Stability of Fluid Motion**	- Theory of Small Perturbation - The Orr-Sommerfeld Equation	1	3
24.	**Turbulent Flows**	- Reynolds Equation and Turbulence Stresses Phenomenological Theories	1	3

25.	**Final projects**	Follow up on final projects	1	3
26.	**Final projects**	Presentation of final projects	1	3
27.	**Final Theoretical Exam**	All Previous Topics	1	3
Number of Weeks /and Contact Hours Per Semester			**16**	**48**

• Practical Aspect

Order	Practical / Tutorials topics	Number of Weeks	Contact Hours	Course ILOs
1	▪ **None**			
Number of Weeks /and Contact Hours Per Semester				

• Training/ Tutorials/ Exercises Aspects:

Order	Tutorials/ Exercises	Week Due	Contact Hours
1	▪ **None**		
Number of Weeks /and Contact Hours Per Semester			

• Teaching Strategies:

- Lectures,
- Self-Learning Problems/Studies,
- Case study,
- Individual Projects and Studies,
- Active learning,
- Computer hands-on sessions.
- Independent Study, and
- Presentation

• Assessment Methods of the Course:

- Oral & Writing Exams
- Individual/Group Projects and Studies Reports,
- Presentation,
- Assignments

• Tasks and Assignments:

No	Assignments	Individual /Groups	Mark	Week Due
1	Homework and Assignments.	Individual	10	3^{rd} , 6^{th} , 9^{th} , 12^{th}

2	Mini/Major Project	Group	10	7th , 10th
3	Case study	Group	10	13th
	Total Score		**30**	

• Learning Assessment:

No	Assessment Method	Week Due	Mark	Proportion of Final Assessment %
1	**Tasks and Assignments**	3rd , 6th , 9th , 12th	**30**	20%
2	**Quizzes**	**3rd , 8th , 13th**	**10**	6.7%
3	**Midterm Exam (Theoretical)**	**8th**	**30**	20%
4	**Final Exam (Theoretical)**	**16th**	**80**	53.3%
	Total		**150**	**100%**

• Learning Resources :

1. Required Textbook(s) :

1. William Graebel, 2007, Advanced Fluid Mechanics, 1st Edition, Academic Press.

2. Muralidhar K. and Biswas G., 2015, Advanced Engineering Fluid Mechanics, 3rd Edition, Alpha Science International Ltd.

2. Essential References:

1. F. Moukalled • L. Mangani M. Darwish,2016, The Finite Volume Method in Computational Fluid Dynamics, Springer.
2. H. Schlichting, 1979, Boundary Layer Theory, McGraw Hill
3. H. Tennekes and J.L. Lumley, 1981, A First Course in Turbulence, MIT Press.
4. A. J. Raudkivi , R. A. Callander , 1975, Advanced Fluid Mechanics: An Introduction, John Wiley & Sons.

3.Electronic Materials and Web Sites *etc.*

1. https://webspace.clarkson.edu/projects/fluidflow/public_html/courses/me527/index.html
2. https://sites.clarkson.edu/gahmadi/courses/me527/
3. https://ocw.mit.edu/courses/mechanical-engineering/2-25-advanced-fluid-mechanics-fall-2013/
4. https://www.kth.se/student/kurser/kurs/FSG3134?l=en
5. https://handbook.unimelb.edu.au/2017/subjects/mcen90018
6. https://cust.edu.pk/advanced-fluid-mechanics-ce2523/
7. https://www.edx.org/course/advanced-fluid-mechanics-1
8. https://nptel.ac.in/courses/112/105/112105218/
9. https://www.elsevier.com/books/advanced-fluid-mechanics/graebel/978-0-12-370885-4
10. https://www.udemy.com/course/fundamentals-of-fluid-mechanics-part-2/
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• **الضوابط والسياسات المتبعة في المقرر Course Policies**	
بعد الرجوع للوائح الجامعة يتم كتابة السياسة العامة للمقرر فيما يتعلق بالآتي:	
1	**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.**
2	**الحضور المتأخر Tardy:** **- 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.**
3	**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.**
4	**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.**
5	**الغش Cheating:** **- في حال ثبوت قيام الطالب بالغش في الامتحان النصفي أو النهائي تطبق عليه لائحة شؤون الطلاب.** **- في حال ثبوت قيام الطالب بالغش او النقل في التكليفات والمشاريع يحرم من الدرجة المخصصة للتكليف.**
6	**الانتحال Plagiarism:** **– في حالة وجود شخص ينتحل شخصية طالب لأداء الامتحان نيابة عنه تطبق اللائحة الخاصة بذلك**
7	**سياسات أخرى Other policies:** **- أي سياسات أخرى مثل استخدام الموبايل أو مواعيد تسليم التكليفات ..... الخ**