MODULE DESCRIPTION FORM

نموذج وصف المادة الدراسية

<table>
<tr><th colspan="6">Module Information
معلومات المادة الدراسية</th></tr>
<tr><td>Module Title</td><td colspan="3">Gas Dynamics</td><td colspan="2">Module Delivery</td></tr>
<tr><td>Module Type</td><td colspan="3">Core learning activity</td><td colspan="2" rowspan="4">☒ Theory
☒ Lecture
☐ Lab
☒ Tutorial
☒ Practical
☐ Seminar</td></tr>
<tr><td>Module Code</td><td colspan="3">ATU12054</td></tr>
<tr><td>ECTS Credits</td><td colspan="3">4</td></tr>
<tr><td>SWL (hr/sem)</td><td colspan="3">100</td></tr>
<tr><td>Module Level</td><td></td><td colspan="2">Semester of Delivery</td><td colspan="2"></td></tr>
<tr><td>Administering Department</td><td>ATU12</td><td>College</td><td colspan="3">PMETC</td></tr>
<tr><td>Module Leader</td><td></td><td>e-mail</td><td colspan="3"></td></tr>
<tr><td>Module Leader’s Acad. Title</td><td></td><td colspan="2">Module Leader’s Qualification</td><td colspan="2"></td></tr>
<tr><td>Module Tutor</td><td></td><td>e-mail</td><td colspan="3">E-mail</td></tr>
<tr><td>Peer Reviewer Name</td><td>Name</td><td>e-mail</td><td colspan="3">E-mail</td></tr>
<tr><td>Scientific Committee Approval Date</td><td>01/02/2024</td><td colspan="2">Version Number</td><td colspan="2">1.0</td></tr>
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<tr><th colspan="4">Relation with other Modules
العلاقة مع المواد الدراسية الأخرى</th></tr>
<tr><td>Prerequisite module</td><td>Fundamentals of Thermodynamics, Fluid Mechanics - static</td><td>Semester</td><td></td></tr>
<tr><td>Co-requisites module</td><td>None</td><td>Semester</td><td></td></tr>
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<table>
<tr><th colspan="2">Module Aims, Learning Outcomes and Indicative Contents
أهداف المادة الدراسية ونتائج التعلم والمحتويات الإرشادية</th></tr>
<tr><td>Module Objectives
أهداف المادة الدراسية</td><td>The objectives of studying isentropic compressible fluid flow can be summarized in the following numerical points:
1. Understanding Compressible Flow: The primary objective is to develop a thorough understanding of the behavior and characteristics of compressible fluids. This includes studying the principles and equations that govern the flow of gases and other compressible fluids.
2. Analysis of Isentropic Processes: Students aim to analyze and comprehend the properties and behavior of fluids undergoing isentropic processes. This involves studying the conservation laws of mass, momentum, and energy for isentropic flow and understanding the relationships between pressure, temperature, density, velocity, and other properties.
3. Mach Number Effects: One of the key objectives is to understand the effects of Mach number on compressible flow. Students learn to calculate and analyze Mach numbers, study the variations in flow properties with respect to Mach number, and investigate phenomena such as shock waves and supersonic flow.
4. Nozzle and Diffuser Design: Students focus on designing and analyzing nozzles and diffusers for specific applications. This objective involves understanding the effects of area changes, expansion, and compression processes on the performance of these components. Students learn to optimize nozzle and diffuser designs to achieve desired pressure, velocity, and mass flow rate conditions.
5. Practical Applications: The ultimate objective is to apply the knowledge of isentropic compressible fluid flow in practical engineering applications. This includes designing and analyzing systems such as gas turbines, jet engines, supersonic aircraft, and rocket nozzles. Students develop the skills to optimize these systems for efficiency, performance, and safety.
By achieving these objectives, students of isentropic compressible fluid flow gain the knowledge and skills necessary to analyze and design systems involving compressible fluids. They contribute to advancements in fields such as aerospace engineering, energy systems, and fluid dynamics, ensuring efficient and effective operation of various engineering applications.</td></tr>
<tr><td>Module Learning Outcomes

مخرجات التعلم للمادة الدراسية</td><td>1. Isentropic Relations: Students gain a thorough understanding of the isentropic relations that govern the behavior of compressible fluids. They learn the equations and relationships that describe the changes in properties such as pressure, temperature, density, velocity, and Mach number for isentropic flow.
2. Mach Number Effects: Students explore the impact of Mach number on compressible fluid flow. They study the critical Mach number, which represents the speed at which local flow velocities reach the speed of sound. Understanding the effects of Mach number is crucial for the design and analysis of high-speed systems.</td></tr>
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	3. Flow Velocity and Sonic Conditions: Students learn to calculate and analyze flow velocities and sonic conditions in isentropic flow. They study the variation of velocity and pressure with respect to the speed of sound and investigate phenomena such as choked flow and critical conditions. 4. Nozzle and Diffuser Performance: Isentropic flow analysis enables students to evaluate the performance of nozzles and diffusers. They learn to design and optimize these components to achieve desired pressure, velocity, and mass flow rate conditions, taking into account the effects of area changes and expansion or compression processes. 5. Application in Engineering: The understanding of isentropic compressible fluid flow has practical applications in various engineering fields. Students learn to apply this knowledge to design and analyze systems such as gas turbines, supersonic aircraft, rocket nozzles, and high-speed flows in pipelines. 6. By mastering the outcomes of isentropic compressible fluid flow, students can effectively analyze and optimize the performance of systems involving compressible fluids, ensuring efficient and safe operation in diverse engineering applications.
Indicative Contents المحتويات الإرشادية	Indicative content includes the following. Part A - Introduction to Compressible Flow: • Definition and characteristics of compressible flow • Distinction between compressible and incompressible flow • Importance and applications of compressible flow in engineering Part B - Conservation Laws and Equations: • Conservation of mass, momentum, and energy for compressible flow • Derivation and analysis of the continuity equation, Euler's equation, and the energy equation • Application of the conservation laws to isentropic flow processes Part C - Basic Gas Dynamics: • Ideal gas equation of state and specific gas constants • Thermodynamic properties of gases (temperature, pressure, density) • Specific heats and their variations with temperature Part D - Isentropic Flow Relations: • Derivation and analysis of the isentropic relations for compressible flow • Relationships between properties such as pressure, temperature, density, velocity, and Mach number for isentropic flow • Application of isentropic flow relations to nozzle and diffuser design Part E - Mach Number Effects and Sonic Conditions: • Effects of Mach number on compressible flow • Calculation and analysis of Mach numbers and their significance • Choked flow and critical conditions in compressible flow Part F - Nozzle and Diffuser Performance: • Analysis and design of converging-diverging nozzles for different applications • Determination of critical conditions and optimum expansion ratios • Evaluation of nozzle efficiency and performance parameters

	By covering these indicative contents, students gain a comprehensive understanding of isentropic compressible fluid flow and its application in various engineering disciplines. They develop the necessary skills to analyze, design, and optimize systems involving compressible fluids, ensuring efficient and effective operation in practical engineering scenarios.

Learning and Teaching Strategies استراتيجيات التعلم والتعليم	
Strategies	To encourage students' participation, refine their critical thinking skills, and make the compressible fluid flow module engaging, the following main strategies can be adopted: 1. Active Learning: Incorporate active learning strategies in classes and tutorials to promote student engagement. This can include group discussions, problem-solving exercises, case studies, and hands-on activities. Encourage students to actively participate, ask questions, and provide solutions. 2. Interactive Demonstrations: Conduct interactive demonstrations to visually illustrate concepts and principles of compressible fluid flow. Use visual aids, simulations, and interactive software to demonstrate real-world examples and phenomena. This can help students develop a deeper understanding of the subject and spark their curiosity. 3. Practical Experiments: Include simple experiments that allow students to observe and measure compressible fluid flow phenomena. These experiments can involve pressure measurements, flow visualization, or velocity measurements. By actively participating in these experiments, students can gain practical insights and develop critical thinking skills. 4. Problem-Based Learning: Provide students with real-world problems related to compressible fluid flow. Encourage them to apply their knowledge and critical thinking skills to solve these problems. Foster a collaborative learning environment where students can discuss and analyze different approaches to problem-solving. 5. Case Studies: Present case studies that showcase the application of compressible fluid flow principles in practical engineering scenarios. Discuss the challenges faced, the decision-making process, and the outcomes. Encourage students to analyze and evaluate these case studies, applying critical thinking skills to propose alternative solutions or improvements. 6. Research and Analysis: Assign research projects or assignments that require students to explore current advancements or challenges in compressible fluid flow. Encourage them to analyze research papers, critically evaluate different methodologies, and propose innovative ideas. This will enhance their critical thinking abilities and expand their understanding of the subject. 7. Encourage Reflection and Discussion: Provide opportunities for students to reflect on their learning experiences and engage in class discussions. Encourage them to share their perspectives, ask questions, and provide

	constructive feedback. This promotes critical thinking, active participation, and a deeper understanding of the subject matter. By implementing these strategies, students' participation in the compressible fluid flow module can be enhanced, while simultaneously refining and expanding their critical thinking skills. The combination of classes, interactive tutorials, practical experiments, and engaging activities will create an enriching learning environment that fosters active engagement and a deeper understanding of the subject.

Student Workload (SWL) الحمل الدراسي للطالب محسوب لـ ١٥ اسبوعا			
Structured SWL (h/sem) الحمل الدراسي المنتظم للطالب خلال الفصل	53	**Structured SWL (h/w)** الحمل الدراسي المنتظم للطالب أسبوعيا	4
Unstructured SWL (h/sem) الحمل الدراسي غير المنتظم للطالب خلال الفصل	47	**Unstructured SWL (h/w)** الحمل الدراسي غير المنتظم للطالب أسبوعيا	5
Total SWL (h/sem) الحمل الدراسي الكلي للطالب خلال الفصل	**100**		

Module Evaluation تقييم المادة الدراسية					
		Time/Number	**Weight (Marks)**	**Week Due**	**Relevant Learning Outcome**
Formative assessment	**Quizzes**	2	10% (10)	5 and 10	LO #1 - #6 and #7 - #12
	Assignments	2	10% (10)	2 and 12	LO #3, #4 and #6, #7
	Projects / Lab.	1	10% (10)	Continuous	All
	Report	1	10% (10)	13	LO #5, #8 and #10
Summative assessment	**Midterm Exam**	2hr	10% (10)	7	LO #1 - #7
	Final Exam	3hr	50% (50)	16	All
Total assessment			100% (100 Marks)		

Delivery Plan (Weekly Syllabus) المنهاج الاسبوعي النظري	
	Material Covered
Week 1	Basic Definitions and Concepts of Fluid Dynamics.
Week 2	Fluid Flow Concepts and Basic Equations.

Week 3	Introduction to Compressible Flow.
Week 4	Basic Equation of Compressible Flow.
Week 5	Conservation Laws.
Week 6	Thermodynamics Laws and Relations.
Week 7	Wave Formulation Propagation. **Midterm Exam**
Week 8	Isentropic Flow of a Perfect Gas in Varying Area Duct.
Week 9	Equations of Motion.
Week 10	Stagnation Concept and Relations.
Week 11	Subsonic and Supersonic Flow through a Varying Area Channels.
Week 12	Isentropic Tables.
Week 13	Isentropic Flow in Converging Nozzles.
Week 14	Isentropic Flow in Converging–Diverging Nozzles.
Week 15	Thrust of Rocket Engine.
Week 16	**Preparatory week before the final Exam**

Delivery Plan (Weekly Lab. Syllabus) المنهاج الاسبوعي للمختبر	
	Material Covered
Week 1	Introduction to Lab Safety and Equipment Familiarization • Introduction to lab safety protocols, procedures, and guidelines • Familiarization with the lab equipment and instruments used in compressible fluid flow experiments • Overview of the lab experiment objectives and expected outcomes
Week 2	Flow Visualization Techniques • Introduction to flow visualization techniques in compressible fluid flow • Demonstration and hands-on practice with techniques such as smoke flow visualization, Schlieren imaging, or oil flow visualization • Analyzing and interpreting flow patterns and phenomena observed in the experiments
Week 3	Measurement of Pressure and Velocity • Introduction to pressure measurement techniques in compressible fluid flow • Hands-on practice with pressure transducers, manometers, or pressure sensors for measuring pressure distributions in different flow scenarios • Introduction to velocity measurement techniques, such as Pitot-static tubes or hot-wire anemometry, for measuring flow velocities
Week 4	Nozzle and Diffuser Performance Analysis • Analysis of nozzle and diffuser performance using experimental setups • Measuring and evaluating key performance parameters such as mass flow rate, pressure recovery, and efficiency

	• Comparison and interpretation of experimental results with theoretical predictions and design considerations
Week 5	Supersonic Flow Analysis • Introduction to supersonic flow phenomena and its measurement techniques • Setting up experiments to study supersonic flow using converging-diverging nozzles or supersonic wind tunnels • Measurement and analysis of key parameters, such as Mach number, total pressure, and static pressure distributions in supersonic flows
Week 6	Case Studies and Research Projects • Discussion of real-world case studies related to compressible fluid flow • Group projects or individual research assignments involving in-depth analysis of specific topics within compressible fluid flow • Presentation of findings and recommendations based on research or case study analysis

Learning and Teaching Resources مصادر التعلم والتدريس		
	Text	**Available in the Library?**
Required Texts	Mair, W. A. "The Dynamics and Thermodynamics of Compressible Fluid Flow. Vol. II. Ascher H. Shapiro. Ronald Press, Nw York, 1954.	Yes
Recommended Texts	Compressible Fluid Flow Michel Saad, Prentice-Hall, Inc., Englewood Cliffs, New Jersy, 1985	No
Websites		

Grading Scheme مخطط الدرجات				
Group	**Grade**	التقدير	**Marks %**	**Definition**
Success Group (50 - 100)	**A -** Excellent	امتياز	90 - 100	Outstanding Performance
	B - Very Good	جيد جدا	80 - 89	Above average with some errors
	C - Good	جيد	70 - 79	Sound work with notable errors
	D - Satisfactory	متوسط	60 - 69	Fair but with major shortcomings
	E - Sufficient	مقبول	50 - 59	Work meets minimum criteria
Fail Group (0 – 49)	**FX –** Fail	راسب (قيد المعالجة)	(45-49)	More work required but credit awarded
	F – Fail	راسب	(0-44)	Considerable amount of work required

Note: Marks Decimal places above or below 0.5 will be rounded to the higher or lower full mark (for example a mark of 54.5 will be rounded to 55, whereas a mark of 54.4 will be rounded to 54. The University has a policy NOT to condone "near-pass fails" so the only adjustment to marks awarded by the original marker(s) will be the automatic rounding outlined above.