	Ministry of Higher Education and Scientific Research - Iraq Warith Al-Anbiyaa University College of Engineering Department of Aircraft Engineering	

MODULE DESCRIPTOR FORM
نموذج وصف المادة الدراسية

Module Information
معلومات المادة الدراسية

Module Title	Gas Dynamics ديناميك غازات	**Module Delivery**	
Module Type	CORE	**Theory** **Tutorial**	
Module Code	AIEN363 (طائرات)		
ECTS Credits	5		
SWL (hr/sem)	125		

Module Level	3	**Semester of Delivery**	6
Administering Department	ME	**College**	ME
Module Leader	Dr.	**e-mail**	
Module Leader's Acad. Title	Dr.	**Module Leader's Qualification**	Ph.D.
Module Tutor	None	**e-mail**	None
Peer Reviewer Name	Dr.	**e-mail**	
Review Committee Approval	01/12/2025	**Version Number**	2025

Relation With Other Modules
العلاقة مع المواد الدراسية الأخرى

Prerequisite module	AIEN363	**Semester**	3
Co-requisites module	None	**Semester**	

Module Aims, Learning Outcomes and Indicative Contents أهداف المادة الدراسية ونتائج التعلم والمحتويات الإرشادية	
Module Aims أهداف المادة الدراسية	1. Establish a strong foundation in the core principles of gas dynamics, including compressibility effects, conservation laws, and ideal gas law. 2. Develop an understanding of different flow regimes in compressible fluids (subsonic, sonic, supersonic, and hypersonic) and their governing equations. 3. Develop an understanding of isentropic flow in a variable area ducts 4. Gain expertise in analyzing shock waves, their formation, properties, and impact on gas flow parameters (pressure, temperature, and velocity). 5. Understands the effect of oblique and expansion waves on the flow. 6. Develop an understanding of the effect of friction and heat addition/rejection on a compressible gas.
Module Learning Outcomes مخرجات التعلم للمادة الدراسية	1. Explain the fundamental concepts of gas dynamics, including compressibility effects, conservation laws, and the ideal gas law. 2. Distinguish between different flow regimes in compressible fluids (subsonic, sonic, supersonic, and hypersonic) and their characteristics. 3. Solve isentropic flow in a variable area duct such as converge and converge diverge nozzles. 4. Learn to calculate the fluid properties of a compressible gas after different shock types, such as (normal, oblique, and expansion waves) 5. Learn to evaluate the effect of shock waves occurrence on different applications such as supersonic wind, supersonic diffuser, and supersonic airfoils. 6. Evaluate the effect of friction on the flow of a compressible gas in a constant area duct. 7. Develop the ability to investigate the effect of heat on the flow of a compressible gas in a constant area duct analytically.

Indicative Contents المحتويات الإرشادية	**Indicative contents include the following:** **Classification of fluid flow**, Definition of compressible flow, Conservation of mass and momentum, First and second laws of Thermodynamic, Equation of state, Wave propagation, Speed of sound, Mach number, Form of pressure wave propagation, classification of compressible flow, Mach line and angle. Governing equations of Isentropic flow in a varying area duct, Stagnation concept, Isentropic relations, Variation of gas properties with varying area duct, Nozzle and Diffuser, Reference concept, Isentropic flow tables, Effect of upstream and downstream pressures in convergent nozzle, Effect of upstream and downstream. Pressures in convergent divergent nozzle, Chocking condition and mass flow rate, Performance of real nozzles, Thrust unit of Rocket engine.[16hrs] **Normal Shock:** Formation of normal shock waves, Governing equations, Gas properties variation across a normal shock, Stationary normal shockwave, Formation of normal shock waves, Governing equations, Gas properties variation across a normal shock, Normal shock tables. Stationary normal shock wave in convergent-divergent nozzle: Effect of pressure ratio on shock wave location. **Converging-diverging nozzle operation modes:** Determining the location of a normal shock wave in a C-D nozzle. **Moving normal shock wave:** Stationary and moving coordinates, Reflected normal shock, Explosive and pressure wave calculation.[12hrs] **Convergent-divergent supersonic diffusers:** Converging-Diverging supersonic diffuser, Design and off-Design diffuser operation mode, Supersonic wind tunnel, Design and off-Design operation modes, Supersonic wind tunnels types. [8hrs] **2D supersonic flow, Oblique Shock Wave:** Governing equations, Surface deflection, wave angle and Mach number relations, Detached shock wave, Oblique shock reflections, Conical shock waves, Supersonic diffuser types, Supersonic spike diffuser. **Expansion Waves, Prandtl-Meyer flow:** Governing equations, Maximum turning angle for Prandtl Meyer flow, Gradual expansions, Prandtl Meyer flow in smooth compression, Reflections of Prandtl Meyer fan. [8hrs] **Flow in constant area duct with friction:** Effect of friction on flow properties, Fanno line, **Working relations for Fanno flow:** Governing equations for adiabatic flow, **Performance of long ducts at variable pressure ratios:** Choking due to friction. Performance of adiabatic duct of constant area with isentropic nozzles, Performance of adiabatic duct at various pressure ratios.[10hrs] **Flow in ducts with heating or cooling**: Governing equations, Isothermal flow in long ducts, Governing equations. [8hrs]

Learning and Teaching Strategies
استراتيجيات التعلم والتعليم

Strategies	• Deliver well-structured lectures that explain the core concepts of gas dynamics, including compressibility effects, conservation laws, and the ideal gas law. Utilize clear visuals like diagrams, animations, and real-world examples to enhance understanding. • Incorporate active learning activities within lectures. This could involve short quizzes, clicker questions, group discussions, or problem-solving exercises to solidify understanding and encourage student participation. • Provide students with a variety of problem-solving exercises, ranging from introductory to more challenging. This caters to different learning styles and allows students to build confidence as they progress. • Whenever possible, connect the theoretical concepts to real-world engineering applications of gas dynamics. • Incorporate regular quizzes and homework assignments to assess student understanding and identify areas needing improvement. Provide timely and constructive feedback to guide student learning. • Utilize well-designed midterm and final exams that test both theoretical knowledge and problem-solving abilities in gas dynamics.

Student Workload (SWL)
الحمل الدراسي للطالب

Structured SWL (h/sem) الحمل الدراسي المنتظم للطالب خلال الفصل	78	**Structured SWL (h/w)** الحمل الدراسي المنتظم للطالب أسبوعيا	5.2
Unstructured SWL (h/sem) الحمل الدراسي غير المنتظم للطالب خلال الفصل	47	**Unstructured SWL (h/w)** الحمل الدراسي غير المنتظم للطالب أسبوعيا	3.13
Total SWL (h/sem) الحمل الدراسي الكلي للطالب خلال الفصل	125		

Module Evaluation
تقييم المادة الدراسية

		Time/ Number	Weight (Marks)	Week Due	Relevant Learning Outcome
Formative assessment	Quizzes	4	20% (20)	3,5,9,11	All
	Assignments	2	10% (10)	2, 12	All
	Projects / Lab.	Lab.4	10% (10)	Continuous	
	Report	-	-	-	-
Summative assessment	Midterm Exam	2 hrs.	10% (10)	7	All
	Final Exam	3 hrs.	50% (50)	16	All
Total assessment			100% (100 Marks)		

Delivery Plan (Weekly Syllabus)
المنهاج الاسبوعي النظري

	Material Covered
Week 1	Introduction to compressible flow
Week 2	Wave propagation in compressible media
Week 3	Isentropic flow in a varying area duct
Week 4	Isentropic flow in a varying area duct
Week 5	Stationary normal shockwave
Week 6	Stationary normal shock wave in convergent-divergent nozzle
Week 7	Convergent-divergent supersonic diffusers
Week 8	Moving normal shock wave
Week 9	Steady two dimensional supersonic flow, Oblique Shock Wave
Week 10	Expansion Waves, Prandtl-Meyer flow
Week 11	Flow in constant area duct with friction
Week 12	Working relations for Fanno flow
Week 13	Performance of long ducts at variable pressure ratios
Week 14	Flow in ducts with heating or cooling
Week 15	Isothermal flow in long ducts
Week 16	Final Exam

Delivery Plan (Weekly Lab. Syllabus) المنهاج الاسبوعي للمختبر	
	Material Covered
Week 1	Exp. 1: Blow-down of Pressurized Tank
Week 2	Exp. 2: Subsonic Compressible Flow in Variable Area Duct
Week 3	Exp. 3: Supersonic Compressible Flow in Variable Area Duct
Week 4	Exp. 4: Shockwave photography using Schlieren Technique
Week 5	Exp. 5:
Week 6	Exp. 6:
Week 7	Exp. 7:

Learning and Teaching Resources مصادر التعلم والتدريس		
	Text	**Available in the Library?**
Required Texts	1. James E. John & P. Theo G. Keith, " Gas Dynamics", 3rd Edition, Pearson Prentice Hall, 2006. 2. Robert D. Zucker & Oscar Biblarz,, "Fundamentals of Gas Dynamics", 2nd Edition, John Wiley & Sons, 2002.	Yes
Recommended Texts	منذر اسماعيل الدروبي، مبادئ ديناميك الغازات، بغداد، وزارة التعليم العالي والبحث العلمي،1980.	No
Websites		

APPENDIX:

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	مقبول بقرار	(45-49)	More work required but credit awarded
	F – Fail	راسب	(0-44)	Considerable amount of work required

Note:

NB 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.