MODULE DESCRIPTION FORM

نموذج وصف المادة الدراسية

Module Information معلومات المادة الدراسية					
Module Title	Numerical Analysis			**Module Delivery**	
Module Type	Basic			☒ **Theory** ☐ **Lecture** ☐ **Lab** ☒ **Tutorial** ☐ **Practical** ☐ **Seminar**	
Module Code	ATU11607				
ECTS Credits	4				
SWL (hr/sem)	100				
Module Level	UGIII		**Semester of Delivery**	2	
Administering Department			**College**	NETC	
Module Leader			**e-mail**		
Module Leader's Acad. Title			**Module Leader's Qualification**		
Module Tutor	Name (if available)		**e-mail**		
Peer Reviewer Name	Nasir Hussein Selman		**e-mail**	Coj.nas@atu.edu.iq	
Scientific Committee Approval Date	01/05/2025		**Version Number**	1.0	

Relation with other Modules العلاقة مع المواد الدراسية الأخرى			
Prerequisite module	None	**Semester**	
Co-requisites module	None	**Semester**	

Module Aims, Learning Outcomes and Indicative Contents أهداف المادة الدراسية ونتائج التعلم والمحتويات الإرشادية	
Module Objectives أهداف المادة الدراسية	1. **Linear Algebra Techniques**: Master methods for solving systems of linear equations using Gaussian elimination, Gauss-Jordan elimination, and matrix inversion. Understand eigenvalues and eigenvectors. 2. **Numerical Methods for Nonlinear Equations and Integration**: Apply iterative methods (Jacobi's and Gauss-Seidel), interpolation techniques, and various methods for solving nonlinear equations (fixed point, bisection, false position, secant, and Newton-Raphson). Implement numerical integration methods, including the trapezoidal and Simpson's methods. 3. **Numerical Solutions for Ordinary Differential Equations (ODEs)**: Solve initial value problems for first and second-order ODEs using methods such as Euler, modified Euler, Runge-Kutta, predictor-corrector, finite difference, and Runge-Kutta-Nystrom methods.
Module Learning Outcomes مخرجات التعلم للمادة الدراسية	1- **Problem Solving in Linear Algebra**: Students will be able to effectively solve systems of linear equations using various techniques, including Gaussian elimination and Gauss-Jordan elimination, and compute matrix inverses. 2- **Application of Numerical Methods**: Students will demonstrate proficiency in applying iterative methods (Jacobi's and Gauss-Seidel) and interpolation techniques to solve nonlinear equations and estimate function values. 3- **Numerical Integration and ODE Solutions**: Students will be capable of utilizing numerical integration methods (trapezoidal and Simpson's) and solving ordinary differential equations (first and second order) using techniques such as Euler, Runge-Kutta, and predictor-corrector methods, analyzing their accuracy and stability.

Indicative Contents
المحتويات الإرشادية
	1- **Linear Algebra**
	• Introduction to systems of linear equations
	• Gaussian elimination and Gauss-Jordan elimination
	• Matrix inversion techniques
	• Eigenvalues and eigenvectors
	• Properties of symmetric, skew-symmetric, and orthogonal matrices
	2- **Numerical Methods in Linear Algebra**
	• Iterative methods for solving linear systems
	  o Jacobi's method
	  o Gauss-Seidel method
	• Interpolation techniques
	  o Lagrange interpolation
	  o Newton's divided difference
	3- Numerical Solutions of Nonlinear Equations
	• Fixed point iteration
	• Bisection method
	• False position (regula falsi) method
	• Secant method
	• Newton-Raphson method
	4- Numerical Integration

	• Trapezoidal rule
	• Simpson's rule
	• Error analysis in numerical integration
	5- Numerical Solutions of Ordinary Differential Equations (ODEs)
	• Initial value problems for first-order ODEs
	  o Taylor series method
	  o Euler and modified Euler methods
	  o Runge-Kutta methods
	  o Predictor-corrector methods
	• Initial value problems for second-order ODEs
	  o Finite difference methods
	  o Runge-Kutta-Nystrom method
	6- Applications and Case Studies
	• Real-world applications of linear algebra and numerical methods
	• Case studies demonstrate the use of numerical techniques in engineering, physics, and data science

Learning and Teaching Strategies استراتيجيات التعلم والتعليم	
Strategies	1- **Lectures and Interactive Discussions**: Deliver foundational concepts through lectures, supplemented by discussions to engage students and clarify complex topics. 2- **Hands-On Practice and Computer Simulations**: Provide problem sets for practical application and utilize software tools (e.g., MATLAB, Python) for implementing algorithms and visualizing results. 3- **Collaborative Projects and Case Studies**: Encourage group projects on real-world applications of numerical methods and integrate case studies to enhance relevance. 4- **Quizzes and Support**: Implement regular quizzes for feedback and offer office hours for additional support, allowing students to clarify doubts. 5- **Peer Teaching**: Encourage students to present topics to their peers, reinforcing their understanding and developing communication skills

Student Workload (SWL) الحمل الدراسي للطالب محسوب لـ ١٥ اسبوعا			
Structured SWL (h/sem) الحمل الدراسي المنتظم للطالب خلال الفصل	48	**Structured SWL (h/w)** الحمل الدراسي المنتظم للطالب أسبوعيا	
Unstructured SWL (h/sem) الحمل الدراسي غير المنتظم للطالب خلال الفصل	52	**Unstructured SWL (h/w)** الحمل الدراسي غير المنتظم للطالب أسبوعيا	
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, #2 and #10, #11
	Assignments	2	10% (10)	2 and 12	LO #3, #4 and #6, #7
	Projects /Siminar	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	linear algebra: - solution of system linear equations; Gauss and Gauss-Jordon method
Week 2	Matrix inversion by Gauss-Jordan method.
Week 3	Eigenvalue and Eigen vectors
Week 4	Numerical method in linear algebra: - solution of system linear equations; by iteration (Jacobi's and Gauss-Siedel) method;
Week 5	Interpolation.
Week 6	Solution of nonlinear equation: -fixed point, bisection method
Week 7	false position method; secant method
Week 8	Newton-Raphson method
Week 9	Numerical integration: - trapezoidal method; Simpson method
Week 10	Mid -Term Exam
Week 11	Numerical solution of ordinary differential equations (ODE):- initial value problem for first order ODE
Week 12	Tayler's Series least square
Week 13	Euler and modified Euler
Week 14	Runge-Kutta; predictor corrector method; initial value problem for 2'nd order ODE
Week 15	finite difference; Runge-Kutta Nystrom method.
Week 16	Final Exam

Learning and Teaching Resources مصادر التعلم والتدريس		
	Text	**Available in the Library?**
Required Texts	Advanced Engineering Mathematics" by Erwin Kreyszig	Yes
Recommended Texts	"Introduction to Linear Algebra" by Gilbert Strang	No
Websites	https://www.lboro.ac.uk/departments/mlsc/student-resources/helm-workbooks/	

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.