

MODULE DESCRIPTION FORM

نموذج وصف المادة الدراسية

Module Information			
معلومات المادة الدراسية			
Module Title	Advanced Mathematics II		Module Delivery
Module Type	Basic Learning Activities		☒ Theory ☐ Lecture ☐ Lab ☒ Tutorial ☐ Practical ☐ Seminar
Module Code	ADMA322		
ECTS Credits	5		
SWL (hr/sem)	125		
Module Level	2	Semester of Delivery	1
Administering Department	Type Dept. Code	College	Type College Code
Module Leader	Dr. Omar Janeh		e-mail: 120049@uotechnology.edu.iq
Module Leader's Acad. Title	Lecturer	Module Leader's Qualification	Ph.D.
Module Tutor	None		e-mail: None
Peer Reviewer Name	1. Dr. Riadh Jabar 2. Azhar Malik		e-mail: Dhari.a.mahmood@uotechnology.edu.iq 120016@uotechnology.edu.iq
Scientific Committee Approval Date	1 / 4 /2026	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. Develop a strong foundation in advanced algebraic structures and their applications. 2. Explore calculus techniques for solving real-world and theoretical problems. 3. Introduce concepts of linear algebra, including vector spaces and matrices. 4. Analyze complex numbers and their role in mathematical modeling. 5. Foster critical thinking and problem-solving skills in abstract mathematics.
Module Learning Outcomes مخرجات التعلم للمادة الدراسية	1. Understand and apply set theory and logical reasoning to develop rigorous mathematical proofs and problem-solving frameworks. 2. Analyze and classify functions, including polynomial, trigonometric, exponential, and hyperbolic functions, for their properties and applications. 3. Evaluate infinite sequences and series, determining convergence using advanced mathematical tests such as ratio, root, and integral tests. 4. Master concepts of limits and continuity, enabling precise analysis of function behavior and application in calculus. 5. Solve differentiation problems, including higher-order and partial derivatives, with applications in optimization and engineering systems. 6. Apply techniques of multivariable calculus, such as gradient, divergence, and curl, to solve problems in vector fields. 7. Formulate and solve optimization problems using methods like Lagrange multipliers and constrained optimization techniques. 8. Compute integrals using advanced techniques, including substitution, integration by parts, and special functions. 9. Evaluate multiple integrals, including double and triple integrals, for solving problems related to volume, mass, and center of gravity. 10. Understand the structure of vector spaces and apply concepts of linear transformations and orthogonality in various domains. 11. Solve systems of linear equations using matrix operations, Gaussian elimination, and LU decomposition. 12. Analyze eigenvalues and eigenvectors to study linear transformations and stability in dynamical systems. 13. Apply complex number theory, including polar forms, Euler's formula, and complex functions, to solve engineering and physics problems. 14. Derive and solve ordinary differential equations (ODEs) using methods such as separation of variables, variation of parameters, and Laplace transforms. 15. Solve partial differential equations (PDEs) using separation of variables, Fourier series, and boundary value problem techniques to address real-world applications.
Indicative Contents المحتويات الإرشادية	Module 1: Foundations of Advanced Mathematics (20 hours) 1. Set theory, logic, and mathematical proofs. 2. Functions: types, properties, and transformations. 3. Sequences and series: convergence, divergence, and tests.

	Module 2: Calculus of Single and Multivariable Functions (25 hours) 1. Limits and continuity of functions. 2. Differentiation techniques: chain rule, implicit, and higher-order derivatives. 3. Applications of differentiation: optimization and curve sketching. 4. Introduction to partial derivatives and their applications.
	Module 3: Integral Calculus and Applications (20 hours) 1. Definite and indefinite integrals: methods of integration. 2. Applications of integrals: areas, volumes, and physical applications. 3. Multiple integrals: double and triple integrals in Cartesian coordinates.
	Module 4: Linear Algebra and Matrix Theory (20 hours) 1. Vectors and vector spaces: linear independence, bases, and dimension. 2. Matrix operations: addition, multiplication, and inverses. 3. Solving systems of linear equations: Gaussian elimination and LU decomposition. 4. Eigenvalues and eigenvectors: diagonalization and applications.
	Module 5: Differential Equations (20 hours) 1. First-order differential equations: separable, exact, and linear forms. 2. Higher-order ODEs: homogeneous and non-homogeneous equations. 3. Applications of ODEs in modeling physical systems.
	Module 6: Complex Numbers and Fourier Series (20 hours) 1. Complex numbers: algebra, polar form, and Euler's formula. 2. Complex functions and residues. 3. Fourier series and applications in solving boundary value problems.
	Self-Study and Revision (20 hours) 1. Problem-solving sessions, assignments, and self-paced learning. 2. Preparation for assessments and project-based tasks.

Learning and Teaching Strategies استراتيجيات التعلم والتعليم	
Strategies	1. Lectures: Instructors will deliver in-class lectures to introduce and explain key networking concepts, architectures, and protocols. These presentations will cover theoretical foundations and practical applications. 2. Interactive Discussions: Students will be encouraged to participate in

	discussions that foster critical thinking and problem-solving skills. These discussions will revolve around case studies, hypothetical scenarios, and current events in networking. 3. Hands-on Laboratory Work: Practical lab sessions will allow students to apply theoretical knowledge by working with networking hardware and simulation software. This includes setting up networks, configuring routers and switches, and analyzing network traffic with tools like Wireshark and Cisco Packet tracer. 4. Group Projects: Students will collaborate on projects that involve designing and implementing network solutions for simulated environments. This promotes teamwork and the practical application of learned concepts, including network planning, security measures, and troubleshooting. 5. Simulations and Virtual Labs: Utilizing advanced simulation tools and virtual lab environments to provide students with hands-on experience, especially when physical resources or access to actual networking equipment is limited. 6. Use of Visuals and Multimedia: Integration of visual aids such as diagrams, flowcharts, and multimedia content to enhance understanding of complex network structures and data flow mechanisms. 7. Assessment and Feedback: Regular assessments through quizzes, tests, and exams to gauge students' understanding and mastery of course content. Feedback will be provided systematically to guide students' learning processes and adjustments. 8. Practice and Revision Sessions: Dedicated sessions for practice and revision will be available to reinforce learning, address students' questions, and prepare them adequately for assessments.
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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	3
Unstructured SWL (h/sem) الحمل الدراسي غير المنتظم للطالب خلال الفصل	77	Unstructured SWL (h/w) الحمل الدراسي غير المنتظم للطالب أسبوعيا	3
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	2	10% (10)	5 and 10	LO #1- #5 and #6 - #11
	Assignments	2	10% (10)	3 and 12	LO #2 and #5, #7, #11
	Projects / Lab.	1	10% (10)	Continuous	All
	Report	1	10% (10)	13	LO #5 - #12
Summative assessment	Midterm Exam	2hr	10% (10)	8	LO #1 - #10
	Final Exam	3hr	50% (50)	16	All
Total assessment			100% (100 Marks)		

Delivery Plan (Weekly Syllabus)	
المنهاج الاسبوعي النظري	
	Material Covered
Week 1	Introduction to Complex Variables - Functions of complex variables: Polynomial, rational, exponential, trigonometric, logarithmic. - Applications: Signal processing, wave equations.
Week 2	Complex Derivatives and Cauchy-Riemann Equations - Complex derivatives and Cauchy-Riemann equations. - Applications: Fluid flow in complex domains, thermodynamics.
Week 3	Complex Integration - Techniques for complex integration and its applications. - Applications: Computing electric fields in engineering.
Week 4	Simply and Multiply Connected Regions

	1. Concepts of simply and multiply connected regions. 2. Applications: Path optimization, network analysis.
Week 5	Cauchy Integral Theorem 1. Cauchy integral theorem and its implications. 2. Applications: Evaluation of definite integrals in engineering.
Week 6	Residue Theorem and Calculation of Residues 1. Solving real integrals using residue theory. 2. Applications: Signal processing, dynamic system modeling.
Week 7	Introduction to Numerical Analysis 1. Understanding numerical errors, isolation of roots. 2. Applications: Precision engineering, computational methods.
Week 8	Root-Finding Methods (Bisection, Newton-Raphson) 1. Root-finding methods like fixed-point iteration, Bisection, Newton-Raphson. 2. Applications: Algorithm design, iterative problem-solving.
Week 9	Gauss-Seidel Iteration for Linear Systems 1. Solving systems of linear equations using Gauss-Seidel iteration. 2. Applications: Network optimization, structural analysis.
Week 10	Curve Fitting and Least Squares Method 1. Curve fitting techniques including least squares and power fit methods. 2. Applications: Data fitting in machine learning and predictive models.
Week 11	Data Linearization and Polynomial Interpolation 1. Linearization of data and interpolation techniques. 2. Applications: Image resizing, simulation modeling.
Week 12	Introduction to Probability and Statistics 1. Random variables, probability distributions, and expected values. 2. Applications: Risk analysis, machine learning preprocessing.
Week 13	Bayesian Statistics and Inference 1. Bayesian statistics for decision-making and prediction.

	2. Applications: AI decision systems, robotics.
Week 14	Statistical Methods for Data Fitting and Regression 1. Regression analysis and data fitting techniques. 2. Applications: Predictive analytics, financial engineering.
Week 15	Advanced Statistical Methods 1. Advanced concepts like maximum likelihood estimation and Markov Chains. 2. Applications: Reinforcement learning, AI model optimization.
Delivery Plan (Weekly Tutorials Syllabus) المنهاج الاسبوعي للدروس التعليمية	
	Material Covered
Week 1	Tutorial 1: Solve basic problems with complex numbers in signal processing.
Week 2	Tutorial 2: Apply to fluid flow problems and thermodynamic equations.
Week 3	Tutorial 3: Solve engineering problems involving path integrals.
Week 4	Tutorial 4: Explore real-world network optimization examples.
Week 5	Tutorial 5: Evaluate definite integrals in real-world physics problems.
Week 6	Tutorial 6: Apply residue theorem to signal and system analysis.
Week 7	Tutorial 7: Practical activities on root-finding in engineering problems.
Week 8	Tutorial 8: Implement algorithms for root-finding in Python/Matlab.
Week 9	Tutorial 9: Solve engineering equations using Gauss-Seidel in code.
Week 10	Tutorial 10: Use curve-fitting methods for predictive analytics.
Week 11	Tutorial 11: Apply interpolation in machine learning and simulation data.
Week 12	Tutorial 12: Solve real-world engineering problems with probability.
Week 13	Tutorial 13: Apply Bayesian methods in AI and robotics problems.
Week 14	Tutorial 14: Implement regression models for predictive analysis.
Week 15	Tutorial 15: Explore reinforcement learning and AI model optimizations

Learning and Teaching Resources مصادر التعلم والتدريس		
	Text	Available in the Library?
Required Texts	1. Erwin Kreyszig - Advanced Engineering Mathematics, 10th Edition 2. C. Ray Wylie & Louis C. Barrett - Advanced Engineering Mathematics 3. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, & Keying E. Ye - Probability and Statistics for Engineers and Scientists, 9th Edition	Yes
Recommended Texts	1. Gilbert Strang - Introduction to Linear Algebra, 5th Edition 2. Steven C. Chapra & Raymond P. Canale - Numerical Methods for Engineers, 7th Edition 3. John H. Mathews & Kurtis D. Fink - Numerical Methods Using MATLAB, 4th Edition 4. Michael D. Greenberg - Advanced Engineering Mathematics 5. Thomas L. Harman, James Dabney, & Norman Richert - Advanced Engineering Mathematics with MATLAB 6. Andrew Gelman et al. - Bayesian Data Analysis, 3rd Edition	Yes
Websites	1. MIT OpenCourseWare: Courses such as Mathematics for Computer Science and Advanced Calculus. 2. Khan Academy: Tutorials on Laplace transforms, vector calculus, and numerical methods. 3. YouTube Channels: 3Blue1Brown: Visual explanations of calculus, linear algebra, and differential equations. 4. MIT OpenCourseWare: Lecture videos on advanced mathematics and numerical methods. 5. Wolfram MathWorld: A comprehensive online resource for mathematical concepts and applications. 6. MATLAB Documentation: Official MATLAB tutorials and examples for numerical analysis and engineering simulations.	

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.				