جامعة الزيتونة الأردنية

Al-Zaytoonah University of Jordan

Course Syllabus

According to JORDAN National Qualification Framework (JNQF)

Course Name: Numerical Analysis (2)

Course Number: 0101377

General Course Information:

Course Title	Numerical Analysis (2)
Course Number	0101377
Credit Hours	3 credit hours
Education Type	Blended learning
Prerequisites/Co-requisites	Numerical Analysis 1
Academic Program	Bachelor Program
Program Code	101
Faculty	Faculty of Science and IT
Department	Mathematics
Level of Course	3
Academic Year /Semester	2023/2024 1st Semester
Awarded Qualification	Bachelor
Other Department(s) Involved in Teaching the Course	-
Language of Instruction	English
Date of Production	2021-2022
Date of Revision	16-10-2023

Course Coordinator:

Coordinator's Name	
Office No.	
Office Phone Extension Number	
Office Hours	
E-mail	

Other Instructors:

Instructor Name	
Office No.	
Office Phone Extension Number	
Office Hours	
Email	

Course Description *(English/Arabic)*:

English	Introducing the students to more numerical methods as well as teaching how to do some error analysis. These methods include finite difference methods for numerical differentiation the trapezoidal rule, Simpson's rule and Gaussian quadrature for numerical integration and Euler's, Taylor series and Runge-Kutta formulas for solving differential equations.
Arabic	تعريف الطلاب بمزيد من الأساليب العددية بالإضافة إلى تعليمهم كيفية القيام ببعض تحليل الأخطاء. تتضمن هذه الطرق طرق الفروق المحدودة للتمايز العددي، قاعدة شبه المنحرف، قاعدة سيمبسون، التربيع الغوسي للتكامل العددي وصيغ أويلر وسلسلة تايلور ورونج–كوتا لحل المعادلات التفاضلية.

Textbook: *Author(s), Title, Publisher, Edition, Year, Book website.*

""Numerical Methods", by J. H. Mathews, 2nd Edition 2014

References: *Author(s), Title, Publisher, Edition, Year, Book website.*

1. "Applied Numerical Analysis", by Gerald & Wheatley , 7th Ed, (2004), Addison-Wesley Publishing Company.
2. "Numerical Analysis", by R. Burden & D. Fairs , 9th Ed., (2010).
3. "Numerical Methods and Computing", by Cheney & KinCaid , 6th Ed., (2008), Thomson Learning Academic Resource Center.
4. "Numerical Methodsfor Engineers", by S. K. Gupta, 3rd Ed., (2013), New Academic Science Ltd, United Kingdom.

Course Educational Objectives (CEOs):

CEO1	Learn techniques for numerical integration and differentiation, such as the trapezoidal rule, Simpson's rule, and numerical differentiation methods.
CEO2	Understand the concepts of stability and convergence in numerical methods, including stability regions for ODE solvers.
CEO3	Explore adaptive techniques for adjusting step sizes and methods in numerical solutions to improve accuracy and efficiency.

Intended Learning Outcomes (ILO's):

Intended learning outcomes (ILOs)		Relationship to CEOs	Contribution to PLOs	Bloom Taxonomy Levels*	JNQF Descriptors**
k	Knowledge and Understanding				
ILO1-k	Able to apply numerical methods to differentiation	CEO1	PLO1-k	Applying	K
ILO2-k	Able to apply numerical methods to integration (quadrature)	CEO1	PLO2-k	Applying	K
ILO3-k	Able to apply numerical methods to solve differential equations,	CEO1	PLO2-k	Applying	K
S					
ILO4-s	Analyzing of functions	CEO3	PLO5-s	Analyzing	S
ILO5-s	applying error analysis to the numerical methods the student is introduced to during the course .	CEO3	PLO6-s	Analyzing	S
C					
ILO6-c	Appraise the different numerical methods used to solve problems.	CEO1	PLO11-c	Applying	C
D	Transferable skills:				
ILO08-d					

***Bloom Taxonomy Levels:**

Level #	1	2	3	4	5	6

Level Name	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
**** Descriptor (National Qualification Framework Descriptors): K: Knowledge, S: Skill, C: Competency.**						

Program Learning Outcome (PLOs):

	(PLOs)	JNQF Descriptors**		
		K	S	C
1.	Knowledge of the main concepts in pure mathematics.	√		
2.	Knowledge of the main concepts in applied mathematics.	√		
3.	Explain concepts, principles and theories in the fields of probability and statistics.	√		
4.	Possession of technological culture related to the fields of mathematics and its applications.	√		
5.	Making use of mathematical logic in practical life.	√		
6.	Engaging scientific methodology as a way of thinking and as a tool in facing problems.		√	
7.	Applying mathematical software packages in problem solving.		√	
8.	Being capable of data analysis.		√	
9.	Capability of teaching according to modern educational techniques.		√	
10.	Develop creative and innovative methods of teaching mathematics.			√
11.	Showing the ability to work under ethical and professional standards within teams.			√
12.	Gaining critical thinking and scientific research skills.			√

**** Descriptors according to the national qualifications framework (K: knowledge, S: skill, C: Competency)**

Weekly Schedule *(please choose the type of teaching)*

- ☐ **Face to Face (F2F)**
  - ✓ **Hybrid** *(One – To - One)*
- ☐ **Online**

Schedule of Simultaneous and their Topics:

Week	First Lecture (F2F)	Second Lecture	ILOs	PLOs	JNQF Descriptors*
1	Numerical Differentiation introduction; finite difference formulas to approximate $f'(x)$; forward and backward formulas of O(h); the central difference formula of	Activity: Background	1	1	K

	O(h2).				
2	Geometric interpretation of the forward, backward and central formulas; deriving difference formulas using Taylor's theorem; a central difference formula of order O(h4) .	Activity: Video 1 Solving exercises	1	7	K
3	A central difference formula of order O(h2) to approximate $f''(x)$; Analysis of the truncation error in the approximations of the different difference formulas.	Activity: Home work1: On the basics	3	8	K
4	Interpolating polynomials (Lagrange's & Newton's); approximating the derivative via differentiation of interpolating polynomials.	Activity : Quiz 1	1	1	S
5	Numerical Integration (Quadrature). The trapezoidal rule; Simpson's 1/3-rule; deriving the trapezoidal rule & Simpson's rule using Taylor's theorem .	Activity: Assignment 1: On differentiation methods	4	7	S
6	Analyzing the truncation error in the approximations of the trapezoidal rule & Simpson's rule; showing that the trapezoidal rule has precision 1 & Simpson's rule has precision 2.	Activity: Video 2	5	8	S
7	Recursive relation between trapezoidal approximations with #panels=2k-1 ; Simpson's approximation as a linear combination of trapezoidal approximations; Romberg algorithm.	Activity: Home work 2 On the subjects studied in weeks 4,5 and 6	1	1	K
Midterm Exam (30%)					
9	Gaussian quadrature and Legendre polynomials; Gaussian quadrature formula with two nodes; Gaussian quadrature formula with three nodes .	Activity: Video3 Solving exercises	4	7	S

10	Transforming a quadrature formula for integrals over [c, d] to a quadrature formula for integrals over [a, b]; comparison between different approximation formulas	Self-reading	2	5	K
11	finding precision of a formula by applying it to polynomials; approximating double integrals.	Activity: Quiz 2	2	1	K
12	Numerical Methods for Solving Differential Equations: Some review of exact methods for solving first-order ordinary differential equations; initial-value problems.	Activity: Self-reading Euler's method; geometric interpretation of Euler's method ; analytic derivation of Euler's method; the modified Euler's method (Heun's method) ; Taylor's method.	5	7	S
13	Runge-Kutta method; Runge-Kutta formula of order 4; multi-step methods.	Activity: Self-reading Systems of First-Order Differential Equations. Transforming higher-order differential equations into a system of first order differential equations; applying methods of single differential equations to solve systems of first-order differential equations.	6	8	C
14	Presentation of the subject: The second fundamental form.	Activity: Self-reading Applications on second-order initial-value problems; applications on second-order boundary-value problems.	6	11	C
15	**Projects Discussion**				
16	**Final Exam**				

* **K: Knowledge, S: Skills, C: Competency**

Teaching Methods and Assignments:

Development of ILOs is promoted through the following teaching and learning methods:

- Lecture.
- flipped learning.
- learning through projects.
- learning through problem solving.
- participatory learning

Course Policies:

A- Attendance policies:
The maximum allowed absences is 15% of the lectures.
B- Absences from exams and handing in assignments on time:
Midterm exam can be retaken based on approval of excuse by the instructor's discretion.
Not handing assignment on time will incur penalties.
C- Academic Health and safety procedures
D- Honesty policy regarding cheating, plagiarism, and misbehaviour:
Cheating, plagiarism, misbehaviour will result in zero grade and further disciplinary actions may be taken.
E- Grading policy:

- All homework is to be posted online through the e-learning system.
- Exams will be marked within 72 hours and the marked exam papers will be handed to the students.
- Online Activities (Course Videos, Discussion Forums, Quizzes) **20%**
- Midterm 30**%**
- Final Exam 50**%**

F- Available university services that support achievement in the course: **E-Learning Platform, Labs, Library.**

Required Equipment:

- PC / Laptop with webcam and mic
- Internet Connection
- Access to the ZUJ E-Learning Platform at https://exams.zuj.edu.jo/
- E-learning plan

Assessment Tools Implemented in the Course:

- Final Exam
- Midterm Exam
- Quizzes
- Homework

Responsible Persons and their Signatures:

Course Coordinator	Waseem Al Mashaaleh	**Completed Date**	**Oct / 2023**
		Signature	

Received by (Department Head)		**Received Date**	/ /
		Signature	