QF01/0408-4.0E	Course Plan for Bachelor program - Study Plan Development and Updating Procedures/ Mathematics Department

Study plan No.	**2021/2022**		**University Specialization**	**Bachelor of Mathematics**	
Course No.	**0101377**		**Course name**	**Numerical Analysis 2**	
Credit Hours	**3**		**Prerequisite/ Co-requisite**	**Numerical Analysis 1**	
Course type	☐ MANDATORY UNIVERSITY REQUIREMENT	☐ UNIVERSITY ELECTIVE REQUIREMENTS	☐ FACULTY MANDATORY REQUIREMENT	☐ Support course family requirements	☐ Mandatory requirements	**Elective requirements**
Teaching style	☐ Full online learning		▪ **Blended learning**		☐ Traditional learning	
Teaching model	☐ 1 Synchronous: 1 asynchronous		▪ **1 face to face : 1 asynchronous**		☐ 2 Traditional	

Faculty member and study divisions' information (to be filled in each semester by the subject instructor)

Name	Academic rank	Office No.	Phone No.	E-mail	
Division number	**Time**	**Place**	**Number of students**	**Teaching style**	**Approved model**
1				Blended	

Brief description

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.

Learning resources

Course book information (Title, author, date of issue, publisher ... etc)	1. "Numerical Methods", by J. H. Mathews, 2nd Edition			
Supportive learning resources (Books, databases, periodicals, software, applications, others)	2. "Applied Numerical Analysis", by Gerald & Wheatley , 7th Ed, (2004), Addison-Wesley Publishing Company. 3. "Numerical Analysis", by R. Burden & D. Fairs , 9th Ed., (2010). 4. "Numerical Methods and Computing", by Cheney & KinCaid , 6th Ed., (2008), Thomson Learning Academic Resource Center. 5. "Numerical Methodsfor Engineers", by S. K. Gupta, 3rd Ed., (2013), New Academic Science Ltd, United Kingdom.			
Supporting websites				
The physical environment for teaching	✓ Class room	☐ labs	✓ Virtual educational platform	☐ Others

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Necessary equipment and software	
Supporting people with special needs	
For technical support	

Course learning outcomes (S= *Skills, C= Competences K= Knowledge,)*

No.	Course learning outcomes	The associated program learning output code
	Knowledge	
K1	Define how to apply numerical methods to differentiation	**MK 1**
K2	Describe how to apply numerical methods to integration (quadrature)	**MK 2**
K3	Practice of applying numerical methods to optimize solutions of problems.	**MK 3**
	Skills	
S1	Build of solvable functions	**MS3**
S2	Measure of error bounds in the numerical methods that students waere introduced during the course.	**MS4**
	Competences	
C1	Reaching the use of applied mathematics for solving real live problems	**MC1**
C2	Cooperate to work effectively in the group assignments.	**MC 1**

Mechanisms for direct evaluation of learning outcomes

Type of assessment / learning style	Fully electronic learning	Blended learning	Traditional Learning (Theory Learning)	Traditional Learning (Practical Learning)
Midterm exam	30%	**30%**	40%	30%
Participation / practical applications	0	**0**	10%	30%
Asynchronous interactive activities	30%	**20%**	0	0
Final exam	40%	**50%**	50%	40%

Schedule of simultaneous / face-to-face encounters and their topics

Week	Subject	learning style	Reference
1	Numerical Differentiation introduction; finite difference formulas to approximate $f'(x)$; forward and backward formulas of O(h); the central difference formula of O(h2).	Lecture	Ref 1 (10-20)
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) .	Lecture	Ref 1 (21-40)

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.	Lecture	Ref 1 (41-60)
4	Interpolating polynomials (Lagrange's & Newton's); approximating the derivative via differentiation of interpolating polynomials.	Lecture	Ref 1 (61-85)
5	Numerical Integration (Quadrature). The trapezoidal rule; Simpson's 1/3-rule; deriving the trapezoidal rule & Simpson's rule using Taylor's theorem .	Lecture	Ref 1 (86-100)
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.	Lecture	Ref 1 (101-120)
7	Recursive relation between trapezoidal approximations with #panels=2k-1 ; Simpson's approximation as a linear combination of trapezoidal approximations; Romberg algorithm.	Blended	Ref 1 (121-137)
8	Gaussian quadrature and Legendre polynomials; Gaussian quadrature formula with two nodes; Gaussian quadrature formula with three nodes .	Blended	Ref 1 (138-160)
9	**Midterm Exam:** Transforming a quadrature formula for integrals over [c, d] to a quadrature formula for integrals over [a, b]; comparison between different approximation formulas	Blended	Ref 1 (161-185)
10	finding precision of a formula by applying it to polynomials; approximating double integrals.	Blended	Ref 1 (210 -235)
11	Numerical Methods for Solving Differential Equations: Some review of exact methods for solving first-order ordinary differential equations; initial-value problems.	Blended	Ref 1 (236-255)
12	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.	Blended	Ref 1 (256-290)
13	Runge-Kutta method; Runge-Kutta formula of order 4; multi-step methods.	Blended	Ref 2 (170-200)
14	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.	Blended	Ref 2 (201-230)
15	Applications on second-order initial-value problems; applications on second-order boundary-value problems.	Blended	Ref 2 (231-255)
16	**Final Exam**		

Schedule of asynchronous interactive activities (in the case of e-learning and blended learning)

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Week	Task / activity	Reference	Expected results
1	Background	Ref 1	Self-reading and Discussion
2	Video 1 Solving exercises	Ref 1	Discussion in the class
3	Home work1: On the basics	Ref 1	Submit a pdf or word sheet
4	Quiz 1	Ref 1	Submitting on the E-learning
5	Assignment 1: On differentiation methods	Ref 1	Talk
6	Video 2	Ref 1	Discussion in the class
7	Home work 2 On the subjects studied in weeks 4,5 and 6	Ref 1+Ref 2	Submit a pdf or word sheet
8	Assignment 2: On Approximation methods	Ref 1+Ref 2	Submitted with the mid exam
9	Self-reading	Ref 2+Ref 3	Talk
10	Video3 Solving exercises	Ref 2+Ref 3	Discussion in the class
11	Home work 3: On the subjects studied after the Mid-Exam	Ref 2+Ref 3	Submit a pdf or word sheet
12	Self-reading	Ref 2+Ref 3	Talk
13	Quiz 2	Ref 2+Ref 3	Submitting on the E-learning
14	Presentation of the subject: Approximation of DEs	Ref 4 + Ref 5	Video presentation
15	Video 4 Revision of all the course	Ref 1-5	Self-reading and Discussion
16	**Final Exam**	-	-