T-104

Course Specification

Course Title:	**Numerical Methods**
Course Code:	**MATH 3312-3**
Program:	**Bachelor in Engineering**
Department:	**Mathematics**
College:	**Science**
Institution:	**King Khalid University**
Version:	**2**
Last Revision Date:	**25/03/2023**

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A. General information about the course:

Course Identification						
1. Credit hours:	4					
2. Course type						
a.	University☐	College ☒	Department☐	Track☐	Others☐	
b.	Required ☒	Elective☐				
3. Level/year at which this course is offered:					6th level / 3rd year	

4. Course general Description

This course covers the following points:

- Rounding error, conditioning, and numbers representation on
- computers
- Numerical methods to solve nonlinear equations:
- Bisection method, fixed-point method, Newton method, approximation, and error
- analysis.
- System of nonlinear equations: Newton method
- System of linear equation:
- Direct methods: Gauss elimination, partial pivoting.
- Iterative methods: Jacobi method, Gauss-Seidel method, error analysis.
- Functions: interpolation and approximation:
- Polynomial approximations: exact, missing, and experimental data. Finite differences,
- Lagrange interpolation, Newton formula, best approximation, error analysis.
- Cubic splines interpolation: Natural cubic splines.
- Numerical integration.
- Use MATLAB for the numerical algorithms.

5. Pre-requirements for this course (if any):

2412 MATH Differential equations

6. Co- requirements for this course (if any):

None

7. Course Main Objective(s)

On successful completion of this course, students should be able to:

- Solve mathematical problems difficult to solve analytically as finding the roots of equations and computing the integrals.
- Use direct and iterative methods for solving systems of linear equations.
- Use interpolation and least squares for Data modeling.
- Analyze the approximation error.
- Use MATLAB for the numerical algorithms.

1. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
17.	Traditional classroom	--	--
18.	E-learning	--	--
19.	Hybrid • Traditional classroom • E-learning	5	100

No	Mode of Instruction	Contact Hours	Percentage
20.	Distance learning	--	--

2. Contact Hour (based on the academic semester)

No	Activity	Contact Hours
21.	Lectures	48
22.	Laboratory/Studio	--
23.	Field	--
24.	Tutorial	--
25.	Others (specify)	--
	Total	**48**

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
1.0	Knowledge and understanding			
1.1	Recognize the computer arithmetic, error analysis; solving nonlinear equations in one variable.	K1	Lectures, up-to-date textbooks, hand-outs, develop skills in using library and other learning resources, use of the Internet	Exams, tutorials, supervision, presentations, essays, feedback on written work and homework.
1.2	Knowing the direct and iterative methods for solving linear systems	K2		
1.3	Recognize the interpolation and polynomial approximation, cubic spline interpolation; least squares approximation	K3		
1.4	Recognize the numerical differentiation and integration.	K4		
2.0	Skills			
2.1	Ability to differentiate between analytical solutions and (approximate) numerical solutions	S1	Tutorials, Group working, problem-solving, discussion, feedback on written work, exam papers, critical assessment, peer assessment,	Exams, tutorials, supervision, presentations, feedback on written work and homework, exam papers, critical assessment, peer assessment, self-assessment.
2.2	Ability to choose and use different numerical methods	S2		
2.3	Ability to check the error analysis of numerical methods.	S3		
2.4	Ability to write and implement algorithms to solve different numerical issues.	S4		

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
			self-assessment.	
3.0	Values, autonomy, and responsibility			
3.1	Adhere to ethical values and excellence in professional practices.	V1	Feedback, experiential learning, structured experiences in groups, self-assessment, profiling.	Critical assessment, self-assessment, Rubrics
3.2	Able to articulate awareness of and demonstrate personal characteristics and critical thinking that positively impact the learning process.	V2		
3.3	Take full responsibility for initiating, identifying, amending, and achieving aims.	V3		

C. Course Content

No	List of Topics	Contact Hours
9.	Rounding error, conditioning, and numbers representation on computers	4
10.	**Numerical methods to solve nonlinear equations:** Bisection method, fixed-point method, Newton method, approximation, and error analysis.	6
3	System of nonlinear equations: Newton method	6
4	**System of linear equation:** • Direct methods: Gauss elimination, partial pivoting. • Iterative methods: Jacobi method, Gauss-Seidel method, error analysis	12
5	**Functions' interpolation and approximation:** • Polynomial approximations: exact, missing, and experimental data. • Finite differences, Lagrange interpolation, Newton formula, best • approximation, error analysis. • Cubic splines interpolation: Natural cubic splines.	8
6	**Numerical integration:** • Using closed Newton's cotes formula (Trapezoidal and • Simpson's rules). • Numerical differentiation: • First derivatives, forward, backward and central difference, Second • derivative approximation, central difference.	6
7	**Ordinary Differential Equations:** • Euler method,	6

	• Runge-Kutta Methods (of 4th order), Boundary-Value and Eigenvalue problems.	
Total		48

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
13.	Practical applications (solutions exercises), quizzes, and homework	Weekly	35
14.	Partial exam (mid term exam)	7	25

* Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.)

E. Learning Resources and Facilities

1. References and Learning Resources

Essential References	Numerical Methods S.R.K. Iyengar, R.K. Jain, Published by New Age International (P) Ltd., Publishers, 2009.
Supportive References	Numerical Analysis, by Richard L. Burden and J. Douglas Faires, 9th ed. Brooks/Cole, 2011. □□Numerical Methods, Rao V. Dukkipati, New Age International (P) Ltd., Publishers, 2010 □□Elementary Numerical Analysis, 3rd edition, Atkinson, Han, John Wiley & Sons, Inc., 2004 □□Numerical Methods for Engineers, 7th Edition by Steven C. Chapra and Raymond P. Canale, McGraw-Hill, 2014.
Electronic Materials	http://www.phengkimving.com/ https://sites.google.com/site/ecalculuscsu/index https://www.intmath.com/ http://archives.math.utk.edu/visual.calculus/ https://www.purplemath.com/modules/index.htm https://math.hmc.edu/calculus/tutorials/
Other Learning Materials	Students might use available ICT to accomplish their computer duties using: MATLAB, MAPLE, MATHEMATICA.

. Required Facilities and equipment

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	Lecture room for 25 students

Items	Resources
Technology equipment (Projector, smart board, software)	• Data show device, Video Conference system and Smart boards • Computers loaded with modern software and connected to Internet service
Other equipment (Depending on the nature of the specialty)	Not Applicable

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Peer Reviewer + Students	Direct
Effectiveness of students' assessment	Peer Reviewer + Q&D Committee	Direct
Quality of learning resources	Programs & Curricula Committee + Q&D Committee	Direct
The extent to which CLOs have been achieved	Quality and Development Committee	Indirect
Other		

Assessor (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)
Assessment Methods (Direct, Indirect)

Specification Approval Data

COUNCIL /COMMITTEE	
REFERENCE NO.	
DATE	25-3-2023