



# Course Specification

## (Bachelor)

Course Title: **Numerical Analysis**

Course Code: **SE4715**

Program: **BSc in Software Engineering**

Department: **Software Engineering**

College: **College of Computing**

Institution: **Umm Al Qura University**

Version: **1.0**

Last Revision Date: **22/04/2025**



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## A. General information about the course:

### 1. Course Identification

1. Credit hours: (3)

2. Course type

A.  University  College  Department  Track  Others

B.  Required  Elective

3. Level/year at which this course is offered: ( 3<sup>rd</sup> year/ 5<sup>th</sup> or 6<sup>th</sup> level) or ( 4<sup>th</sup> year/8<sup>th</sup> level)

4. Course General Description:

This course introduces students to numerical methods for solving mathematical problems using computational techniques. Emphasis is placed on the analysis of errors, stability, and efficiency of numerical algorithms. Applications include solving linear and nonlinear equations, interpolation, numerical integration, and differential equations.

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

CS2105 - Data Structures and Algorithms with Java

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

N/A

7. Course Main Objective(s):

Upon successful completion of this course, you will be able to:

1. Understand the theoretical foundation of numerical methods.
2. Apply numerical algorithms to solve mathematical and real-world problems.
3. Analyze the accuracy, efficiency, and stability of numerical solutions.
4. Implement numerical methods using programming tools.

### 2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	45	100%
2	E-learning	0	0
3	Hybrid <ul style="list-style-type: none"> <li>• Traditional classroom</li> <li>• E-learning</li> </ul>	0	0
4	Distance learning	0	0



### 3. Contact Hours (based on the academic semester)

No	Activity	Contact Hours
1.	Lectures	45
2.	Laboratory/Studio	0
3.	Field	0
4.	Tutorial	0
5.	Others (specify)	0
<b>Total</b>		<b>45</b>

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

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
<b>1.0</b>	<b>Knowledge and understanding</b>			
1.1	Understand error analysis and its significance in numerical methods.	K1	Lecture, Exercise	Quiz, Exams, Assignments
1.2	Learn the theoretical foundation of numerical methods for solving real-world problems.	K2	Lecture, Exercise	Quiz, Exams, Assignments
<b>2.0</b>	<b>Skills</b>			
2.1	Apply root-finding methods like Bisection and Newton-Raphson to solve equations.	S1	Lecture, Exercise	Quiz, Exams, Assignments
2.2	Design and implement numerical solutions for linear systems (e.g., LU decomposition).	S2	Lecture, Exercise	Quiz, Exams, Assignments
2.3	Analyze data using interpolation techniques such as Lagrange and spline interpolation.	S3	Lecture, Exercise	Quiz, Exams, Assignments



Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
2.4	Implement numerical methods using programming tools such as MATLAB or Python.	S2	Lecture, Exercise	Quiz, Exams, Assignments
<b>3.0</b>	<b>Values, autonomy, and responsibility</b>			
3.1	Collaborate in teams to develop numerical solutions for real-world problems.	V2	Lecture, Exercise	Quiz, Exams, Assignments
3.2	Evaluate the societal and environmental impact of numerical methods in engineering.	V1	Lecture, Exercise	Quiz, Exams, Assignments

### C. Course Content

No	List of Topics	Contact Hours
1.	Introduction to Numerical Analysis	3
2.	Error Analysis and Stability	3
3.	Root-Finding Methods (Bisection, Newton)	3
4.	Polynomial Interpolation and Splines	3
5.	Numerical Differentiation	3
6.	Numerical Integration (Trapezoidal, Simpson's)	3
7.	Systems of Linear Equations (Gaussian Elimination, LU Decomposition)	3
8.	Iterative Methods for Linear Systems (Jacobi, Gauss-Seidel)	3
9.	Numerical Solutions of ODEs (Euler, Runge-Kutta)	3
10.	Finite Difference Methods for PDEs	3
11.	Advanced Topics: Stability and Convergence Analysis	3
12.	Applications in Science and Engineering	6
13.	Project/Case Studies	6
<b>Total</b>		<b>45</b>



## D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	Quizzes	2-14	15
2.	Projects	2-14	15
3.	Assignments	2-14	10
4.	Mid Term	7	20
5.	Final Exam	16-17	40

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

## E. Learning Resources and Facilities

### 1. References and Learning Resources

<b>Essential References</b>	<ul style="list-style-type: none"> <li>Ascher, U. M., &amp; Greif, C. (2011). <i>A first course in numerical methods</i>. SIAM.</li> <li>Ovall, J. S. (2024). <i>Numerical Mathematics</i>. SIAM.</li> <li>Hooshyar, M. A. (2025). <i>An Introduction to Applied Numerical Analysis</i>.</li> </ul>
<b>Supportive References</b>	<ul style="list-style-type: none"> <li>Chapra, S. C., &amp; Clough, D. E. (2022). <i>Applied Numerical Methods with Python for Engineers and Scientists</i>.</li> <li>Kong, Q., Siau, T., &amp; Bayen, A. (2020). <i>Python programming and Numerical Methods: A Guide for Engineers and Scientists</i>. Academic Press.</li> <li>Epperson, J. F. (2013). <i>An introduction to numerical methods and analysis</i>. John Wiley &amp; Sons.</li> </ul>
<b>Electronic Materials</b>	
<b>Other Learning Materials</b>	

### 2. Required Facilities and equipment

Items	Resources
<b>facilities</b> (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	Traditional Classroom
<b>Technology equipment</b> (projector, smart board, software)	Multimedia Projector
<b>Other equipment</b> (depending on the nature of the specialty)	N/A





## F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Students	Direct, Indirect
Effectiveness of Students assessment	Faculty, Peer reviewer	Direct, Indirect
Quality of learning resources	Faculty, Course coordinator	Direct, Indirect
The extent to which CLOs have been achieved	Course coordinator, Program management committee	Direct
Other		

**Assessors** (Students, Faculty, Program Leaders, Peer Reviewers, Others (specify))

**Assessment Methods** (Direct, Indirect)

## G. Specification Approval

<b>COUNCIL /COMMITTEE</b>	<b>SOFTWARE ENGINEERING DEPARTMENT COUNCIL</b>
<b>REFERENCE NO.</b>	<b>THE 17<sup>TH</sup> MEETING FOR THE ACADEMIC YEAR 1446H</b>
<b>DATE</b>	<b>22/04/2025</b>

