MATH 301 - Numerical Methods and Scientific Computing

Course Code	Course Name	Semester	
MATH 301	Numerical Methods and Scientific Computing	Fall ☒ Spring ☐ Summer ☐	
Hours		**Credit**	**ECTS**
Theory	**Practice** / **Lab**	3	5
3	0 / 0		

Course Details	
Department	Aerospace Engineering
Course Language	English
Course Level	Undergraduate ☒ Graduate ☐
Mode of Delivery	Face to Face ☒ Online ☐ Hybrid ☐
Course Type	Compulsory ☒ Elective ☐
Course Objectives	Understand numerical methods in solving real-world scientific problems. Analyze and evaluate the accuracy, stability, and convergence. Solve linear and nonlinear equations. Implement numerical methods through programming languages Apply interpolation and approximation techniques. Numerically solve differential equations (ODEs and PDEs). Optimize algorithms for computational efficiency and performance. Develop problem-solving skills using numerical simulations. Communicate results effectively through visualization and error analysis.
Course Content	Introduction to Numerical Methods Overview of numerical methods, sources of error, and computational tools Root-Finding Methods Solving linear systems Interpolation and Approximation Numerical Differentiation and Integration Solving ODEs and PDEs Practical Applications
Course Method/ Techniques	Lecture ☒ Question & Answer ☐ Presentation ☐ Discussion ☐
Prerequisites/ Corequisites	
Work Placement(s)	
Textbook/References/Materials	

- Chapra, S and Canale R (2021) *Numerical Methods for Engineers,* 8th Edition*,* Mc-Graw Hill.
- Course notes

Course Category				
Mathematics and Basic Sciences	☒		Education	☒
Engineering	☒		Science	☒
Engineering Design	☐		Health	☐
Social Sciences	☐		Profession	☐

Weekly Schedule

No	Topics	Materials/Notes
1	Course description, introduction	Course description, introduction, error in numerical analysis
2	Solution of nonlinear equations	Root finding: Secant method, Bisection and Newton Raphson Iteration Methods
3	Solution of nonlinear equations	Regula Falsi method, Fixed point iteration method
4	Solution of systems of linear equations	Gauss elimination, Gauss-Jordan elimination, LU decomposition
5	Solution of systems of linear equations	Matrix inversion, Gauss-Siedel iteration method
6	Least-square regression	Linear Regression, Polynomial regression, Non-linear regression
7	Interpolation and polynomial approximation, curve-fitting	Interpolation Polynomials, Lagrange interpolation, Newton Interpolation
8	Midterm Exam	
9	Numerical differentiation	Numerical differentiation
10	Numerical differentiation	Numerical differentiation
11	Numerical integration	Trapezoid rule, Simpson rule
12	Numerical integration	Composite Simpson rule, Romberg integration
13	Solution of order ordinary differential equations	Euler method, 2nd order Runge-Kutta Method, 4th order Runge-Kutta Method
14	Solution of partial differential equations	Techniques for solving PDEs with finite difference methods.
15	Boundary value problems	Boundary value problems
16	Final Exam	

Assessment Methods and Criteria		
In-term studies	**Quantity**	**Percentage**
Attendance		
Lab		
Practice		
Fieldwork		
Course-specific internship		
Quiz/Studio/Criticize		
Homework	4	20%
Presentation / Seminar		
Project		
Report		
Seminar		
Midterm Exam	1	30
Final Exam	1	50
	Total	**100%**
Contribution of Midterm Studies to Success Grade		50
Contribution of End of Semester Studies to Success Grade		50
	Total	**100%**

ECTS Allocated Based on Student Workload			
Activities	**Quantity**	**Duration (Hrs)**	**Total Workload**
Course Hours	16	3	48
Lab			
Practice			
Fieldwork			
Course-specific Work Placement			
Out-of-class study time			
Quiz/Studio/Criticize			
Homework	4	8	32
Presentation / Seminar			
Project			
Report			
Midterm Exam and Preparation for Midterm	1	20	20
Final Exam and Preparation for Final Exam	1	20	20
Total Workload			**120**
Total Workload / 25			**4.80**
ECTS Credit			**5**

Course Learning Outcomes	
No	**Outcome**
L1	to solve real-life and engineering applications reflecting the student ability.
L2	to recognize and apply appropriate theories, principles and concepts relevant to numerical methods.
L3	to assess and evaluate the literature within the field of numerical methods.
L4	to analyze and interpret information from a variety of sources relevant to numerical methods.
L5	to compare numerical methods for advantages and drawbacks.
L6	to choose the suitable numerical method among several existing methods for a specific type of problem and develop the computational solution.
L7	to implement numerical methods using any of existing programming languages and compare them.

Contribution of Course Learning Outcomes to Program Outcomes

Contribution Level: 1: Very Slight, 2: Slight, 3: Moderate, 4: Significant, 5: Very Significant

	P1	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**P8**	**P9**	**P10**	**P11**	**P12**	**P13**	**P14**	**P15**	**Total**
L1	5	5		5		5	5	3	3							29
L2	5	5		5		5	5	3	3							29
L3	5	5		5		5	5	3	3							29
L4	5	5		5		5	5	3	3							29
L5	5	5		5		5	5	3	3							29
L6	5	5		5		5	5	3	3							29
L7	5	5		5		5	5	3	3							29
															Total	