SEMESTER S5

NUMERICAL COMPUTATION USING PYTHON

Course Code	PEMRT524	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None/ (Course code)	Course Type	Theory

Course Objectives:

1. To provide students with a solid foundation in numerical methods for solving engineering problems using Python.
2. To enable students to implement numerical techniques for nonlinear equations, interpolation, integration, differentiation, and ordinary differential equations.
3. To develop students' skills in applying numerical methods to analyse and interpret engineering data and solve real-world problems.

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SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**Root Finding Methods (6 Hours) (Derivation or proof not required)** Bisection method; Newton-Raphson method; Secant method; False Position Method; Fixed-point iteration; Convergence and error analysis of root-finding methods. **Solving nonlinear equations using the above methods in Python (2 Hours)**	**8**
2	**Interpolation (9 Hours) (Derivation or proof not required)** Finite difference interpolation: Newton's finite and backward difference interpolation methods. Polynomial Interpolation: Lagrange interpolation and Newton's divided difference interpolation. Spline Interpolation: Cubic splines and B-splines. Error analysis in interpolation. **Implementing interpolation methods in Python (2 Hours)**	**11**

3	**Numerical Integration and Differentiation (6 Hours)** Numerical Differentiation: Finite difference methods; Error analysis in numerical differentiation. Numerical Integration: Trapezoidal rule, Simpson's rule, Gaussian quadrature, Adaptive quadrature methods. **Writing Python programs to perform numerical differentiation and integration (2 Hours)**	**8**
4	**Solution of Ordinary Differential Equations (7 Hours)** Initial Value Problems: Euler's method; Runge-Kutta methods; Multistep methods (Adams-Bashforth and Adams-Moulton methods). Boundary Value Problems: Shooting method; Finite difference method. **Solving ODEs using Python (2 Hours)**	**9**

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

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Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	**15**	**10**	**10**	**40**

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks **(8x3 =24marks)**	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Course Outcomes (COs)

At the end of the course students should be able to:

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Implement root-finding algorithms in Python to solve nonlinear equations and analyse the convergence behaviour of these methods.	**K3**
CO2	Apply interpolation techniques in Python for data fitting and solving engineering problems and perform error analysis.	**K3**
CO3	Develop Python programs to implement numerical differentiation and integration techniques.	**K3**
CO4	Implement numerical methods in Python to solve ordinary differential equations.	**K3**

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

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CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3				3							3
CO2	3				3							3
CO3	3				3							3
CO4	3				3							3

Note: *1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation*

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Numerical Methods in Engineering with Python 3	Jaan Kiusalaas	Cambridge University Press	3 & 2013
2	Numerical Methods for Engineers	Steven C. Chapra and Raymond P. Canale	McGraw-Hill Education	7 & 2014

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Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Numerical Analysis	Richard L. Burden and J. Douglas Faires	Cengage Learning	10 & 2015
2	Applied Numerical Methods with MATLAB for Engineers and Scientists	Steven C. Chapra	McGraw-Hill Education	4 & 2017
3	Introductory Methods of Numerical Analysis	S.S.Sastry	Prentice Hall India Learning Private Limited	5 & 2012
4	Numerical Method and Programming	Bikas Chandra Bhui & Dipak Chatterjee	Vikas	2 & 2016
5	Numerical Methods Using Matlab	Mathews and Fink	Pearson Education India	4 & 2015

Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	NPTEL - MATLAB Programming for Numerical Computation, IIT Madras NPTEL - Numerical methods, IIT Roorkee NPTEL - Applied Numerical Methods, IIT Kanpur
2	NPTEL - MATLAB Programming for Numerical Computation, IIT Madras NPTEL - Numerical methods, IIT Roorkee NPTEL - Applied Numerical Methods, IIT Kanpur
3	NPTEL - MATLAB Programming for Numerical Computation, IIT Madras NPTEL - Numerical methods, IIT Roorkee NPTEL - Applied Numerical Methods, IIT Kanpur
4	NPTEL - MATLAB Programming for Numerical Computation, IIT Madras NPTEL - Numerical methods, IIT Roorkee NPTEL - Applied Numerical Methods, IIT Kanpur

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