

<b>Course title:</b> Applied numerical methods				
<b>Course code:</b> ENR 159		<b>No. of credits:</b> 3	<b>L-T-P:</b> 22-10-20	<b>Learning hours:</b> 52
<b>Pre-requisite course code and title (if any):</b> NA				
<b>Department:</b> Department of Energy and Environment				
<b>Course coordinator:</b> Dr. Som Mondal			<b>Course instructor(s):</b> Dr. Som Mondal/Dr. Aviruch Bhatia	
<b>Contact details:</b> som.mondal@terisas.ac.in				
<b>Course type:</b> Elective			<b>Course offered in:</b> Semester 2	
<b>Course description</b>				
<p>This course is designed for application of numerical methods in solving problems related to renewable energy technologies. The course starts with introduction of numerical methods and its applicability in renewable technologies with an introduction to basic computation using MATLAB. It covers the concepts of solution techniques of linear and non-linear equations and systems of equations. In module 3, differentiation and integration using numerical methods are covered. Application of different initial value and boundary value problems in renewable energy using finite difference method is taught in module 4. An introduction to solution of partial differential equation and finite element method is also covered. Computational practical problem solving is an integral part of the course.</p>				
<b>Course objective</b>				
<p>The objective of the course is to prepare students with knowledge of numerical methods which may be applied to solve complex problems in renewable energy field.</p>				
<b>Course contents</b>				
Module	Topic	L	T	P
1	<b>Introduction</b>	2	0	0
	Application of numerical methods in renewable energy Introduction to various softwares, their capabilities, limitation and tools, basic computation process			
2	<b>Linear equation and non-linear equations</b>	8	2	6
	Linear algebraic equations and matrices			
	Gauss elimination, LU-factorization, matrix inverse and condition, Eigen value problems, Iterative methods, Convergence and accuracy of iterative methods			
	Solution of non-linear equations: Regula-Falsi method, Fixed-point Iteration, Newton-Raphson Method, Order of Convergence			
	Solution of system of non-linear equations Case study			
3	<b>Numerical differentiation and integration</b>	4	2	4
	Numerical differentiation: high-accuracy differentiation formulas, first order and second order differentiation, derivatives of unequally spaced data, derivatives for data with errors, partial derivatives Numerical integration: numerical integration formulas, numerical integration of functions, integrals for data with errors			
4	<b>Solution of ordinary differential equation (ODE)</b>	8	6	10
	Implicit & explicit Finite-Difference Method (FDM), FDM for Initial Value ODE, Modified Euler Method; Runge-Kutta Method, Multi-point Methods			
	Boundary Value-ODE, Dirichlet and Neuman boundary conditions			
	Solution of second order partial differential equations: elliptic and parabolic equations Case studies			
		<b>22</b>	<b>10</b>	<b>20</b>

<p><b>Evaluation criteria</b></p> <ul style="list-style-type: none"> <li>▪ Assignments: 20%</li> <li>▪ Two Minor tests: 15% (each)</li> <li>▪ Major exam: 50%</li> </ul>
<p><b>Learning outcomes</b></p> <ul style="list-style-type: none"> <li>▪ To formulate engineering problems and develop algorithm for numerical solution.</li> <li>▪ Understand and identify the right numerical methods for solution.</li> <li>▪ Solve the problems using software like MATLAB, PYTHON etc.</li> </ul>
<p><b>Pedagogical approach</b></p> <p>A combination of class-room interactions, practical, tutorials and assignments.</p>
<p><b>Materials</b></p> <p><b>Recommended readings</b></p> <p>Chapra, S.C., “Applied Numerical Methods with MATLAB”, Tata McGraw Hill, New Delhi, 2007  Chapra, S.C. and Canale, R.P., “Numerical methods for Engineers”, Tata McGraw Hill, New Delhi, 2007  Jain, M.K., Iyenger, S.R.K. and Jian, R.K., “Numerical Methods for Scientific and Engineering Computation, New Age International ltd”, New Delhi, 2008  Kreyszig, E., “Advanced Engineering Mathematics”, John Wiley &amp; Sons Inc, India, 1999  Saumyen Guha and Rajesh Srivastava, “Numerical Methods for Engineering and Science”, Oxford Higher Education, 2010  Joe D. Hoffman, “Numerical Methods for Engineers and Scientists”, Second Edition, Taylor and Francis, USA, 2001</p>
<p><b>Additional information (if any):</b>NA</p>
<p><b>Student responsibilities</b></p> <p>Attendance, feedback, discipline: as per university rules.</p>

### Course Reviewers

1. Dr. Sumit Basu, Professor, Mechanical Engineering, Indian Institute of Technology Kanpur
2. Dr. Suresh A. Kartha, Associate Professor, Civil Engineering, Indian Institute of Technology Guwahati