COURSE OUTLINE

Faculty of Chemical and Energy Engineering Department : Department of Energy Engineering.	
Code and Subject: **SKTN 2393 – Applied Numerical Methods for Nuclear Engineers** Total Lecture Hours: **56 hrs**	**Semester: I** **Academic Session: 20222023**

Lecturer **Room No.** **Telephone No.** **E-mail**	: : : :	Mohsin Mohd Sies N01-324 mohsin@utm.my
Synopsis	:	This course formally introduces the steps involved in engineering analysis (mathematical modeling, solving the governing equations numerically, and interpretation of the results). Example of case studies in applied mechanics, strength of materials, themal science, and fluid mechanics are presented. Methods for solving the nonlinear equations, simultaneous linear algebraic equations, eigenvalue problem, interpolation, numerical differentiation, numerical integration, initial value problems, and boundary value problem are introduced. Students will be required to use computing tools such as Matlab or Octave to implement the solutions for the problems..
Prerequisites	:	SCSJ/SECJ 2273 Programming for Engineers

Learning Outcomes:
By the end of the course, students should be able to:

No.	Course Learning Outcome	Programme Learning Outcome(s) Addressed	Bloom Taxonomy	Weightage (%)	Assessment Methods
CO1.	Construct mathematical models or the governing equations for the complex physical systems under investigation.	PLO1, PLO2	C5	30	Quiz, HW, Test, Project
CO2.	Solve the governing equations using appropriate numerical methods.	PLO1, PLO5	C4	30	Quiz, HW, Test, Project
CO3.	Develop a well-structured and reliable Matlab or Octave computer program for the chosen numerical method.	PLO5	C5	30	Quiz, HW, Test, Project
CO4.	Analyze the validity and accuracy of the numerical solutions.	PLO9	C5	10	Quiz, HW, Test, Project

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Program Outcomes (PO) related to the course:

PLO1 Ability to apply knowledge of mathematics, natural science, engineering fundamentals, chemical/petroleum/bio-process/ gas/nuclear engineering principles to the solution of complex engineering problems.

PLO2 Ability to identify, formulate, conduct research literature, and analyse complex chemical/ petroleum/ bio-process/ gas/ nuclear engineering problems using first principles of mathematics and engineering sciences.

PLO5 Ability to inculcate modern computational techniques and tools complex chemical/ petroleum/ bioprocess/ gas/ nuclear which include prediction and modeling to solve complex engineering problem with an understanding of the limitations.

PLO9 Ability to communicate effectively through written and oral modes to all levels of society.

Student Learning Time

Teaching and Learning Activities	**ıdent Learning Time (hours)**
1. Face to Face Learning	
a. Lecturer-Centered Learning i. Lecture	42
2. Self-Directed Learning	
a. Non-face-to-face learning or student-centered learning (SCL) such as manual, assignment, module, e-Learning, etc.	28
b. Revision	38
c. Assessment Preparations	9
3. Formal Assessment	
a. Continuous Assessment	3
b. Final Exam	0
Total (SLT)	120

Teaching Methods

This course consists of lectures and hands on learning using computational tools such as Octave, Matlab, and spreadsheets for the coding and implementation of numerical solutions. Students will also perform projects to further instill the understanding and impress on the use of numerical methods as a tool to solve engineering problems.

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Weekly Schedule

Week	Topic	
1	**Introduction to engineering analysis** a) Course requirement and overview b) Engineering problem solving c) Taylor series d) Error and uncertainty	*It is expected that students will be able to:* • Differentiate between numerical and analytical solutions of mathematical problems • Describe and apply Taylor Series as the basis of numerical analysis • Analyse error and error propagation
2	**Solution of nonlinear equations** a) Incremental search, Bisection, Newton-Ralphson, and secant methods. b) Engineering applications	*It is expected that students will be able to:* • Identify engineering problems that involve solving of nonlinear equations • Formulate a numerical solution approach to solve it • Implement selected numerical methods to solve it
3	**Simultaneous linear algebraic equations** a) Elimination Methods - Gauss Jordan elimination, LU decomposition, Jacobi iteration, Gauss-Seidel iteration b) Engineering applications	*It is expected that students will be able to:* • Identify engineering problems that involve simultaneous linear algebraic equations • Formulate a numerical solution approach to solve it • Implement elimination methods to solve it
4	**Simultaneous linear algebraic equations** a) Iterative Methods - Jacobi iteration, Gauss-Seidel iteration b) Engineering applications	*It is expected that students will be able to:* • Identify engineering problems that involve simultaneous linear algebraic equations • Formulate a numerical solution approach to solve it • Implement iterative methods to solve it
5	**Eigenvalue-eigenvector problem** a) Characteristic equations and Faddeev-Leverrier method b) Power methods c) Engineering applications	*It is expected that students will be able to:* • Identify engineering problems that involve eigenvalue problems • Formulate a numerical solution approach to solve it • Implement the characteristic equations and power methods to solve it

6	**Curve fitting and interpolation** a) Least-squares regression b) Engineering applications	*It is expected that students will be able to:* • Differentiate between problems that involve regression and interpolation. • Identify engineering problems that involve curve fitting and regression • Formulate a numerical solution approach to solve it • Implement the higher order least squares regression methods to solve it
7	**Curve fitting and interpolation** a) Newton and Lagrange Interpolation b) Spline interpolation c) Engineering applications	*It is expected that students will be able to:* • Identify engineering problems that involve curve fitting and regression • Formulate a numerical solution approach to solve it • Implement the Newton, Lagrange and spline polynomial interpolation methods to solve it
8	**Mid-Semester Break**	
9	**Numerical Differentiation** a) Finite-difference, Taylor's series expansion b) Engineering applications	*It is expected that students will be able to:* • Identify engineering problems that involve differentiations • Formulate a numerical solution approach to solve it • Implement finite difference methods to solve it
10	**Numerical integration** c) Newton-Cotes Formulas, Simpson's rule, Romberg integration, Gauss quadrature d) Engineering applications	*It is expected that students will be able to:* • Identify engineering problems that involve integrations • Formulate a numerical solution approach to solve it • Implement selected numerical integration methods to solve it
11	**ODE : Initial-value problem** a) Euler's and Runge-Kutta methods	*It is expected that students will be able to:* • Identify and classify different types of ordinary differential equations • Identify engineering problems that involve initial value problems • Formulate a numerical solution approach to solve it

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		• Implement the Euler and Runge Kutta methods of various orders to solve it
12	**ODE : Initial-value problem** a) Simultaneous differential equations b) Higher order differential equations c) Engineering applications	*It is expected that students will be able to:* • Identify engineering problems that involve simultaneous differential equations • Formulate a numerical solution approach to solve it • Implement Euler methods applied to simultaneous differential equations to solve it
13	**ODE : Boundary-value problem** a) Shooting and finite-difference methods b) Engineering applications	*It is expected that students will be able to:* • Identify engineering problems that involve boundary value problems • Formulate a numerical solution approach to solve it • Implement shooting and finite difference methods to solve it
14	**Project Submission week**	

References:

1. MATLAB® Programming with Applications for Engineers (First Edition), Stephen J. Chapman
2. Numerical Methods For Engineers, Steven C. Chapra, Raymond P. Canale. — 6th ed
3. Rao, S. S. 2002. Applied Numerical Methods for Engineers and Scientists. New Jersey: Prentice Hall.

Assessment:

No.	Assessment	Number	% each	% total	Dates
1	Homework & Quizzes			10	As scheduled
2	Tests (Test 1 and Test 2)	2	25	50	Test 1 before and Test 2 after mid-semester break
3	Projects	2	20	40	As scheduled
	Overall Total			**100**	

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