Course Outline
MAT 201 – Numerical Methods

Instructor

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Course Overview

This course is designed for the student to understand the basics of Numerical analysis. After completing this course, students should be able to understand how computers compute different mathematical solution using iterative techniques.

This is an introductory Level course and there is no prerequisite.

Text Book:

1. Numerical Methods for Engineers by Steven C. Chapra and Raymond P. Canale, McGraw Hills Education, 6th Edition (Chapra)

Course Materials

All the course materials (Including name for any new books) will be available at

- http://www.neub.shparvez.net/mat-201/

Course Learning Outcomes

After completing this course students should be able to:

- Understand mathematical modeling
- Understand how computers compute complex mathematics like
  - Finding Roots
  - Integration
  - Differentiation
  - Regression
  - Interpolation
  - Solving Differential equations
- Understands different types of error

Course Schedule

Week	Topic to be Covered	Learning Outcomes
Week 1	Lecture 1: Numerical methods and Errors • Mathematical Model • Significant Figures • Accuracy and Precision • Error Definitions • Error Classification • Taylor Series and Theorem introduction • Numerical Differentiation introduction • Total Numerical Erors	Students should be able to • Understand the importance of mathematical model in numerical computation. • Understand the difference between Accuracy and Precision and concept of error due to imprecise measurements. • Understand and interpret different types of error and how the value of error

Week	Topic to be Covered	Learning Outcomes
	• Other Errors **Reading Lists:** • Chapra Chapter 1 • Chapra Chapter 3	changes with iterations in iterative methods.
Week 2	Lecture 2: Series and Sequence • Series and Sequence • Convergence vs Divergence • Taylor Series • Maclaurin Series • Estimating value of a function using Taylor Series **Reading Lists:** • Chapra Chapter 4	Students should be able to • Understand the difference between Series and Sequence. • Understand the when a series converges and diverges. • Use Taylor Series and Maclaurin series as a tool for finding value of function at certain point using an initial value.
Week 3	Lecture 3: Bracketing methods for finding roots • What is root • Graphical Method for finding roots • Bracketing method for finding roots • Bisection method for finding roots • Termination criteria and error estimates for bracketing methods • False Position method for finding roots **Reading Lists:** • Chapra Chapter 5	Students should be able to • Understand how different closed/bracketing methods of finding roots work. • Use different closed methods to find roots of different equations. • Choose closed methods based on equations. • Differentiate between different closed methods.
Week 4	Lecture 4: Open methods for finding roots • Open methods • Open Methods vs Closed Methods • Fixed Point Iteration method for finding roots • Convergence and Divergence criterion for Fixed Point Iteration • Newton Raphson Method for finding roots • Error estimates for open methods • Pitfalls of Newton Raphson method • Secant Method • Modified Secant Method • Difference between secant method and false position method **Reading Lists:** • Chapra Chapter 6	Students should be able to • Understand how different open methods of finding roots work. • Use different open methods to find roots of different equations. • Choose open methods based on equations. • Differentiate between different open methods. • Understand that not all methods can be used to solve all equations.

Week	Topic to be Covered	Learning Outcomes
Week 5	Lecture 5: Polynomials • Polynomial Definition • Polynomial in engineering and science • Computing with polynomial • Polynomial deflation • MÜLLER'S Method **Reading Lists:** • Chapra Chapter 7 **Tutorial 1** **Topic:** Lecture 1, 2, and 3	Students should be able to • Understand the basics of Polynomials. • Use polynomials to represent different physical systems. • Reduce order of polynomial using Polynomial Deflation technique. • Find roots of polynomial using MÜLLER'S Method
Week 6	Lecture 6: Simultaneous Linear Algebraic Equations • Matrix introduction • Matrix Operation • Representing Linear algebra using matrix • Graphical Method for finding solution of Simultaneous Linear Algebraic Equations • Cramer's Rule for finding solution of Simultaneous Linear Algebraic Equations • Elimination of unknowns • Naïve Gauss Elimination method for finding solution of Simultaneous Linear Algebraic Equations • Pitfalls of Elimination methods • Techniques for improving solution • Gauss –Jordan method for finding solution of Simultaneous Linear Algebraic Equations • LU Factorization [Decomposition] method for finding solution of Simultaneous Linear Algebraic Equations • Matrix Inverse **Reading Lists:** • Chapra Chapter 9 • Chapra Chapter 10 Revision and Solve class in preparation for Mid semester examination.	Students should be able to • Understand Basics of Matrix. • Use different Matrix operations. • Representing Linear algebra using matrix • Solve different Simultaneous equations using different methods like Graphical method, Cramer's Rule, Naïve Gauss Elimination method, Gauss –Jordan method, LU Factorization Method etc. • Choose different methods based on problem statements.

Week	Topic to be Covered	Learning Outcomes
Week 7	Lecture 7: Numerical Integration • Integration • Newton-Cotes Integration Formulas • Trapezoidal Rule • Error of trapezoidal rule • Composite Trapezoidal Rule • Error of composite trapezoidal rule • Simpson's Rules • Multiple application of Simpson's 1/3 rule • Simpson's 3/8 Rule • Integration with Unequal Segments **Reading Lists:** • Chapra Chapter 21	Students should be able to • Understand the concepts of integration using numerical method instead of exact method • Use different numerical methods like Trapezoidal Rule, Simpson's Rule, etc to find integration value of different functions.
Week 8	Lecture 8: Numerical Differentiation • Numerical Differentiation • Forward finite-difference Method • Backward finite-difference Method • Centered finite-difference Method • Numerical Differentiation for Unequally spaced data **Reading Lists:** • Chapra Chapter 23	Students should be able to • Understand the concepts of differentiation using numerical method instead of exact method • Use different numerical methods like Forward finite-difference, Backward finite-difference, Centered finite-difference Method, etc to find gradient of different functions.
Week 9	Lecture 9: Iterative Methods • Gauss –Seidel method • Jacobi iteration • Convergence of iterative method • Convergence Criterion for the Gauss-Seidel Method • Relaxation • Newton-Raphson **Reading Lists:** • Chapra Chapter 11 Lecture 10: Regression • Review of Statistics • Linear Least-Square Regression • Least-Squares Fit of a Straight Line **Reading Lists:** Chapra Chapter 17	Students should be able to • Understand how iterative methods can be used to solve simultaneous equations. • Solve simultaneous equations using different iterative methods like Gauss – Seidel Method, Jacobi Iteration, Newton-Raphson method, etc. • Recall basic concepts of Statistical analysis like mean, median, mode, variance, standard deviation, etc. • Understand the basic concept of linear regression

Week	Topic to be Covered	Learning Outcomes
Week 10	Lecture 10: Regression • Quantification of Error • Linearization of nonlinear relationship • Polynomial Regression • General Linear Least squares • Solving General Linear Least Squares Coefficients • Nonlinear regression **Reading Lists:** • Chapra Chapter 17	Students should be able to • Use Linear Least-square regression, polynomial regression, etc to predict a function from data points. • Understand the difference between Linear and polynomial regression.
Week 11	Lecture 11: Interpolation • Interpolation Introduction • Polynomial Interpolation problem • Newton Interpolating Polynomials • Lagrange interpolating polynomial • Inverse Interpolation • Extrapolation • Spline Interpolation **Reading Lists:** • Chapra Chapter 18 **Tutorial 2**	Students should be able to • Use interpolation to predict intermittent data points from known data points. • Understand the difference between Interpolation and Extrapolation. • Differentiate between different types of interpolation techniques.
Week 12	Lecture 12: Initial Value Problems • Initial Value Problems • Euler's Method • Error analysis of Euler's method • Higher order Taylor series method • Heun's Method • Midpoint Method • Runge-Kutta (RK) Methods • Classical Fourth-Order Runge-Kutta Method **Reading Lists:** • Chapra Chapter 25 Revision and Solve Class	Students should be able to • Solve Differential equations using different techniques like Euler's Method, Heun's Method, Midpoint Method, RK Method, etc.

Assignments
Several assignments (Up to 7) will be given during the course of the semester. Due dates and syllabus will be announced in the class

Assignment Policy
Assignments Must be submitted within due dates. No excuse or requests will be considered regarding late submission.

Grading Policy

Attendance	: 10 marks
Tutorial	: 10 marks
Assignment	: 10 marks
Mid Semester Examination	: 30 marks
Semester Final Examination	: 40 marks

Grades and grades point will be based on the following criteria.

Marks Range	Letter Grade	Grade Point
80% and Above	A+	4.00
75% - 79%	A	3.75
70% - 74%	A-	3.50
65% - 69%	B+	3.25
60% - 64%	B	3.00
55% - 59%	B-	2.75
50% - 54%	C+	2.50
45% - 49%	C	2.25
40% - 44%	D	2.00
Less than 40%	F	0.00

Exam Schedule

Exam	Schedule
Tutorial Exam #1	TBA
Mid Semester Examination	Announced by the Controller of Examination Office
Tutorial Exam #2	TBA
Semester Final Examination	Announced by the Controller of Examination Office

Attendance Policy

Attendance will be taken based on the following criteria:

- Students who are on time will get full attendance without any penalty.
- Students who are no more than 30 minutes late will get 50% attendance penalty (Meaning half of the attendance will be accounted).
- Students who are more than 30 minutes late will get 90% attendance penalty.

Mark for attendance will be awarded as follows.

Level of Attendance	Mark
96% to 100%	10
91% to 95%	9
86% to 90%	8
81% to 85%	7
76% to 80%	6
71% to 75%	5
66% to 70%	4
61% to 65%	3
60%	2
Below 60%	0

Other policies

Bunking of class will be severely penalized. Mass bunking during tutorials will result in zero marks for all students. Other than bunking, unusual distractions during lectures by any students will also be severely penalized.