King Fahd University of Petroleum & Minerals
Department of Mathematical Sciences
Introduction to Numerical Computing (MATH 371)
Course Syllabus (Term 191)

Textbook: "Numerical Analysis" by Richard L. Burden, J. Douglas Faires , 10th Edition, 2016.
Reference: "Numerical Methods for Engineers", Steven C. Chapra and Raymond P. Canale, "6th Edition."

Course Description:
Floating-point arithmetic and error analysis. Solution of non-linear equations. Polynomial interpolation. Numerical integration and differentiation. Data fitting. Solution of linear algebraic systems. Initial and boundary value problems of ordinary differential equations.

Course Objectives:
This course is designed to introduce numerical methods for solving a variety of problems, linear, nonlinear, and numerical approximation. In this course, we focus on both: the theoretical and computational aspects.

Students Learning Outcome: After completion of the course, the students should be able to:

1. Use Taylor Series to approximate functions, evaluate the approximation errors and estimate their upper bounds.
2. Understand and program algorithms to locate the approximate roots of equations.
3. Understand and program algorithms to numerically solve linear systems of equations.
4. Learn how to smooth collected engineering data using the least squares method.
5. Use polynomials to interpolate collected precise (Note: Interpolation applies to precise data while the least-squares method applies to data exhibiting a significant degree of error or scatter.) engineering data or approximate function.
6. Understand and program algorithms to evaluate the derivative or the integral of a given function, evaluate the approximation error involved and estimate its upper bound.
7. Understand and program algorithms to solve engineering ordinary differential equations (ODEs) or partial differential equations (PDEs).
8. Understand relationships among methods, algorithms, and computer errors.
9. Apply numerical and computer programming tools to solve common engineering problems.

Computer Usage: A computer software will be used as a computational platform.

Attendance: KFUPM attendance policy will be enforced.

Grading Policy:
The overall grade of the course is **500** marks. The course grade will be calculated using the following scheme
1. Two Major Exams (each 100 point).
2. Final Exam (150 point) (Comprehensive).
3. Classwork (75 point).
4. Programming assignments (75 point).

Academic Integrity: All KFUPM policies regarding ethics apply to this course.

Plagiarism and Cheating: (Please read carefully)

This course is composed of both individual as well as group assignments. It is important that your individual assignment be completed with your own efforts instead of copying it from your fellow student. KFUPM instructors follow "zero tolerance" approach with regard to cheating and plagiarism. During examinations (quizzes, major exams, lab reports) cheating or any attempt of cheating by use of illegal activities, techniques and forms of fraud will result in a grade of F in the course along with reporting the incident to the higher university administration.

Homework

Homework constitute an important component of this course. You are expected to express your answers clearly with solid justifications. Stating the final answer to a question without any justifications shall attract ZERO mark. Late submissions of homework assignments will be graded subject to reduced credit at the rate of 10% of the maximum mark per day late, or part thereof, unless you have a permission from your instructor. Submissions of homework assignments are not accepted after the solutions had been discussed in class, and/or had been posted online, and/or graded assignments returned.

Pseudocodes and Codes

Pseudocodes and Codes are essential elements of the course. You should expect at least one question on each of these two elements in each major exam. You must train yourself well enough to describe numerical algorithms using pseudocodes and converting them into correct codes. You may also expect to be asked to do the other way around; i.e., convert a code into a well-written pseudocode. While your instructor may ask you to code any of the pseudocodes included in the Textbook and relevant to the course syllabus, as part of any requested assignment, the following list of pseudocodes will not be included in the major exams due to their length and/or complexity: Algorithms 3.4, 3.5, 6.2, 6.4, 6.7, and 11.3.

Requirements for Written Assignments

• Box your final answer(s) and important intermediate results.

• Staple your notes together, (i.e. no paper clips, torn or folded corners) with the assignment cover page

(if applicable).

Major Exams Formula Sheets

Each major exam will have a formula sheet when necessary that will aid students during the exams. Copies of the Formula Sheets will be available in the Blackboard for students to reference while studying. You should not print the Formula Sheet and bring the hard copy with you to the exam location; instead a copy of the Formula Sheet shall be provided to you together with the exam sheets on the exam day. Formula sheets will not be provided during quizzes.

Class Schedule

Week	Date	Sec.	Topic	Suggested Problems
1	Sept 1-5	1.1 1.2	Taylor Polynomials and Series Round-off Errors and Computer Arithmetic(Rounding and Chopping)	1, 3, 5, 7, 10, 13a, 13b 1, 4, 5
2	Sept 8-12	1.3 ---	Algorithms and Convergence Introduction to Programming	1, 2
3	Sept 15-19	2.1 2.2	The Bisection Method Fixed-Point Iteration	2, 4a, 4b, 5c, 5d, 6*, 7* 3, 8, 9, 10*, 14
23rd September National Day Holiday				
4	Sept 22-26	2.3	Newton's Method and its Extensions	2, 4a, 6a, 6b, 8a, 11*, 14*, 16*
5	Sep 29-Oct 3	3.1 3.3	Interpolation and the Lagrange Polynomials (up-to Example 3) Divided Differences (up-to Example 1)	1a, 1c, 3, 6a, 8a, 9, 13a 1, 2
Exam 1 on Wednesday October 09, 2019 at 06:00-08:00 pm in Building 57, Material: 1.1 up-to 3.3				
6	Oct 6-10	3.5	Cubic Spline Interpolation	1, 2, 3d, 5d, 7d, 8d
7	Oct 13-17	4.1	Numerical Differentiation (Forward, Backward, and Central for f′(x) and Central for f′′(x) (Skip five point formulas)	1, 2, 3, 4, 6a, 8a, 9a, 20
8	Oct 20-24	4.3 4.4	Elements of Numerical Integration (up-to Definition 4.1) Composite Numerical Integration (up-to Example 2)	2c, 2d, 4, 6, 13 1a, 1e*, 3*, 7a, 7b, 9, 11a, 11b
9	Oct 27-31	5.1 5.2	The Elementary Theory of IVPs (Review) Euler's Methods	 1a, 1d, 3a, 3d, 5a*, 5b*, 7a, 7b
10	Nov 3-7	5.4	Runge–Kutta Methods	1a, 1d, 3, 5, 9, 13
Exam 2 on Wednesday November 13, 2019 at 05:30 – 07:30 pm in Bldg 54, Material: 3.5 up-to 5.4				
11	Nov 10-14	6.1 6.2	Linear systems of Equation Pivoting Strategies (Partial Pivoting only)	1a, 1b, 3a, 5a, 5b 1a, 1b, 9, 15
12	Nov 17-21	6.5	Matrix Factorization	1a, 3a, 3c, 5a
13	Nov 24-28	7.3	The Jacobi and Gauss-Siedel Iterative Techniques	1a, 1c, 3, 5, 7
14	Dec 1-5	8.1	Discrete Least Squares Approximation (Degree one and two only)	1, 2, 3, 4
15	Dec 8-12	11.3	Finite-Difference Methods for Linear Problems	1a, 1b, 3a, 3b, 4a, 4b
Final exam on Wednesday December 18, 2019 at 08:00 – 11:00 pm, Material: **(Comprehensive)**				

Notes: 1. Suggested problems with * are done with a Computer Algebra System.
2. No Proofs of theorems are required.