King Fahd University of Petroleum & Minerals
Mathematics & Statistics Department

MATH 371
Introduction to Numerical Computing

Term 182

Course Syllabus

Course Coordinator

Dr. Kareem Elgindy.

Course Instructors

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Credit

3-0-3.

Required Textbook

- R.L. Burden, J.D. Faires, and A.M. Burden. *Numerical Analysis*. Cengage Learning, 10th edition, 2015.

Optional Textbooks

- E.W. Cheney and D.R. Kincaid. *Numerical Mathematics and Computing*. Brooks/Cole, Cengage Learning, 7th edition, 2013.
- T. Sauer. *Numerical Analysis*. Always learning. Pearson, 2nd edition, 2011.
- Uri M. Ascher and Chen Greif. *A First Course on Numerical Methods*, volume 7. Siam, 2011.
- E. Süli and D.F. Mayers. *An Introduction to Numerical Analysis*. Cambridge University Press, 2003.
- Lloyd N. Trefethen and David Bau III. *Numerical Linear Algebra*, volume 50. Siam, 1997.

Optional MATLAB Textbooks and References

- Steve Otto and James P. Denier. *An Introduction to Programming and Numerical Methods in MATLAB*. Springer Science & Business Media, 2005.
- Desmond J. Higham and Nicholas J. Higham. *MATLAB Guide*, volume 150. Siam, 3rd edition, 2016.
- Brian R. Hunt, Ronald L. Lipsman, and Jonathan M. Rosenberg. *A Guide to MATLAB: For Beginners and Experienced Users*. Cambridge University Press, 3rd edition, 2014.
- Christos Xenophontos. A Beginner's Guide to MATLAB. *Department of Mathematical Sciences, Loyola College*, 2002.

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; we focus on the theoretical and computational aspects.

Learning Outcomes

After successfully completing this course the students shall 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 engineering data and approximate functions.
6. Understand and program algorithms to evaluate the derivative and the integral of a given function, evaluate the approximation error involved, and estimate its upper bound.
7. Understand and program algorithms to solve ordinary differential equations.
8. Understand relationships among methods, algorithms, and computer errors.
9. Apply numerical and computer programming tools to solve common engineering problems.

Grading Policy

The overall grade of the course is 400 marks. The course grade will be calculated using the following scheme.

Two Major Exams	20% each
Final Major Exam *(Comprehensive)*	30%
Classwork (Homeworks & Quizzes)	15% *(7.5% each with classwork average within* $[42, 45]$*)*
MATLAB Assignments	15%

The conversion from the overall percent grades into the final letter grades is shown in Table 1.

Overall Percent Grade	Letter Grade
$\geq 90\%$	*A+*
$[85\%, 90\%)$	*A*
$[80\%, 85\%)$	*B+*
$[75\%, 80\%)$	*B*
$[70\%, 75\%)$	*C+*
$[60\%, 70\%)$	*C*
$[55\%, 60\%)$	*D+*
$[50\%, 55\%)$	*D*
$< 50\%$	*F*

Table 1: Mapping of the overall percent grades into the final letter grades.

Passing Grade

A student must score at least 50% (200 marks) of the overall course grade to pass the course.

Class Schedule

Table 2 below provides a preliminary schedule.

Table 2: Class schedule.

Week	Dates	Sections	Topics
1	Jan. 06-10	1.1	Taylor Polynomials and Series
		1.2	Decimal Machine Numbers
2	Jan. 13-17	1.2	Finite-Digit Arithmetic (Up to Table 1.3)
		1.3	Algorithms and Convergence
3	Jan. 20-24	–	MATLAB
4	Jan. 27-31	2.1	The Bisection Method
		2.2	Fixed-Point Iteration
5	Feb. 03-07	2.3	Newton's Method
		3.1	Interpolation and the Lagrange Polynomial (Up to Example 3)
Major Exam 1 on Wednesday Feb. 13, 2019 During 6:00 pm – 8:00 pm Material: 1.1–3.1			
6	Feb. 10-14	3.3	Divided Differences (Up to Example 1)
		3.5	Cubic Spline Interpolation
7	Feb. 17-21	4.1	Formulas 4.1, 4.5, and 4.9 – Round-Off Error Instability
		4.3	Elements of Numerical Integration (Up to Definition 4.1)

8	Feb. 24-28	4.4 4.7	Composite Numerical Integration Gaussian Quadrature (Up to Example 1)
9	Mar. 03-07	5.1 5.2	The Elementary Theory of Initial-Value Problems Euler's Method
10	Mar. 10-14	5.3 5.4	The Order of Euler's Method in View of Definition 5.11 Taylor's Theorem in Two Variables – Runge-Kutta Methods of Order Two – Runge-Kutta Order Four – Computational Comparisons
Major Exam 2 on Wednesday Mar. 20, 2019 During 6:15 pm – 8:15 pm **Material: 3.3–5.3**			
11	Mar. 17-21	6.1 6.2	Linear Systems of Equations Partial Pivoting
12	Mar. 24-28	6.5 6.6	Matrix Factorization Tridiagonal Matrices
13	Mar. 31 - Apr. 04	7.3	The Jacobi and Gauss-Seidel Iterative Techniques
14	Apr. 07-11	8.1	Linear, Quadratic, and Exponential Least-Squares
15	Apr. 14-18	11.3	Finite-Difference Methods for Linear Problems (Up to Example 1)
Final Major Exam on Saturday Apr. 20, 2019 During 8:00 am – 11:00 am **Material: Comprehensive**			

Homeworks

Homeworks 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 MATLAB Codes

Pseudocodes and MATLAB 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 MATLAB codes. You may also expect to be asked to do the other way around; i.e., convert a MATLAB 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.

Communications

Talking in person is the preferred method to communicate with your instructor; email is the next best option.

Academic Integrity

All KFUPM policies regarding ethics apply to this course. It is important to learn that we as members of KFUPM community shall not tolerate academic dishonesty. You are encouraged to work together on the assignments but copying in any form or submitting work done by others as your own is a violation of the Academic Integrity.

Further Important Notes

- Proofs of theorems are out of the course scope.
- Calculators are allowed in all progress tests and major exams.
- The recommended versions of MATLAB to use in this course are MATLAB R2018b or MATLAB R2018a, which are the latest stable releases.

May Allah Grant You Great Success