King Fahd University of Petroleum & Minerals

Department of Mathematics

MATH 371 Syllabus, **Term 252**

Coordinator: Dr. Said Algarni

Course Code: Math 371 - **Numerical Computing - Credit Hours: 3-1-3**

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. 7th Edition (2015).

The Course Objective: The objective of the course is to:
1. Introduce students to the field of Numerical Methods.
2. Use computing software for hands on knowledge.

The Course Content: Floating-point arithmetic and error analysis. Solution of nonlinear equations. Polynomial interpolation. Numerical integration and differentiation. Data fitting. Matrix factorization. Jacobi, Gauss-Siedel and Conjugate Gradient methods. Eigenvalues and Singular Value Decomposition (SVD). Newton's and Steepest Descent methods for system of nonlinear equations. Initial and boundary value problems of ordinary differential equations (ODEs); Using computer software as a computational platform.

Prerequisite: MATH 201

Computer Usage: Computer software is an integral part of this course and mainly we shall use MATLAB as the computational platform.

The Course Learning Outcome: After completion of the course, the students should be able to:
1. Apply Taylor series to approximate functions.
2. Solve numerically system of linear and nonlinear equations
3. Use interpolation and least square approximations for data fitting
4. Use numerical differentiation and integration formulas.
5. Solve numerically initial and boundary value problems for ODEs.
6. Apply singular value decomposition.
7. Apply numerical and computer programming tools to solve real-life problems.

The Course Grading Policy:

	Date	**Materials**	**Points**	**Percentage**
Major Exam I (MCQ)	17th February	**Sec. 1.1- 4.4 (14 questions)**	70 points	23.33%
Major Exam II (MCQ)	9th April	**Sec. 5.1- 7.3 (14 questions)**	70 points	23.33%
Final Exam (MCQ)	TBA	**Comprehensive (20 questions)**	100 points	33.33%
Classwork	▪ It is based on quizzes, class tests, or other class activities determined by the instructor. ▪ The average (out of 30) of the class work of each section has to be in the interval $[y-1, y+1]$, where $\boldsymbol{y = \frac{median(Exam\ I)\% + median(Exam\ II)\%}{20/3}}$		30 points	10%
Lab	MATLAB Assignments (minimum 3 assignments)		30 points Subjective to bounds [70%, 75%]	10%
	Total		300 points	100%

Letter Grades: The letter grades will follow a grading curve, which depends on the average for each instructor in the course.

Exam Questions: The questions of the exams are similar to the examples and exercises in the textbook.

Cheating in Exams: Cheating or any attempt of cheating by use of illegal activities, techniques and forms of fraud will result in a grade of DN in the course along with reporting the incident to the higher university administration for further action. Cheating in exams includes (but is not restricted to):

- Looking at the papers of other students.
- Talking to other students.
- Using mobiles, smart watches or any other electronic devices.
- Using ChatGPT or any AI source.

Other Exam Issues:

- No student will be allowed to take the exam if he/she does not bring his/her KFUPM ID, or National/Iqama ID, or Driver's License with him/her to the exam hall.
- Students are not allowed to have their mobiles, smart watches, or any electronic device in the exam hall. A violation of this will be considered an attempt of cheating.
- A student must sit in the seat assigned to him/her. A violation of this will be considered an attempt of cheating.

Missing an Exam: In case a student misses an exam (Exam I, Exam II, or the Final Exam) for a legitimate reason (such as medical emergencies), he/she must bring an official excuse from Students Affairs. Otherwise, he/she will get a score of zero in the missed exam.

Attendance: Students are expected to attend all lecture and lab classes.

- If a student misses a class/lab, he/she is responsible for any announcement made in that class/lab.
- After warned **twice** by the instructor, a DN grade will be awarded to any student who accumulates
    - accumulates 12 unexcused absences in lecture and lab classes. (20%)
    - accumulates 20 excused and unexcused absences in lecture and lab classes. (33%)

The Usage of Mobiles in Class: Students are not allowed to use mobiles for any purpose during class time. Students who want to use electronic devices to take notes must take permission from their instructor. Violations of these rules will result in a penalty decided by the instructor.

Academic Integrity: All KFUPM policies regarding ethics apply to this course. See the Undergraduate Bulletin in the Registrar's website.

Weekly Coverage of Course Material

Week	Date	Sec.	Topic
1	Jan. 11-15	1.1 1.2	Review of Calculus: Taylor Polynomials and Series Round-off Errors and Computer Arithmetic: (Skip Binary Machine Numbers)
2	Jan. 18-22	2.1 2.2	The Bisection Method Fixed-Point Iteration
3	Jan. 25-29	2.3 3.1	Newton's Method and its Extensions (Newton's method and Secant method only) Interpolation and the Lagrange Polynomials (up-to Example 3)
4	Feb. 1-5	3.5 4.1	Cubic Spline Interpolation (up-to Example 4) Numerical Differentiation (for f' and f'') (**Skip** five-point formulas and Round-off Instability)
5	Feb. 8-12	4.4 5.1	Composite Numerical Integration (up-to Example 2 and skip Composite Midpoint rule) The Elementary Theory of IVPs
Exam#1: Sec. 1.1- 4.4 (9 sections) TBA			
6	Feb. 15-19	5.2 5.4	Euler's Methods (Skip Lemma 5.7, Lemma 5.8, and Theorem 5.10) Runge-Kutta Methods (only Midpoint Method and Runge-Kutta Method of order 4)
Sunday, February 22: Saudi Founding Day Holiday			
7	Feb. 23-26	6.1 6.2	Linear Systems of Equation Pivoting Strategies (Partial Pivoting only)
8	Mar. 1-5	6.5 7.1 7.2	Matrix Factorization Norms of Vectors and Matrices (Definitions only: both Vectors and Matrices) Eigenvalues and Eigenvectors (Up to Example 3)
9	Mar. 8-12	7.3 7.6	The Jacobi and Gauss-Seidel Iterative Techniques (Up to Example 3) The Conjugate Gradient Method (Skip Preconditioning)
March 15-26: Eid Al-Fitr Holidays			
10	Mar. 29 – April 2	8.1	Discrete Least Squares Approximation
11	April 5-9	9.1 9.2	Linear Algebra and Eigenvalues (Skip Theorem 9.1 and Example 1) Orthogonal Matrices (Definition 9.9 only)
Exam#2: Sec. 5.1- 7.3 (9 sections) TBA			
12	April 12-16	9.6	The Singular Value Decomposition (Up to Example 4)
13	April 19-23	10.2	Newton's Method (Skip Theorem 10.7)
14	April 26-30	10.4	Steepest Descent Method
15	May 3-7	11.3	Finite-Difference Methods for Linear Problems (Up to Example 1)
16	May 10	**Review/ Catching up**	

Note: No proof of theorems.
Final Exam (Comprehensive): Follow the registrar final schedule on his webpage.

Suggested Practice Exercises

Sr.	Sec. No.	Exercises #
1	1.1	9, 10, 12, 13, 17, 20, 21
2	1.2	1, 3, 5(c), 7(a), 11(b), 14
3	2.1	2, 4, 6(b), 8, 11, 13
4	2.2	1, 2, 4, 6, 8, 10, 12, 14, 17
5	2.3	2, 3, 6, 8
6	3.1	2, 4, 5(c), 7, 9, 10, 14(d), 16
7	3.5	4(a), 4(c), 6(b), 8(b), 10, 12, 14, 17
8	4.1	2, 4, 6, 8, 15, 20, 22
9	4.4	2, 4, 7(a, b), 9, 11(a, b), 15
10	5.1	1(just the 1^{st} part), 3
11	5.2	2(a, b), 4, 5(a, d), 7, 9, 16
12	5.4	2(a, d), 4(a, d), 14, 18(a)
13	6.1	1(b, d), 3(b), 6(a, c), 9
14	6.2	2(b, c), 4, 9(b), 11, 13
15	6.5	2, 4(a, c), 5(b, c), 9(a)
16	7.1	1(a, c), 2(b, c), 5(a, c), 7(a), 8(b)
17	7.2	1(a, d), 3(a), 5(a), 9
18	7.3	2(a, c), 4(a, c), 6(a, c), 8(a, c)
19	7.6	1(b), 2(b), 5(a, c)
20	8.1	3, 5(a, b), 7(a)
21	9.1	1(a), 2(d), 6(a, c)
22	9.6	1(a, d), 3(a, d), 5, 6(a, b), 7(d)
23	10.2	1(a, d), 3(d), 5, 7(a, c)
24	10.4	1(a), 2(d), 4, 5(a,b)
25	11.3	1, 3(a), 4(a)