KFUPM Computing
Department of Mathematics

King Fahd University of Petroleum & Minerals

Department of Mathematics

Math 371 Syllabus, Semester 261

Coordinator: Dr. Said Algarni (garnis@kfupm.edu.sa)

Course Code & Title: Math 371 - **Numerical Computing**

Course 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).

Course Description: 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

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

Course Learning Outcomes: Upon the completion of the course, 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

Grading Policy:

	Date	Materials	Points
Exam I (MCQ)	TBA	Sec. 1.1- 4.4 (14 questions)	70 points
Exam II (MCQ)	TBA	Sec. 5.1- 7.3 (14 questions)	70 points
Final Exam (MCQ)	TBA	Comprehensive (20 questions)	100 points
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 $y = \frac{median(Exam\ I)\% + median(Exam\ II)\%}{20/3}$		30 points
Lab	MATLAB Assessments (minimum 3 assessments)		30 points, Subjective to bounds [70%, 75%]
	Total		300 points

Letter Grades: Final letter grades will be assigned according to a grading curve, which will be determined based on the overall performance of all students enrolled in the course. The exact cutoffs may change from one term to another, depending on how the scores are distributed.

Exam Questions: Exam questions will be similar in style and level of difficulty to the examples and exercises provided in the textbook.

Examination Policies: You are expected to adhere to KFUPM policies for all examinations in this course, including quizzes, major exams, midterms, and final exams. The following policies are enacted in this course during examinations:

- Students are expected to arrive at the examination hall on time with proper University ID.
- Students are seated according to the instructor's seat assignment and may request a seat change only for legitimate reasons.
- Late arrival to the exam may result in the student being denied admission. Once a student has completed the examination and left the examination hall/room, no late student will be admitted.
- Students are not permitted to leave the examination room to use the restroom during an exam, except in rare cases involving a documented medical condition (e.g., diabetes, kidney disease). Any excused restroom leave will be fully supervised by a same-gender proctor.
- Students must leave all smart devices outside the examination hall, including smartphones, smartwatches, earbuds, and unauthorized calculators. Possession of any unauthorized device will be considered a cheating attempt and will be handled accordingly.

- Cheating attempts will be reported according to KFUPM policy and will result in a DN grade in the course, along with potential further penalties upon investigation.

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), the student must submit an official excuse approved by the Deanship of Student Affairs within **seven calendar days** of the missed exam date. Without an approved excuse, the student will receive a score of zero for the missed exam. When the excuse is accepted, the coordinator will arrange a makeup exam for the missed exam.

Class Attendance: Students are expected to arrive on time for class, consistent with expectations in professional settings. Recording attendance for another student, signing another student's attendance, or asking another student to record yours will be reported for investigation and may result in severe consequences for both students involved. A DN grade will be given after two warnings if a student reaches 12 unexcused absences in lectures and labs or a total of 20 absences in lectures and labs, whether excused or not.

Use of Mobile Devices in Class: The use of mobile phones during class is strictly prohibited. Students who wish to use laptops or tablets for notetaking must first obtain permission from the instructor. Any violation will result in a penalty determined by the instructor.

Academic Integrity: All KFUPM academic integrity policies apply to this course. For details, students should refer to the Undergraduate Bulletin available on the Registrar's website.

Accessibility and Accommodations: Students with documented special needs, approved by the Deanship of Student Affairs, should contact the course coordinator to arrange reasonable accommodation.

Honor code: Students of this course are expected to maintain the highest level of academic integrity and ethics. A KFUPM student does not cheat or tolerate those who do. Every student is expected to submit work that is entirely their own, to properly cite all sources used, and to refrain from any form of academic misconduct.

Plagiarism: Use of another person's ideas, processes, results, or words requires appropriate credit or reference to the author. Use of Generative AI tools is subject to the instructor's authorization. Submitting the same work in more than one course without the instructor's permission is not allowed.

Suggested Weekly Coverage Plan

Week	Date	Sec.	Titles
1	19–20 Aug	1.1	Review of Calculus: Taylor Polynomials and Series
2	23–27 Aug	1.1 1.2	Cont. Round-off Errors and Computer Arithmetic: (Skip Binary Machine Numbers)
3	30 Aug–3 Sep	2.1 2.2	The Bisection Method Fixed-Point Iteration
4	6–10 Sep	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)
5	13–17 Sep	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)
6	20–22 Sep	4.4 5.1	Composite Numerical Integration (up-to Example 2 and skip Composite Midpoint rule) The Elementary Theory of IVPs
23–24 Sep: National Day Holiday			
7	27 Sep–1 Oct	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)
8	4–8 Oct	6.1 6.2	Linear Systems of Equation Pivoting Strategies (Partial Pivoting only)
9	11–15 Oct	6.5 7.1	Matrix Factorization Norms of Vectors and Matrices (Definitions only: both Vectors and Matrices)
10	18–19 Oct	7.2	Eigenvalues and Eigenvectors (Up to Example 3)
20–22 Oct: Mid-term break			
11	25–29 Oct	7.3 7.6	The Jacobi and Gauss-Siedel Iterative Techniques (Up to Example 3) The Conjugate Gradient Method (Skip Preconditioning)
12	1–5 Nov	8.1	Discrete Least Squares Approximation
13	8–12 Nov	9.1 9.2	Linear Algebra and Eigenvalues (Skip Theorem 9.1 and Example 1) Orthogonal Matrices (Definition 9.9 only)
14	15–19 Nov	9.6	The Singular Value Decomposition (Up to Example 4)
22–23 Nov: Autumn break			
15	24–26 Nov	10.2	Newton's Method (Skip Theorem 10.7)
16	29 Nov–3 Dec	10.4	Steepest Descent Method
17	6–10 Dec	11.3	Finite-Difference Methods for Linear Problems (Up to Example 1)

Note: No proofs of theorems are required**.**

Final Exam (Comprehensive): Follow the Registrar's final-examination schedule published on the Registrar's website

Suggested Practice Problems

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)