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. (6th Edition).

 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; 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. <u>Apply</u> Taylor Series to approximate functions.
2. <u>Solve</u> numerically system of linear and nonlinear equations
3. <u>Use</u> interpolation and least square approximations for data fitting
4. <u>Use</u> numerical differentiation and integration formulas.
5. <u>Solve</u> numerically initial and boundary value problems for ODEs.
6. <u>Apply</u> singular value decomposition.
7. <u>Apply</u> numerical and computer programming tools to solve real-life problems.

The Course Grading Policy:

	Date	**Materials**	**Points**	**Percentage**
Major Exam I (MCQ)	TBA	**Sec. 1.1- 4.4 (14 questions)**	70 points	23.33%
Major Exam II (MCQ)	TBA	**Sec. 5.1- 7.6 (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 25) of the class work of each section has to be in the interval $[y-1, y+1]$, where $$y = \frac{median(Exam\ I)\% + median(Exam\ II)\%}{8}$$		20 points	6.66%
Lab	MATLAB Assignments (minimum 3 assignments)		40points Subjective to bounds [70%, 75%]	13.33%
	Total		300 points	100%

Letter Grades: The letter grades will follow a grading curve, which depends on the average of all students enrolled 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.

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.

Week	Date	Sec.	Topic
1	Jan. 12-16	1.1 1.2	Review of Calculus: Taylor Polynomials and Series Round-off Errors and Computer Arithmetic: (Skip Binary Machine Numbers)
2	Jan. 19-23	2.1 2.2	The Bisection Method Fixed-Point Iteration
3	Jan. 26-30	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. 02-06	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. 09-13	4.4 5.1	Composite Numerical Integration (up-to Example 2 and skip Composite Midpoint rule) The Elementary Theory of IVPs
6	Feb. 16-20	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)
			Exam#1:DATE, Sec. 1.1- 4.4 (10 sections)
			Sunday, Feb. 23, 2025: Saudi Founding Day
7	Feb. 23-27	6.1 6.2	Linear Systems of Equation Pivoting Strategies (Partial Pivoting only)
8	March 02-06	6.5 7.1 7.2	Matrix Factorization Norms of Vectors and Matrices (Definitions only: both Vectors and Matrices) Eigenvalues Eigenvector (Up to Example 3)
9	March 09-13	7.3 7.6	The Jacobi and Gauss-Seidel Iterative Techniques (Up to Example 3) The Conjugate Gradient Method (Skip Preconditioning)
10	March 16-20	8.1	Discrete Least Squares Approximation
			March 23- April 3: Eid Al-Fitr Holidays
11	April 06-10	9.1 9.2	Linear Algebra and Eigenvalues (Skip Theorem 9.1 and Example 1) Orthogonal Matrices (Definition 9.9 only)
			Exam#2: DATE, Sec. 5.1- 7.6 (10 sections)
12	April 13-17	9.6	The Singular Value Decomposition (Up to Example 4)
13	April 20-24	10.2	Newton's method (Skip Theorem 10.7)
14	April 27-May 01	10.4	Steepest Descent Method
15	May 04-08	11.3	Finite-Difference Methods for Linear Problems (Up to Example 1)
16	May 11		**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 1st 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)