King Fahd University of Petroleum and Minerals

Department of Mathematics & Statistics

Math 472 Syllabus, Term 211

Coordinator/Instructor: Dr. Muhammad Yousuf

The Course Code and Name: Math 472, Numerical Analysis II
The Course Credit Hours: 3-0-3
Textbook: "Numerical Analysis" by Richard L. Burden, J. Douglas Faires 10th (2016)
Reference Books:

- 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.

The Course Objective:
This is the second part of the undergraduate Numerical Analysis course that aims to cover more advanced numerical methods to solve problems that arise in the applied sciences and engineering. We will cover many practical applications of numerical analysis such as interpolation, polynomial approximation, adaptive approximation, numerical differentiation and integration, IVPs and BVPs of ODEs, IVPs of stiff ODEs, and data fitting. The course also aims to reinforce the understanding of the sources, significance, calculation, and interpretation of numerical errors associated with numerical computations. In order to make the presentation concrete and appealing we adopt the programming environment MATLAB as a faithful companion to analyze and solve a range of problems numerically.

The Course Content:
Approximation of functions: Polynomial interpolation, spline interpolation, least squares theory, adaptive approximation. Differentiation. Integration: basic and composite rules, Gaussian quadrature, Romberg integration, adaptive quadrature. Solution of ODEs: Euler, Taylor series and Runge-Kutta methods for IVPs, multistep methods for IVPs, systems of higher-order ODEs. Shooting, finite difference and collocation methods for BVPs. Stiff equations.

Computer Usage: Computer software is essential for this course. Mainly we will be using MATLAB as the computational platform.

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

- Approximate functions and interpolate precise data using Taylor series and polynomials, polynomial approximations, and piecewise polynomial approximations.
- Fit the best curve in the least-squares sense for data exhibiting a significant degree of error or scatter.
- Approximate the derivatives and definite integrals of functions.
- Approximate the solutions to IVPs and BVPs of ODEs.
- Determine the region of absolute stability for one- and multi-step methods to solve IVPs of stiff ODEs.

The Course Grading Policy: There may be some changes later.

	Date	Time	Place	Materials	Percentage
Exam I					25%
Exam II					25%
Final Exam					35%
Quizzes	5 online quizzes. To be conducted online through Blackboard.				10%
Projects	Three Applications projects using Matlab				15 %

Exam Questions: The questions of the exams are based on the examples and exercises in the textbook.

Misconduct in Exams: 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 university higher administration. Cheating in exams includes (but is not limited to) receiving help from anyone or any other outside source and unauthorized use of the book, course notes, phones.

Missing an Exam:

Midterm Exam: No make-up exam will be given under any circumstances. In case a student misses midterm exam for a legitimate reason (such as medical emergencies etc.), his grade for this exam will be determined based on the existing formula which depends on his performance in the final exam.

Final Exam: If a student misses the final exam for a legitimate reason (such as medical emergencies), he will be given a make-up final exam.

Attendance: Students are expected to attend all lecture classes.

- If a student misses a class, he is responsible for any announcement made in that class.
- A DN grade will be awarded to any student who accumulates
  - 9 unexcused absences in lecture classes.
  - 12 excused and unexcused absences in lecture classes.

Academic Integrity: All KFUPM policies regarding ethics apply to this course. See the Undergraduate Bulletin.

The Pacing Schedule

Week	Date	Sec.	Topics	**Important Problems**
1	Aug 29 -Sep 02	1.1 3.1	Taylor Polynomials and Series review Interpolation and the Lagrange Poly	1, 3, 5, 7, 11, 13 1, 3, 5, 7, 9, 10
2	Sep 05-09	3.3 3.4	Divided Difference Hermit Polynomial	1, 2, 3, 5 1, 3, 5, 6
3	Sep 12-16	3.4 3.5	Hermit Polynomial (Continue) Cubic Spline Interpolation	 1, 2, 3, 5, 11, 12, 13, 14
4	Sep 19-23	4.1 4.2	Numerical Differentiation Richardson's Extrapolation	

5	Sep 26-30	4.3 4.4	Elements of Numerical Integration Composite Numerical Integration	
6	Oct 03-07	4.7	Gaussian Quadraturs	
7	Oct 10-14	5.1 5.2	The Elementary Theory of I.V.P. Euler' Methods	
8	Oct 17-21	5.3	Higher Order Taylor Methods	
9	Oct 24-28	5.4	Runge – Kutta Methods	
10	Oct 31 -Nov 04	5.6	Multi Step Methods	
11	Nov 07-11	5.9	Higher-Order Equations and Systems of Differential Equations	
12	Nov 14-18	5.11	Stiff Differential Equations	
11	Nov 07-11	11.1	Linear Shooting Method	
12	Nov 14-18	11.3	Finite-Difference Methods for Linear Problems	
13	Nov 21-25	8.1	Discrete Least-Square Approximations	
14	Dec 05-09	8.3	Chebyshev Polynomials	
15	Dec 12-16	8.4	Rational Function Approximations	
16	Dec 19-20		Catchup and Review	

Online MATLAB Help:

• MATLAB® Primer. https://www.mathworks.com/help/pdf_doc/matlab/getstart.pdf

• Christos Xenophontos. A Beginner's Guide to MATLAB.

http://math.loyola.edu/~loberbro/matlab/Beginners_guide_to_MATLAB.pdf