KOÇ UNIVERSITY
College of Engineering
Mechanical Engineering Department

Title:	**MECH 307 Numerical Methods for Mechanical Engineering** (an area elective for Mechanical Engineering students)
KU Credits:	3
ECTS Credits:	6
Audience:	Required area course for Mechanical Engineering students
Prerequisite:	MATH. 204 and COMP. 130 or 131; or consent of the instructor
Classes:	Tuesday & Thursday 10:00-11:15
PS:	Thursday 17:30-18:45 in ENG Z21 & Friday 10:00-11:15 in ENG Z21
DS:	---
Lab:	---
Semester:	Spring 2018
Instructor:	Murat Sözer Office: ENG 249 and KOLT (Library Z06-C), phone: 1582, e-mail: msozer@ku.edu.tr Office Hours: Tuesdays and Thursdays, 14:00-15:00 or by appointment.
Teaching Assistant:	Mert Hanıcıoğlu, Office: ENG 255 and ENG 106, phone: x2603, e-mail: mhancioglu@ku.edu.tr Hasan Çağlar, ENG 106 and 255, x1852, hcaglar16@ku.edu.tr Office Hours: please e-mail to TAs to get an appointment.

KOLT Tutoring:

Day	Time	Place	Tutor	Cubicle No
Monday	11:30 - 12:45	KOLT	Nilüfer Özhan	13
Monday	13:00 - 14:15	KOLT	Deniz Sayınbaş	3
Monday	16:00 - 17:15	KOLT	Burak Çakal	6
Tuesday	11:30 - 12:45	KOLT	Nilüfer Özhan	13
Tuesday	13:00 - 14:15	KOLT	Deniz Sayınbaş	3
Tuesday	16:00 - 17:15	KOLT	Ezgi Çevik	9
Tuesday	17:30 - 18:45	KOLT	Burak Çakal	6
Wednesday	11:30 - 12:45	KOLT	Nilüfer Özhan	6
Wednesday	13:00 - 14:15	KOLT	Deniz Sayınbaş	3
Thursday	11:30 - 12:45	KOLT	Burak Çakal	6
Thursday	16:00 - 17:15	KOLT	Ezgi Çevik	6
Friday	10:00 - 11:15	KOLT	Ezgi Çevik	6

Course Description

- Introduction to programming in MATLAB,
- foundations in computing,
- root finding,
- solving systems of linear equations with direct and iterative methods,
- solving nonlinear equations of multi-variables,
- curve-fitting,
- numerical differentiation and integration,
- solving ODEs and PDEs using Eulerian time-marching scheme and finite difference method (FDM),
- solving many engineering problems related with initial- and boundary-value problems, Laplace and heat equations.

Textbook: No textbook. Class notes will be used.

Reference books:

- Applied Numerical Analysis Using MATLAB, Laurene V. Fausett, Prentice Hall
- Applied Numerical Analysis, Curtis. F. Gerald and Patrick O. Wheatley, Pearson
- Numerical Methods Using MATLAB, Mathews and Fink, Prentice Hall.
- An Introduction to Matlab, David F. Griffiths, University of Dundee.
- Numerical Methods with MATLAB, Gerald Recktenwald, Prentice Hall.
- Numerical Methods, An Intro. with App. Using MATLAB, Gilat and Subramaniam, J.Wiley
- Applied Numerical Methods with MATLAB for Engineers and Scientists, Chapra, McGraw Hill

Motivation:

- It is usually difficult to obtain exact analytic solutions to important problems in engineering.
- Numerical methods and computers enabled solutions of a wide range of problems.
- This course is organized to serve as an introduction to numerical methods.
- The emphasis will be based on the following two:
  (1) the fundamental concepts of numerical analysis, and
  (2) hands-on experience in implementing the numerical methods.
- MATLAB will be used in the applications, projects and homework.
  Hence, at the beginning of the semester, coding in MATLAB will be studied for 3 weeks.

Contents:

0. Introduction to MATLAB.
1. Foundations.
2. Solving equations of one variable (root-finding).
3. Solving systems of linear equations: direct methods (Gaussian elimination & inverse matrix).
4. Solving systems of linear equations: iterative methods (Jacobi & Gauss-Seidel methods).
5. Solving nonlinear equations with several variables (Newtonian method with Jacobian matrix).
8. Interpolation.
9. Curve-fitting (least square method; overdetermined cases).
11. Numerical differentiation (finite differences) and integration (trapezoidal and Simpson's 1/3 rule).
12. Ordinary Differential Equations: Initial-Value Problems, 1st Order (Euler method).
13. Ordinary Differential Equations: Initial-Value Problems, 2nd and Higher Order (Euler method).
14. Ordinary Differential Equations: Boundary Value Problems (finite-difference method).
15. Partial Differential Equations: Boundary Value Problems (finite-difference method) and Initial Value Problems (finite-difference method coupled with Euler time-marching scheme).

Course Share Folder: The following items are available in the share folder at F:\COURSES\UGRADS\MECH201

- lecture notes,
- class assignments (problems, solutions and Matlab codes),
- practice exercises (not to be graded, for your own practice),
- online quizzes,
- old years' exams (problems & solutions of 2003-2009),
- practice exams (sets of problems and solutions to get ready for midterm exams and final),
- instant feedback (virtual office hour).

Tentative **Schedule:**

Day	Date	Chapter
1	Feb. 06	0 (Matlab Tutorial)
2	Feb. 08	0
3	Feb. 13	0
4	Feb. 15	0
5	Feb. 20	0
6	Feb. 22	1
7	Feb. 27	2
8	March 01	2
9	March 06	3-4
10	March 08	3-4
11	March 13	5
12	March 15	5
13	March 20	8
14	March 22	9
15	March 27	9

Day	Date	Chapter
16	March 29	11
17	April 03	11
18	April 05	12
19	April 10	Spring Break
20	April 12	Spring Break
21	April 17	12
22	April 19	13
23	April 24	13
24	April 26	14
25	May 01	Holiday
26	May 03	14
27	May 08	14
28	May 10	15
29	May 15	15
30	May 17	15

HW Schedule: Approximately 10 HWs will be given during the semester.
See the schedule file in the share folder.

Design Project Schedule: Two of the following alternatives will be assigned. The due dates will be announced later.

Design Project (DP)	Chapter	Project (details will be supplied in hand-outs)
1	9	Curve Fit to Experimental Data
2	11	Numerical Differentiation and Integration of Experimental Data
3	13	ODE: Initial-Value Problem (Time Marching)
4	14	ODE: Boundary Value Problems (Steady Heat Equation & Potential Equation in Fluid Mechanics)
5	15	PDE (Unsteady Heat Equation)

Grading:

Attendance	2 %	(See the next page for detail.)
Homeworks + Design Projects + Graded Class Assignments + Quizzes	20 %	
Midterm Exam I	20 %	March 31 (Chps. 0-9)
Midterm Exam II	20 %	April 28 (Chps. 11-13)
Final Exam	38 %	May 28 (Chps. 0-15; cumulative)

Expected Studying Time:

Item	Approximate studying time [hours] per week	Approximate studying time [hours] per semester (= 14 weeks)
Lecture	2 * 1.25 = 2.50	35.00
Problem Solution Session (PS)	1.25	17.50
Review of class notes and PS	2.00	28.00
HW	3.00	35.00
Weekly sub-total	9.75	
Design Projects		10.00
Midterm Exam 1 (studying & exam)		15.00
Midterm Exam 2 (studying & exam)		15.00
Final Exam (studying & exam)		25.00
TOTAL		201.50

Teaching Methods:

The following items are used

- tutorial on programming in Matlab (3 weeks);
- lecture notes;
- lecture videos;
- programming in Matlab for solving many engineering problems;
- homework and project assignment;
- problem solving sessions;
- review for exams.

Course Objectives:

This course is to have students become competent in …

- programming in Matlab to implement numerical methods when solving many engineering problems;
- knowing the foundations of computing;
- calculating the roots of a function;
- understanding the fundamentals of linear algebra;
- knowing the direct and iterative solution techniques to solve a linear equation set;
- knowing the iterative solution technique to solve a nonlinear equation set;
- knowing the direct solution techniques (Gauss elimination and inverse matrix approach) and iterative solution techniques (Jacobian and Gauss-Seidel Iterative Methods) to solve a linear equation set;
- knowing exact polynomial curve fit;
- knowing best-curve fit;
- converting a continuous domain into a discrete domain;
- applying numerical differentiation methods;
- applying numerical integration methods;
- numerically solving initial-value problems (ODEs) of 1st and higher orders;
- numerically solving boundary-value problems (ODEs and PDEs).

Course Outcome:

At the end of this course, the students will be able to …

- program in Matlab;
- implement numerical methods in Matlab to solve a wide variety of engineering problems;
- understand the solution types (no-, unique, and infinitely-many solutions) of linear algebra in general;
- calculate the roots of a function using bi-section, fixed-point iteration, Newton's methods, and also by searching for sign changes;
- calculate the unknowns of a linear equation set using direct solution techniques (Gauss elimination and inverse matrix approach) for the unique-solution case;
- calculate the unknowns of a linear equation set using iterative solution techniques (Jacobian and Gauss-Seidel Iterative Methods) for the unique-solution case;
- calculate the unknowns of a nonlinear equation set using the iterative solution technique (Jacobian Method);
- know how to fit a unique N'th order polynomial curve passing from N+1 data points;
- know how to fit a polynomial or special-function curve passing from data points using (1) least-square method and (2) over-determined system;
- apply numerical differentiation with finite-differences and calculate the 1st and higher order derivatives of analytical functions or experimental data points;
- apply numerical integration using (1) trapezoidal rule and (2) Simpson's 1/3 rule, and calculate definite integrals of analytical functions or experimental data points;
- numerically solve initial-value problems (ODEs) of 1st and higher orders using Eulerian time-marching scheme and search for convergence of result by reducing time step;
- discretize a solution domain; and numerically solve boundary-value problems (ODEs and PDEs) using finite-difference method.

Format of Exams: Matlab is allowed;
Lecture notes are placed in a shared exam folder and allowed to use them during the exam.
Your own HW and assignments are also allowed.

Late Assignment: If an assignment (HW or project) is turned in late, you lose 25% of the grade per day.

Attendance to class: You are required to attend at least two thirds (= 67%) of the classes. Otherwise, you receive grade F.

Attendance grade (out of 2%) is calculated as follows
(medical report or a similar excuse will not affect the grading):

Full attendance to the class:	5%
1-day-absence:	4%
2-day-absence:	3%
3-day-absence:	2%
4- or more-day-absence:	0%

Attendance to PS: Every Friday.
You are strongly suggested to attend weekly Problem Sessions (PS).
(1) Exercise problems will be solved by either a TA, tutor or the instructor; and
(2) A quiz may be given similar to the problems already solved.

Moral Expectations from Students

The students are expected to submit their own work in all exams, projects, homeworks and class assignments.

- In quizzes and exams, students show how well they have learnt the material. Therefore they must not exchange any information.
  All forms of information transfer between students, and ***any*** talking will be considered as cheating.

- In HWs, students enhance their knowledge and show their skills.
  You can give/take brief tips from others verbally on how to do things, but you are expected not to exchange papers or electronic files, and not to work together, or not let others do your work (even partially).

- Please be on time when entering the classroom. The class starts at 10:00.

- Please put your mobile phones to airplane or silence mode and do not use it.

- This course takes place in a computer lab so that (1) the theoretical part will be taught initially, and (2) then you will be given time for practicing on computer in the second part. You are not allowed to use computers while the instructor teaches during the first lecturing part. So, the monitors must be turned off during this first part.