University of Jordan
School of Engineering
Civil Engineering Department

Advanced Numerical Methods (0901731)
Syllabus

Spring 2018/2019

INSTRUCTOR:
Dr. Rabab Allouzi (r.louzi@ju.edu.jo)

OFFICE HOURS:
Sunday,Tuesday and Thursday 3:00 pm – 3:30 pm
Monday and Wednesday: 11AM-12:30PM

GRADING SYSTEM:
Mid Exam (40%)
First Project (10%)
Second Project (10%)
Final Exam (40%)

REFERENCES:

Chapra, S.C., and R.P. Canale. *Numerical Methods for Engineers*, 6th edition, McGraw Hill, 2010. ISBN 978-0-07-340106-5

Epperson, J.. *An Introduction to Numerical Methods and Analysis*. 2nd edition, Wiley, 2013

Jaan Kiusalaas. *Numerical Methods in Engineering with MATLAB*. 2nd edition, Cambridge university press, 2010

Ferziger. *Numerical Methods for Engineering Applications*. 2nd edition, Wiley,1998

CONTENT:

Week	Topics
1	**Introduction to numerical methods** - Mathematical Modeling and Engineering Problem Solving - Programming and Software
2	**Error Analysis:** - Approximations and Round-Off Errors - Truncation Errors and the Taylor Series - Total Numerical Error
3	**Matlab** - The use of Matlab software and how certain features are accommodated in the numerical analysis. - Matlab applications in engineering
4	**Numerical Differentiation and Integration** - Newton-Cotes Integration Formulas - Numerical Differentiation - Case Study
5-7	**Ordinary Differential Equations** - Boundary-Value Problems - Eigenvalue Problems - Case Study
8-11	**Partial Differential Equations** - Types of PDEs - Explicit method and stability - Implicit Methods - Crank-Nicolson Method - Finite Difference- elliptic equations - Finite Difference- parabolic equations - Case Study
12-14	**Finite Element Method** - Introduction to FE - The General Approach - Finite-Element Application in One Dimension - Case study (1-D problem) - Two-Dimensional Problems - Solving PDEs with Software Packages - Case Study (2-D problem)
15-16	**Fourier Transformation**

	- Curve Fitting with Sinusoidal Functions - Continuous Fourier Series - Frequency and Time Domains - Fourier Integral and Transform - Discrete Fourier Transform (DFT) - Fast Fourier Transform (FFT) - The Power Spectrum

PROJECT:

- Case studies will be distributed between students to be solved with Matlab.
- Any solution that does not look professional will not be reviewed and will receive automatically a zero.
- Do not crowd your solutions; start each solution on a separate page.
- Draw your illustrations neatly.
- Indicate your sign convention, and relevant parameters, labels, and coordinates on your illustrations.
- Your final answer should be identifiable; underline or draw a box around your final answer. No multiple answers.
- Provide full solutions. If it is not possible to follow your solution logic easily, you may get zero for your solution even if your "final" answer has the right value or expression.

POLICIES:

- MAKE UP exam policy: for students who cannot attend regular exams due to serious illness, or family emergency (all with written proof approved from the University of Jordan regulations), a makeup exam may be arranged AFTER the regular exam. The instructor must be notified prior to the exam, and no exceptions will be made.
- You are NOT ALLOWED to use CELL PHONE. Close your phone before you get to class unless you are expecting an emergency call then please let your instructor know before class.
- If you have a course-related question, please see the instructor during office hours or set an appointment by email.
- All cheating in the course will be referred to the Office of the Dean of Students
- You are expected to arrive in class and be seated on time and not leave the classroom before the instructor dismisses class. If you will not be arriving on time or have to leave early then let the instructor know beforehand.
- Individuals engaged in any activity that disturbs the attention of the class will be asked to leave the classroom immediately.

LEARNING OUTCOMES:

- To be familiar with numerical error sources and the significant digits.
- To be able to program numerical methods using MATLAB.

- To compute the integration numerically especially gauss quadrature method that is currently used in Finite Element Method.
- Demonstrate their understanding of how physical systems are modeled by differential equations.
- To calculate the solution of ordinary differential equation under initial conditions and boundary value problems using shooting method and finite difference method. Structural applications like defection of beams and sagging of cables are taught.
- To compute and use of eigenvalues and eigenvectors in structural applications like buckling of columns
- To solve partial differential equations numerically and use it in structural applications.