



**The Hashemite University**  
**Faculty of Engineering**  
**Course Syllabus**  
**Department of Mechanical Engineering**

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<b>Course Title:</b>	Numerical Analysis (3,0, 0)	<b>Course Number:</b>	110402303
<b>Designation:</b>	Compulsory	<b>Prerequisite(s):</b>	101203
<b>Instructor:</b>	Dr. Mohammad Gharaibeh	<b>Instructor's e-mail:</b>	mohammada_fa@hu.edu.jo
<b>Office Hours:</b>	11:00 – 01:00pm (Sunday), 11:00-12:30pm (Wednesday) or by appointment.		

**Course Description (catalog):** Basic principles of numerical analysis and methods for solving different engineering problems: error analysis, solution of linear and nonlinear algebraic equations, regression and interpolating polynomials, numerical differentiation and integration, numerical solution of ordinary and partial differential equations.

**Textbook(s) and/or Other Supplementary Materials:**

- *Numerical Methods for Engineers* by Chapra, S.C. and Canale, R.P., McGraw-Hill, 5<sup>th</sup> edition.

**References:**

- *Applied Numerical Analysis* by Curtis F. Gerald and Patrick O. Wheatley, Addison-Wesley, 6<sup>th</sup> edition.
- *An Introduction to Numerical Methods and Analysis* by James F. Epperson, Wiley, 2001.

**Major Topics Covered:**

Topic	# Weeks	# of contact hours
Error Analysis: Approximations and Round-Off Errors	1	3
Error Analysis: Truncation Errors and the Taylor Series	1	3
Roots of Equations: Bracketing and Open Methods	3	9
Linear Algebraic Equations: Gauss Elimination, LU Decomposition and Special Matrices	3	9
Curve Fitting: Least Squares Regressions and Interpolation	2	6
Numerical Differentiation and Integration Formulas	2	6
Ordinary Differential Equations: Runge-Kutta Methods, boundary value and eigenvalue problems.	3	9
<b>Total</b>	<b>15</b>	<b>45</b>

\*Contact hours include lectures, quizzes and exams

**Specific Outcomes of Instruction (Course Learning Outcomes):**

After completing the course, the student will be able to:

- Explain and define the meaning of numerical techniques. (a)
- Evaluate and compare the accuracy of different numerical solution methods. (a, e)
- Demonstrate the fundamentals of numerical methods for: Root of equations, solving systems of linear equations, Data interpretation by curve fitting and interpolation, numerical differentiation and integration. (a, e)
- Manipulate numerical solutions for 1<sup>st</sup> and 2<sup>nd</sup> order differential equations. (a, e)
- Use available engineering softwares to solve engineering problems based on the class contents. (k).

**Student Outcomes (SO) Addressed by the Course:**

#	Outcome Description	Contribution
<b>General Engineering Student Outcomes</b>		
(a)	an ability to apply knowledge of mathematics, science, and engineering	H
(b)	an ability to design and conduct experiments, as well as to analyze and interpret data	
(c)	an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	
(d)	an ability to function on multidisciplinary teams	L
(e)	an ability to identify, formulate, and solve engineering problems	H
(f)	an understanding of professional and ethical responsibility	
(g)	an ability to communicate effectively	
(h)	the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context	
(i)	a recognition of the need for, and an ability to engage in life-long learning	
(j)	a knowledge of contemporary issues	
(k)	an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	M
<b>H=High, M= Medium, L=Low</b>		

<b>Grading Plan:</b>	1st Exam	30 Points	<b>TBA</b>
	2nd Exam	30 Points	<b>TBA</b>
	HWs. & Qs	*****	
	Design Project	--- Points	
	Final exam	40 Points	

**Prepared by:**

Dr. Mohammad A Gharaibeh

**Date:** 09 Sep. 2018

## **Course Content:**

### **Chapter 3: Error Analysis: Approximations and Round-Off Errors (1)**

3.3 Error Definitions.

### **Chapter 4: Error Analysis: Truncation Errors and the Taylor Series (1)**

4.1 Taylor Series.

4.3 Total Numerical Error.

### **Chapter 5: Roots of Equations: Bracketing Methods (1)**

5.2 Bisection Method.

5.3 False Position Method.

### **Chapter 6: Roots of Equations: Open Methods (2)**

6.1 Simple Fixed-Point Iteration.

6.2 Newton-Raphson Method.

6.3 Secant Method and Modified Secant.

6.4 Multiple Roots.

6.5 Systems of Nonlinear Equations.

### **Chapter 9: Linear Algebraic Equations: Gauss Elimination (2)**

9.1 Solving Small Numbers of Equations.

9.2 Naive Gauss Elimination.

9.3 Pitfalls of Elimination Methods.

9.4 Techniques for Improving Solutions.

9.7 Gauss-Jordan.

### **Chapter 10: Linear Algebraic Equations: LU Decomposition and Matrix Inversion (1.5)**

10.1 LU Decomposition.

10.2 The Matrix Inverse.

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#### FIRST EXAM

### **Chapter 11: Linear Algebraic Equations: Special Matrices and Gauss-Seidel (1.5)**

11.2 Gauss-Seidel and Jacobi Iteration.

### **Chapter 17: Curve Fitting: Least-Squares Regression (1.5)**

17.1 Linear Regression.

17.2 Polynomial Regression.

### **Chapter 18: Curve Fitting: Interpolation (2)**

18.1 Newton's Divided Difference Interpolating Polynomials.

18.2 Lagrange Interpolating Polynomial.

### **Chapter 21: Numerical Differentiation and Integration: Newton-Cotes Integration Formulas (2)**

21.1 Trapezoidal Rule.

21.2 Simpson's Rules.

21.3 Integration with Unequal Formulas.

### **Chapter 23: Numerical Differentiation and Integration: Numerical Differentiation (1.5)**

23.1 High Accuracy Differentiation Formulas.

23.3 Derivatives of Unequally Spaced Data.

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#### SECOND EXAM

### **Chapter 25: Ordinary Differential Equations: Runge-Kutta Methods (3)**

25.1 Euler's Method.

25.2 Improvements of Euler's Method.

25.3 Runge-Kutta Methods.

25.4 System of Equations.

### **Chapter 27: Ordinary Differential Equations: Boundary-Value and Eigenvalue Problems (2)**

27.1 General Methods for Boundary-Value Problems and Derivative Boundary Conditions.

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#### FINAL EXAM

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