جامعة الزيتونة الأردنية

Al-Zaytoonah University of Jordan

# Course Syllabus

***According to JORDAN National Qualification Framework (JNQF)***

# Course Name: Numerical Analysis (1)

# Course Number: 0101272

## General Course Information:

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|---|---|
| Course Title | Numerical Analysis (1) |
| Course Number | 0101272 |
| Credit Hours | 3 credit hours |
| Education Type | Blended learning |
| Prerequisites/Co-requisites | Linear Algebra (1)+ Calculus (1) |
| Academic Program | Bachelor Program |
| Program Code | 101 |
| Faculty | Faculty of Science and IT |
| Department | Mathematics |
| Level of Course | 2 |
| Academic Year /Semester | 2023/2024 1st Semester |
| Awarded Qualification | Bachelor |
| Other Department(s) Involved in Teaching the Course | - |
| Language of Instruction | English |
| Date of Production | 2021-2022 |
| Date of Revision | 16-10-2023 |

## Course Coordinator:

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| Coordinator's Name | Tariq Hamadneh |
| Office No. | 9228 |
| Office Phone Extension Number | |
| Office Hours | 10-11, 13-14 Sunday, Tuesday<br>11-12:30 Monday, Wednesday |
| E-mail | t.hamadnah@zuj.edu.jo |

## Other Instructors:

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|---|---|
| Instructor Name | Waseem Almashaleh |
| Office No. | 9121 |
| Office Phone Extension Number | 444 |
| Office Hours | 08:00-11:00 Monday-Wednesday /08:00-9:30 Sunday-Tuesday |
| Email | w.almashaleh@zuj.edu.jo |

## Course Description *(English/Arabic)*:

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| **English** | Students will study the folowing: Introduction to representation of numbers, Errors and their sources, Numerical solution of nonlinear equations with one variable (the bisection, the fixed-point, Newton-Raphson and the secant methods), Multiplicity, the modified Newton's method, Synthetic division, Approximating functions by Taylor polynomials, Interpolation (Lagrange's formula and Newton's finite divided differences formula), Numerical methods to solve systems of linear equation: direct methods (Cramer's Method, inverse method, Gauss elimination method) and iterative methods (Jacobi method and Gauss-Seidel method). |

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| **Arabic** | سيدرس الطالب: مقدمة في تمثيل الأعداد والأخطاء وأنواعها ومصادرها، الحلول العددية للمعادلات غير الخطية بمتغير واحد (طريقة التنصيف، طريقة النقطة الثابتة، طريقة نيوتن–رافسون، طريقة القاطع)، تكرار الجذور، طريقة نيوتن المعدلة، القسمة التركيبية، تقريب الاقترانات بكثيرات الحدود من نوع تايلور، التعديل الداخلي (طريقة لاجرانج، طريقة نيوتن)، الحلول العددية للأنظمة الخطية (الطرق المباشرة: طريقة كرامر، طريقة المصفوفة العكسية، طريقة جاوس)، (الطرق غير المباشرة التتابعية: طريقة جاكوبي وطريقة جاوس سادل). |

## Textbook: *Author(s), Title, Publisher, Edition, Year, Book website.*

"Numerical Analysis", by R. Burden & D. Fairs , 7th Ed. 2017

## References: *Author(s), Title, Publisher, Edition, Year, Book website.*

1-"Applied Numerical Analysis", by Gerald & Wheatley , 7th Ed., (2004), Addison-Wesley Publishing Company.
2-"Numerical Methods: Using Matlab", by John H. Mathews and Kurtis D. Fink, 4th Ed., (2004) , Prentice-Hall Pub. Inc.
3-"Numerical Methods and Computing", by Cheney & KinCaid , 6th Ed., (2008), Thomson Learning Academic Resource Center.
4-"Numerical Methodsfor Engineers", by S. K. Gupta, 3rd Ed., (2013), New Academic Science Ltd, United Kingdom.

## Course Educational Objectives (CEOs):

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| **CEO1** | Develop a strong understanding of the principles and concepts behind numerical methods for solving mathematical problems. |
| **CEO2** | Be proficient in using methods like bisection, Newton-Raphson, and secant methods for finding roots of equations. |
| **CEO3** | Study interpolation techniques, such as polynomial interpolation, and understand how to approximate functions using interpolation. |

## Intended Learning Outcomes (ILO's):

| Intended learning outcomes (ILOs) | | Relationship to CEOs | Contribution to PLOs | Bloom Taxonomy Levels* | JNQF Descriptors** |
|---|---|---|---|---|---|
| **k** | Knowledge and Understanding | | | | |
| **ILO1-k** | Get introduced to the various methods to approximate roots of functions. | CEO1 | PLO1-k | Understanding | K |
| **ILO2-k** | Get introduced to the types of polynomials used to approximate functions. | CEO3 | PLO2-k | Understanding | K |
| **ILO3-k** | Get introduced to the exact and iterative methods to solve linear systems. | CEO2 | PLO1-k | Applying | K |
| **S** | | | | | |
| **ILO4-s** | Analyze how and why the algorithms discussed work. | CEO2 | PLO5-s | Analyzing | S |

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| **ILO5-s** | Enable the student to apply error analysis to the numerical methods he is introduced to during the course | CEO3 | PLO6-s | Analyzing | S |
| **C** | | | | | |
| **ILO6-c** | Work independently to solve assignments in the course. | CEO2 | PLO11-c | Applying | C |
| **IL07-c** | Cooperate to work effectively in the group assignments. | CEO2 | PLO11-c | Applying | C |
| **D** | Transferable skills: | | | | |
| **ILO08-d** | | | | | |

| ***Bloom Taxonomy Levels:** | | | | | | |
|---|---|---|---|---|---|---|
| **Level #** | 1 | 2 | 3 | 4 | 5 | 6 |
| **Level Name** | Remembering | Understanding | Applying | Analyzing | Evaluating | Creating |

**** Descriptor (National Qualification Framework Descriptors): K: Knowledge, S: Skill, C: Competency.**

## Program Learning Outcome (PLOs):

| **(PLOs)** | **JNQF Descriptors**** | | |
|---|---|---|---|
| | **K** | **S** | **C** |

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|---|---|---|---|---|
| 1. | Knowledge of the main concepts in pure mathematics. | √ | | |
| 2. | Knowledge of the main concepts in applied mathematics. | √ | | |
| 3. | Explain concepts, principles and theories in the fields of probability and statistics. | √ | | |
| 4. | Possession of technological culture related to the fields of mathematics and its applications. | √ | | |
| 5. | Making use of mathematical logic in practical life. | √ | | |
| 6. | Engaging scientific methodology as a way of thinking and as a tool in facing problems. | | √ | |
| 7. | Applying mathematical software packages in problem solving. | | √ | |
| 8. | Being capable of data analysis. | | √ | |
| 9. | Capability of teaching according to modern educational techniques. | | √ | |
| 10. | Develop creative and innovative methods of teaching mathematics. | | | √ |
| 11. | Showing the ability to work under ethical and professional standards within teams. | | | √ |
| 12. | Gaining critical thinking and scientific research skills. | | | √ |

**** Descriptors according to the national qualifications framework (K: knowledge, S: skill, C: Competency)**

**Weekly Schedule** *(please choose the type of teaching)*

- □ **Face to Face (F2F)**
  - ✓ **Hybrid** *(One – To - One)*
- □ **Online**

## Schedule of Simultaneous and their Topics:

| Week | First Lecture (F2F) | Second Lecture (F2F) | ILOs | PLOs | JNQF Descriptors* |
|---|---|---|---|---|---|
| 1 | I Mathematical Preliminaries<br>Continuity, differentiation, Rules of differentiation. Rolle's Theorem. Mean value theorem. Extreme value theorem. Intermediate value theorem. Bolzano theorem | Activity: Background | 1 | 1 | K |
| 2 | Applications of the I.V.T. and Rolle's Theorem to prove the existence and uniqueness of a root of a function. | Activity: Video 1 Solving exercises | 1 | 4 | K |
| 3 | II. Solutions of Equations in One Variable<br>The bisection method. Analysis of the bisection method, error analysis. Applications of the | Activity: Home work1: On the subjects studied on the first three weeks | 1 | 5 | K |

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| | bisection method. | | | | |
| **4** | The Fixed-Point method: definition, theorem of existence, theorem of uniqueness. Analysis of the Fixed-point method. | Activity: Quiz 1 | 1 | 1 | K |
| **5** | The Newton-Raphson Method, derivation and applications. | Activity: Assignment 1: On applications of the I.V.T. and Rolle's Theorem | 4 | 7 | S |
| **6** | The Secant method, derivation and applications. Zeros of Polynomials and multiplicity. Applications. | Activity: Video 2 | 5 | 8 | S |
| **7** | The Modified Newton method. Horner's Method (synthetic division). | Activity: Home work 2 On the subjects studied in the weeks 4,5 and 6 | 1 | 1 | K |
| Midterm Exam (30%) | | | | | |
| **9** | III. Interpolation and Polynomial Approximation Taylor Polynomial; applications. | Activity: Assignment 2: On the Fixed-Point method Newton-Raphson method | 2 | 4 | K |
| **10** | Interpolation and Lagrange's Polynomial. | Activity: Self-reading | 5 | 8 | S |
| **11** | Iterated Interpolation; Newton's Divided Differences form. Analysis and applications | Activity: Video3 Solving exercises | 2 | 1 | K |
| **12** | IV. Direct Methods for Solving Linear Systems Review of systems and matrices. | Activity: Self-reading | 4 | 7 | S |
| **13** | Gaussian Elimination and Backward Substitution, applications. Matrix inversion. | Activity: Quiz 2 | 4 | 8 | S |
| **14** | Norms of Vectors and Matrices. | Activity: Presentation of the subject: The second fundamental form. | 7 | 12 | C |
| **15** | **Projects Discussion** | | | | |
| **16** | **Final Exam** | | | | |

* K: Knowledge, S: Skills, C: Competency

## Teaching Methods and Assignments:

Development of ILOs is promoted through the following teaching and learning methods:

- Lecture.
- learning through projects.
- learning through problem solving.

## Course Policies:

A- Attendance policies:
The maximum allowed absences is 15% of the lectures.
B- Absences from exams and handing in assignments on time:
Midterm exam can be retaken based on approval of excuse by the instructor's discretion.
Not handing assignment on time will incur penalties.
C- Academic Health and safety procedures
D- Honesty policy regarding cheating, plagiarism, and misbehaviour:
Cheating, plagiarism, misbehaviour will result in zero grade and further disciplinary actions may be taken.
E- Grading policy:

- All homework is to be posted online through the e-learning system.
- Exams will be marked within 72 hours and the marked exam papers will be handed to the students.
- Online Activities (Course Videos, Discussion Forums, Quizzes) **20%**
- Midterm 30**%**
- Final Exam 50**%**

F- Available university services that support achievement in the course: **E-Learning Platform, Labs, Library.**

## Required Equipment:

- PC / Laptop with webcam and mic
- Internet Connection
- Access to the ZUJ E-Learning Platform at https://exams.zuj.edu.jo/
- E-learning plan

## Assessment Tools Implemented in the Course:

- Final Exam
- Midterm Exam
- Quizzes
- Homework

## Responsible Persons and their Signatures:

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| **Course Coordinator** | Waseem Almzshaaleh | **Completed Date** | **Oct / 2023** |
| | | **Signature** | |
| **Received by (Department Head)** | | **Received Date** | / / |

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|---|---|
| **Signature** | |