**MODULE DESCRIPTION FORM**

نموذج وصف المادة الدراسية

| **Module Information**<br>معلومات المادة الدراسية | | | | | |
|---|---|---|---|---|---|
| **Module Title** | **Numerical Analysis** | | | **Module Delivery** | |
| **Module Type** | **Core** | | | ☒ **Theory** | |
| **Module Code** | **UOMU02011064** | | | ☐ **Lecture** | |
| **ECTS Credits** | **6.00** | | | ☒ **Lab** | |
| **SWL (hr/sem)** | **150** | | | ☒ **Tutorial**<br>☐ **Practical**<br>☐ **Seminar** | |
| **Module Level** | | **3** | **Semester of Deliver** | | **6** |
| **Administering Department** | | **PM** | **College** | | |
| **Module Leader** | **Marwan Abbas** | | **e-mail** | | |
| **Module Leader's Acad. Title** | | **Prof.** | **Module Leader's Qualification** | | **Ph.D.** |
| **Module Tutor** | | | **e-mail** | | |
| **Peer Reviewer Name** | | | **e-mail** | | |
| **Scientific Committee Approval Date** | | **01/6/2023** | **Version Number** | | |

| **Relation with other Modules**<br>العلاقة مع المواد الدراسية الأخرى | | | |
|---|---|---|---|
| **Prerequisite module** | **NO** | **Semester** | |
| **Co-requisites module** | **NO** | **Semester** | |

| Module Aims, Learning Outcomes and Indicative Contents<br>أهداف المادة الدراسية ونتائج التعلم والمحتويات الإرشادية | |
|---|---|
| **Module Objectives**<br>أهداف المادة الدراسية | 1. Develop a solid foundation in numerical concepts and techniques used in numerical Analysis.<br>2. Understand the principles and applications of numerical methods for solving engineering problems.<br>3. Gain proficiency in using software tools and programming languages for numerical analysis.<br>4. Acquire the skills to analyze and interpret numerical results to make informed engineering decisions.<br>5. Apply mathematical modeling techniques to solve real-world engineering problems. |
| **Module Learning Outcomes**<br>مخرجات التعلم للمادة الدراسية | The intended subject specific learning outcomes. On successfully completing the module students will be able to:<br>1. Acquire a comprehensive understanding of the fundamental principles and concepts underlying a broad range of basic methods used in Numerical Analysis.<br>2. Demonstrate proficiency in applying a variety of established techniques and effectively utilizing computational tools to solve engineering problems.<br>3. Apply the acquired knowledge and skills in basic numerical approximation to address complex problems in diverse contexts, demonstrating the ability to critically assess and select appropriate tools and techniques.<br>4. Effectively employ MATLAB commands and functions to implement and execute Numerical Analysis tasks, demonstrating competence in utilizing computational tools for problem-solving. |
| **Indicative Contents**<br>المحتويات الإرشادية | Part A<br>Introduction, Mathematical Analysis, Numerical Differentiation and Integration **[ 20 hr.]**<br><br>Numerical Solutions of Ordinary Differential Equations, Systems of Linear Equations **[ 20 hr.]**<br><br>Revision problem classes and quiz **[3 hrs]**<br><br>Part B<br><br>Eigenvalues and Eigenvectors**,** Numerical Methods in Probability and Statistics**,** Numerical Methods for Control Systems **[ 20 hr.]** |
| **Learning and Teaching Strategies**<br>استراتيجيات التعلم والتعليم | |
| **Strategies** | 1. Establish a solid foundation: Start by thoroughly understanding the fundamental concepts and principles of Numerical Analysis. This includes grasping the Numerical techniques and numerical methods |

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| | commonly used in the field.<br>2. Practice problem-solving: Numerical Analysis involves solving complex problems. Regularly practice solving a variety of problems to enhance your problem-solving skills and develop a deeper understanding of the subject matter.<br>3. Utilize resources: Take advantage of textbooks, online resources, and reference materials specific to Numerical Analysis. These resources can provide additional explanations, examples, and practice problems to reinforce your understanding. |

| **Student Workload (SWL)**<br>الحمل الدراسي للطالب محسوب لـ ١٥ اسبوعا | | | |
|---|---|---|---|
| **Structured SWL (h/sem)**<br>الحمل الدراسي المنتظم للطالب خلال الفصل | 63 | **Structured SWL (hr/w)**<br>الحمل الدراسي المنتظم للطالب أسبوعيا | **4** |
| **Unstructured SWL (h/sem)**<br>الحمل الدراسي غير المنتظم للطالب خلال الفصل | 87 | **Unstructured SWL (hr/w)**<br>الحمل الدراسي غير المنتظم للطالب أسبوعيا | **6** |
| **Total SWL (h/sem)** | **150** | | |

| **Module Evaluation**<br>تقييم المادة الدراسية | | | | | |
|---|---|---|---|---|---|
| | | **Time/Number** | **Weight (Marks)** | **Week Due** | **Relevant Learning Outcome** |
| **Formative assessment** | **Quizzes** | 2 | 10% (10) | 5 and 10 | LO #1, #2 and #10, #11 |
| | **Assignments** | 2 | 10% (10) | 2 and 12 | LO #3, #4 and #6, #7 |
| | **Projects / Lab.** | 2 | 10% (10) | Continuous | All |
| | **Report** | 1 | 10% (10) | 13 | LO #5, #8 and #10 |
| **Summative assessment** | **Midterm Exam** | 2hr | 10% (10) | 7 | LO #1 - #7 |
| | **Final Exam** | 3hr | 50% (50) | 16 | All |
| **Total assessment** | | | 100% (100 Marks) | | |

| **Delivery Plan (Weekly Syllabus)**<br>المنهاج الاسبوعي النظري | |
|---|---|
| **Week** | **Material Covered** |
| **Week 1** | Introduction to Numerical Analysis; numerical analysis and its applications in engineering, Sources of error in numerical computations |
| **Week 2** | Numerical Methods for Solving Equations; Bisection method, Newton-Raphson method, Secant method |
| **Week 3** | Interpolation and Approximation; Polynomial interpolation, Lagrange interpolation, |

| | |
|---|---|
| | Least squares approximation |
| **Week 4** | Numerical Differentiation and Integration; Forward, backward, and central difference approximations, Trapezoidal rule, Simpson's rule |
| **Week 5** | Numerical Solutions of Ordinary Differential Equations; Euler's method, Runge-Kutta methods, Multistep methods |
| **Week 6** | Systems of Linear Equations; Direct methods: Gaussian elimination, LU decomposition, Iterative methods: Jacobi method, Gauss-Seidel method= |
| **Week 7** | Eigenvalues and Eigenvectors; Power method, QR method |
| **Week 8** | Numerical Solutions of Partial Differential Equations; Finite difference methods, Finite element methods |
| **Week 9** | Numerical Optimization; Unconstrained optimization: Golden section search, Newton's method, Constrained optimization: Linear programming, quadratic programming |
| **Week 10** | Numerical Methods for Data Analysis; Curve fitting, Statistical regression |
| **Week 11** | Numerical Methods in Probability and Statistics; Monte Carlo simulation, Numerical integration of probability density functions |
| **Week 12** | Numerical Methods for Signal Processing; Discrete Fourier transform, Fast Fourier transform |
| **Week 13** | Numerical Methods for Image Processing; Image enhancement techniques, Image restoration methods |
| **Week 14** | Numerical Methods for Control Systems; Numerical simulation of control, systems, Model predictive control |
| **Week 15** | Review and Project Presentations |
| **Week 16** | Preparatory week before the final Exam |

| **Delivery Plan (Weekly Lab. Syllabus)**<br>المنهاج الاسبوعي للمختبر | |
|---|---|
| | **Material Covered** |
| **Week 1** | Lab 1: Introduction to Numerical Analysis and MATLAB. |
| **Week 2** | Lab 2: Numerical Methods |
| **Week 3** | Lab 3: Interpolation and Curve Fitting |
| **Week 4** | Lab 4: Numerical Integration |
| **Week 5** | Lab 5: Numerical Solutions of Ordinary Differential Equations |
| **Week 6** | Lab 6: Systems of Linear Equations |
| **Week 7** | Lab 7: Numerical Solutions of Partial Differential Equations; Finite difference methods, Finite element methods |

| **Learning and Teaching Resources**<br>مصادر التعلم والتدريس |
|---|

| | Text | Available in the Library? |
|---|---|---|
| **Required Texts** | 1. "Numerical Analysis" by R. L. Burden and J. D. Faires: This book covers fundamental numerical methods and their applications in a concise and accessible manner.<br>2. "Numerical Methods for Engineers" by S. C. Chapra and R. P. Canale: This textbook focuses on the practical aspects of numerical analysis and provides a wide range of examples and exercises. | **No** |
| **Recommended Texts** | 1. "Numerical Analysis: Mathematics of Scientific Computing" by D. Kincaid and W. Cheney: This book emphasizes the mathematical foundations of numerical methods and includes rigorous analysis of algorithms.<br>2. "Numerical Recipes: The Art of Scientific Computing" by W. H. Press et al.: This popular book provides a comprehensive collection of numerical algorithms, along with code implementation in various programming languages. | **No** |
| **Websites** | 1. (https://www.mathworks.com/)<br>2. (http://www.numericalmethods.eng.usf.edu/)<br>3. (https://www.engineering.com/) | |

| **Grading Scheme**<br>مخطط الدرجات | | | | |
|---|---|---|---|---|
| **Group** | **Grade** | التقدير | **Marks %** | **Definition** |
| **Success Group (50 - 100)** | **A** - Excellent | امتياز | 90 – 100 | Outstanding Performance |
| | **B** - Very Good | جيد جدا | 80 – 89 | Above average with some errors |
| | **C** - Good | جيد | 70 – 79 | Sound work with notable errors |
| | **D** - Satisfactory | متوسط | 60 – 69 | Fair but with major shortcomings |
| | **E** - Sufficient | مقبول | 50 – 59 | Work meets minimum criteria |
| **Fail Group (0 – 49)** | **FX** – Fail | راسب (قيد المعالجة) | 45 – 49 | More work required but credit awarded |
| | **F** – Fail | راسب | 0 – 44 | Considerable amount of work required |

**Note:** Marks Decimal places above or below 0.5 will be rounded to the higher or lower full mark (for example a mark of 54.5 will be rounded to 55, whereas a mark of 54.4 will be rounded to 54. The University has a policy NOT to condone "near-pass fails" so the only adjustment to marks awarded by the original marker(s) will be the automatic rounding outlined above.

**Module 1**

| Code | Course/Module Title | ECTS | Semester |
|---|---|---|---|
| PM 304 | Numerical Analysis | 6 | 6 |
| **Class (hr/w)** | **Lect/Lab./Prac./Tutor** | **SSWL (hr/sem)** | **USWL (hr/ sem)** |
| 2 | 2 | 63 | 87 |

**Description**

Numerical Analysis is a field of study that focuses on developing and analyzing algorithms for solving mathematical problems using numerical methods. It involves the use of computational techniques to approximate solutions to complex mathematical equations and problems that are difficult or impossible to solve analytically.

In this course, students will learn fundamental numerical algorithms and techniques such as interpolation, numerical integration, numerical solution of differential equations, and numerical linear algebra. They will gain a solid understanding of the theoretical principles behind these methods and develop practical skills in implementing them using programming languages such as MATLAB.

Through theoretical lectures, practical exercises, and computer-based assignments, students will learn how to analyze the accuracy and efficiency of numerical methods, and how to choose appropriate algorithms for specific problem scenarios. This course will equip students with the necessary tools to solve a wide range of engineering and scientific problems that involve complex mathematical computations.