

# MODULE DESCRIPTION FORM

| Module Information                 |                        |                               |                                                                                                                                                                                                                                                     |
|------------------------------------|------------------------|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Module Title                       | Analytic mathematics   |                               | Module Delivery                                                                                                                                                                                                                                     |
| Module Type                        | Core                   |                               | <input checked="" type="checkbox"/> Theory<br><input checked="" type="checkbox"/> Lecture<br><input type="checkbox"/> Lab<br><input checked="" type="checkbox"/> Tutorial<br><input type="checkbox"/> Practical<br><input type="checkbox"/> Seminar |
| Module Code                        | MATH220                |                               |                                                                                                                                                                                                                                                     |
| ECTS Credits                       | 6                      |                               |                                                                                                                                                                                                                                                     |
| SWL (hr/sem)                       | 125 H/Sem.             |                               |                                                                                                                                                                                                                                                     |
| Module Level                       | 2                      | Semester of Delivery          | 4                                                                                                                                                                                                                                                   |
| Administering Department           | Biomedical engineering | College                       | College of Engineering                                                                                                                                                                                                                              |
| Module Leader                      | Ali akbar wathiq       | e-mail                        | <a href="mailto:ali55@gmail.com">ali55@gmail.com</a>                                                                                                                                                                                                |
| Module Leader's Acad. Title        | Assistant lecture      | Module Leader's Qualification | M.sc                                                                                                                                                                                                                                                |
| Module Tutor                       | Ali akbar wathiq       | e-mail                        | <a href="mailto:ali55@gmail.com">ali55@gmail.com</a>                                                                                                                                                                                                |
| Peer Reviewer Name                 |                        | e-mail                        |                                                                                                                                                                                                                                                     |
| Scientific Committee Approval Date |                        | Version Number                | 1.0                                                                                                                                                                                                                                                 |

| Relation with other Modules |  |          |  |
|-----------------------------|--|----------|--|
| Prerequisite module         |  | Semester |  |
| Co-requisites module        |  | Semester |  |

## Module Aims, Learning Outcomes and Indicative Contents

### Module Objectives

1. This module is an important module that should be taken by students in mathematics, engineering, and natural science. It represents the Infinite Series, which give students precise ways to express many numbers and functions as arithmetic sums with infinitely many terms. Partial derivatives and multiple integrals are then covered in this module. An introduction to the order and degree of ordinary differential equations, and types and solutions of 1st order differential equations are also presented.
2. Enable the student to know many types of infinite sequences and infinite series and which of them are converged or diverged.
3. Understand the representation of functions as power series and study their radius and interval of convergence.
4. Learn how infinite series are used in approximation of functions, solving differential equations, and in numerical methods (e.g., Taylor series expansion).
5. Learn how to deal with functions of more than one variable and understand how changes in each variable affect the function.
6. Learn how to interpret the meaning of partial derivatives in real-world contexts, such as in physics (rate of change of temperature, pressure, etc.). Learn the definition of a double integral and understand how it extends the concept of a single integral to two dimensions.
7. Understand how to set up and evaluate double integrals over rectangular and more general regions (non-rectangular regions) in the xy-plane.
8. Introduce the order and degree of differential equations and solving 1st order DE using different methods.





|                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Module Learning Outcomes | Knowledge                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | A2 | <p>A2.1 <b>Define</b> the fundamental concepts of infinite sequences and series, including convergence and divergence.</p> <p>A2.2 <b>Explain</b> the principles of convergence tests such as the Integral Test, Comparison Tests, Ratio Test, and Root Test.</p> <p>A2.3 <b>Apply</b> convergence tests to determine whether a given infinite series converges or diverges.</p> <p>A2.4 <b>Analyze</b> the behavior of infinite series, including absolute and conditional convergence, using appropriate mathematical methods.</p> |
|                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|                          | Skills                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | B1 | <p>B1.1 Communicate effectively</p> <p>B1.2 Students will have developed problem solving and reasoning abilities that will serve them well in many important petroleum engineering aspects as well as their lives.</p>                                                                                                                                                                                                                                                                                                               |
|                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | B2 | <p>B2.1 Communicate effectively – graphically with a range of audiences using contemporary tools.</p> <p>B2.2 Communicate verbally and in writing with a range of audiences using contemporary tools.</p>                                                                                                                                                                                                                                                                                                                            |
| Indicative Contents      | Ethics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | C2 | <p>C2.1 Recognize professional and ethical responsibility.</p> <p>C2.2 Adhere and respect diversity.</p>                                                                                                                                                                                                                                                                                                                                                                                                                             |
|                          | <p>Indicative content includes the following.</p> <p><b>Unit 1:</b> Infinite Sequences and Series, Sequences, Infinite Series, The Integral Test, Comparison Tests, Absolute Convergence, The Ratio and Root Tests, Alternating, Series and Conditional Convergence, Power Series, Taylor and Maclaurin Series</p> <p>Convergence of Taylor Series, The Binomial Series and Applications of Taylor Series [8 hours].</p> <p><b>Unit 2:</b> Functions of Several Variables, Limits and Continuity in Higher Dimensions, The Chain Rule, Directional Derivatives and Gradient Vectors, Tangent Planes and Differentials, Extreme Values and Saddle Points, Lagrange Multipliers, Taylor's Formula for Two Variables, Partial Derivatives with Constrained Variables [8 hours].</p> <p><b>Unit 3:</b> Double Integral, Double and Iterated Integrals over Rectangles, Double Integrals over General Regions, Area by Double Integration, Double Integrals in Polar Form [6 hours].</p> |    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

**Unit 4:** First-Order Differential Equations, Introduction to Ordinary and, Partial Differential Equations (order and degree), Types and Solutions of 1st Order LDE [6 hours].

### Learning and Teaching Strategies

#### Strategies

- Presentation
- Interactive learning
- Discussions
- Brainstorming
- Group Solving Problems
- Problem-Based Learning
- Self-learning

### Student Workload (SWL) for 15 weeks

|                          |     |                        |      |
|--------------------------|-----|------------------------|------|
| Structured SWL (h/sem)   | 77  | Structured SWL (h/w)   | 5.13 |
| Unstructured SWL (h/sem) | 48  | Unstructured SWL (h/w) | 3.2  |
| Total SWL (h/sem)        | 125 |                        |      |





| Module Evaluation     |                              |             |                  |          |                           |
|-----------------------|------------------------------|-------------|------------------|----------|---------------------------|
| تقييم المادة الدراسية |                              |             |                  |          |                           |
|                       |                              | Time/Number | Weight (Marks)   | Week Due | Relevant Learning Outcome |
| Formative assessment  | Quizzes                      | 2           | 10% (10)         | 5 and 10 | A2                        |
|                       | Interaction within the class | All         | 10% (10)         | All      | A2                        |
|                       | Assignments                  | 2           | 10% (10)         | 4 and 10 | A2                        |
|                       | Projects / Lab.              |             |                  |          |                           |
|                       | Report                       | 1           | 10% (10)         | 13       | A2                        |
| Summative assessment  | Midterm Exam                 | 1hr         | 10% (10)         | 14       | A2,B1                     |
|                       | Final Exam                   | 3hr         | 50% (50)         | 15       | A2                        |
| Total assessment      |                              |             | 100% (100 Marks) |          |                           |

| Delivery Plan (Weekly Syllabus) |                                                                                                                                                                                               |                  |
|---------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| المنهاج الاسبوعي النظري         |                                                                                                                                                                                               |                  |
|                                 | Material Covered                                                                                                                                                                              | LOs              |
| Week 1                          | <b>Infinite Sequences and Series</b> <ul style="list-style-type: none"> <li>Sequences</li> <li>Infinite Series</li> </ul>                                                                     | A2-1, B1.1, C2-1 |
| Week 2                          | <b>Infinite Sequences and Series</b> <ul style="list-style-type: none"> <li>The Integral Test</li> <li>Comparison Tests</li> </ul>                                                            | A2-1, B2.1, C2-3 |
| Week 3                          | <b>Infinite Sequences and Series</b> <ul style="list-style-type: none"> <li>Absolute Convergence; The Ratio and Root Tests</li> <li>Alternating Series and Conditional Convergence</li> </ul> | A2-3, A2-1, C2-1 |
| Week 4                          | <b>Infinite Sequences and Series</b> <ul style="list-style-type: none"> <li>Power Series</li> <li>Taylor and Maclaurin Series</li> </ul>                                                      | A2-2, A2-1       |
| Week 5                          | <b>Infinite Sequences and Series</b> <ul style="list-style-type: none"> <li>Convergence of Taylor Series</li> <li>The Binomial Series and Applications of Taylor Series</li> </ul>            | A2-4, A2-3, B2.2 |
| Week 6                          | <b>Partial Derivatives</b> <ul style="list-style-type: none"> <li>Functions of Several Variables</li> <li>Limits and Continuity in Higher Dimensions</li> </ul>                               | A2-1, A2-3, B2.2 |

|                |                                                                                                                                                                                                                                                                                                                                                                        |                        |
|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| <b>Week 7</b>  | <b>Partial Derivatives</b> <ul style="list-style-type: none"> <li>• The Chain Rule</li> <li>• Directional Derivatives and Gradient Vectors</li> </ul>                                                                                                                                                                                                                  | A2-3, A2-4, C2-2       |
| <b>Week 8</b>  | <b>Partial Derivatives</b> <ul style="list-style-type: none"> <li>• Tangent Planes and Differentials</li> <li>• Extreme Values and Saddle Points</li> </ul>                                                                                                                                                                                                            | A2-4, A2-3, A3-2       |
| <b>Week 9</b>  | <b>Partial Derivatives</b> <ul style="list-style-type: none"> <li>• Lagrange Multipliers</li> <li>• Taylor's Formula for Two Variables</li> <li>• Partial Derivatives with Constrained Variables</li> </ul>                                                                                                                                                            | A2-4, B2.1, C2-1       |
| <b>Week 10</b> | <b>Multiple Integrals</b> <ul style="list-style-type: none"> <li>• Double Integral</li> <li>• Double and Iterated Integrals over Rectangles</li> </ul>                                                                                                                                                                                                                 | A2-3, B2.1, C2-1       |
| <b>Week 11</b> | <b>Multiple Integrals</b> <ul style="list-style-type: none"> <li>• Double Integrals over General Regions</li> </ul>                                                                                                                                                                                                                                                    | A2-1.A2-3 B2-1         |
| <b>Week 12</b> | <b>Multiple Integrals</b> <ul style="list-style-type: none"> <li>• Area by Double Integration</li> </ul>                                                                                                                                                                                                                                                               | A2-2, A2-3, B1.2, C2-3 |
| <b>Week 13</b> | <b>Multiple Integrals</b> <ul style="list-style-type: none"> <li>• Double Integrals in Polar Form</li> </ul>                                                                                                                                                                                                                                                           | A2-2, A2-1, B1.1       |
| <b>Week 14</b> | <b>First-Order Differential Equations</b> <ul style="list-style-type: none"> <li>• Introduction to Ordinary and Partial Differential Equations</li> <li>• Order and Degree of Ordinary Differential Equations</li> </ul> <b>First-Order Differential Equations</b> <ul style="list-style-type: none"> <li>• Types and Solutions of 1<sup>st</sup> Order LDE</li> </ul> | A2-2, A2-3, C2-2       |
| <b>Week 15</b> | <b>First-Order Differential Equations</b> <ul style="list-style-type: none"> <li>• Types and Solutions of 1<sup>st</sup> Order LDE</li> </ul>                                                                                                                                                                                                                          | A2-2, B1.1             |

| <b>Learning and Teaching Resources</b><br><b>مصادر التعلم والتدريس</b> |                                                                                               |                                  |
|------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|----------------------------------|
|                                                                        | <b>Text</b>                                                                                   | <b>Available in the Library?</b> |
| <b>Required Texts</b>                                                  | 1. "Thomas Calculus" G. Thomas, M. Weir, et al., 13th edition, 2024.                          | Yes                              |
| <b>Recommended Texts</b>                                               | . "Thomas Calculus" G. Thomas, M. Weir, et al., 13th edition, 2024.                           | No                               |
| <b>Websites</b>                                                        | <a href="https://eng.alayen.edu.iq/colleges/e/42">https://eng.alayen.edu.iq/colleges/e/42</a> |                                  |





## Grading Scheme

مخطط الدرجات

| Group                       | Grade            | التقدير             | Marks (%) | Definition                            |
|-----------------------------|------------------|---------------------|-----------|---------------------------------------|
| Success Group<br>(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<br>(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.

