# MODULE DESCRIPTION FORM

## نموذج وصف المادة الدراسية

| Module Information<br>معلومات المادة الدراسية | | | | | |
|---|---|---|---|---|---|
| Module Title | **Mathematics** | | | Module Delivery | |
| Module Type | **Core** | | | ☒Theory<br>☐ Lecture<br>☐ Lab<br>☒ Tutorial<br>☐ Practical<br>☐ Seminar | |
| Module Code | COGTEK 201 | | | | |
| ECTS Credits | **7** | | | | |
| SWL (hr/sem) | **175** | | | | |
| Module Level | | 2 | Semester of Delivery | | 3 |
| Administration Department | | RETE | College | College of Oil and Gas Techniques Engineering - Kirkuk, Northern Technical University, Iraq | |
| Module Leader | Saad Saleem Merie | | e-mail | saad.saleem@ntu.edu.iq | |
| Module Leader's Acad. Title | | Assistant lecturer | Module Leader's Qualification | | |
| Module Tutor | Saad Saleem Merie | | e-mail | saad.saleem@ntu.edu.iq | |
| Peer Reviewer Name | | | e-mail | | |
| Scientific Committee Approval Date | | | Version Number | | |

| Relation with other Modules<br>العلاقة مع المواد الدراسية الأخرى | | | |
|---|---|---|---|
| Prerequisite module | Mathematics Principles | Semester | 1 |
| Co-requisites module | None | Semester | |

# Module Aims, Learning Outcomes and Indicative Contents
## أهداف المادة الدراسية ونتائج التعلم والمحتويات الإرشادية

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| **Module Aims**<br>**أهداف المادة الدراسية** | • To equip students with the knowledge and understanding of mathematical concepts, notation and techniques relevant to mechanical engineering.<br>• To develop skills and confidence in mathematical modelling and problem solving.<br>• To support students in understanding mathematical aspects of other modules. |
| **Module Learning Outcomes**<br><br>**مخرجات التعلم للمادة الدراسية** | On successful completion of this module, students should be able to:<br><br>1. Use vectors to represent three-dimensional space, including points, lines and planes and find intersections among these.<br>2. Differentiate and integrate vectors in the context of dynamics problems and understand scalar and vector products and their use in mechanics and dynamics.<br>3. Integrate and differentiate functions using a range of techniques and relate derivatives and integrals to engineering applications such as rates of change, maxima and minima, areas, volumes, averages, flow rates, work, centres of mass, etc.<br>4. Sketch (freehand) basic and composite functions, recognising limiting behaviours and discontinuities.<br>5. Create mathematical models of engineering systems described by first order ordinary differential equations, and solve the equations analytically and via Euler's method.<br>6. Differentiate and integrate functions of more than one variable.<br>7. Understand the formation of matrices, their associated algebra, their use in the solution of simultaneous equations and in graphical transformations, and the concepts of eigenvalues and eigenvectors.<br>8. Understand, manipulate and plot complex numbers and functions in various forms, find complex solutions of equations, and appreciate the links between exponential, trigonometric and hyperbolic functions.<br><br>Skills outcomes<br>• Mathematical modelling and problem solving skills<br>• Ability to apply mathematics to represent, analyse and design engineering systems. |
| **Indicative Contents المحتويات الإرشادية** | Definitions and use of vectors in 3D space; vector algebra; the scalar and vector products and their uses.<br>Functions and graphs; limits of functions.<br>Techniques for differentiation: product rule; quotient rule; chain rule; implicit differentiation; logarithmic differentiation; differentiating parametric equations; differentiating vectors in Cartesian and polar coordinate systems.<br>Techniques for integration: substitution; integration by parts; partial fractions; integration of vectors; numerical integration.<br>Engineering applications of integration and differentiation. |

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| | Functions of more than one variable: partial differentiation; multiple integrals. First order differential equations; mathematical modelling and problem solving. Vector equations of lines and planes.<br>Matrix algebra; transformation matrices; eigenvalues and eigenvectors.<br>Complex numbers; hyperbolic functions. |

| **Learning and Teaching Strategies**<br>**استراتيجيات التعلم والتعليم** | |
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| **Strategies** | Implementing active learning in a class room requires preparation and some changes to the lecture. However, the lecture content is not changed or replaced with new material. The same lecture content is delivered to the students in a better way and the lecture time is used more effectively. The following are some of the techniques of active learning and cooperative learning I personally use in my engineering classes to enhance student's understanding and retention of the material:<br>○ **One Minute Paper**: Students are asked to write a one minute note (about the previous lecture, the homework or the material in general) to the instructor on a piece of paper. This provides a fast way for the teacher to have a quick feedback on students understanding of what was covered previously.<br>○ **Muddiest Point**: When there is a long lecture with multiple topics covered, the students are given the chance to discuss the material covered in the lecture and list the most difficult parts of the lecture.<br>○ **Clarification Pause**: During the lecture, the students are given the time to go over the material written on the board, think about it and ask if they have any questions. Then, the lecturer answers the different questions raised before resuming the next part of the lecture.<br>○ **Questions and answers**: Usually during the lecture, questions are raised about the new material presented and questions are solved on the board. A sample of the questions asked include "Why do you think this topic is important?" or "what is the relation between what we were talking about and this technique?" or "which technique is best?"<br>○ **Critical Thinking, Group Discussion**: Students are given a handout with multiple problems and they are asked to apply what they learned in the lecture to solve the problems in groups. They are asked to discuss it together and come up with a single solution that all members agree on.<br>○ **Critical Thinking, Think-pair-share:** Students are asked to work individually on a problem for a short time; then students pair up to compare their answers. Then they have to explain their answer and share it with the rest of the class.<br>○ **Peer Teaching:** If one member of the team solves the problem correctly, He will explain it to the rest of the group and discuss with them why his/her answer is correct and their answer is not. This |

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| | allows the students to find out what went wrong and the mistake they made in solving the problem. This technique will help the student to avoid these mistakes when doing the homework or the exams.<br><br>○ **Active Review Sessions**: For each exam, students are given a practice test with a set of problems a week in advance. They are encouraged to work on the practice test individually first and then in groups to discuss the answers. During the review session, the students are asked questions about the problems in the practice test and they are given the choice to decide which problems they want the professor to concentrate on. |

## Student Workload (SWL)
## الحمل الدراسي للطالب

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| Structured SWL (h/sem)<br>الحمل الدراسي المنتظم للطالب خلال الفصل | 78 | Structured SWL (h/w)<br>الحمل الدراسي المنتظم للطالب أسبوعيا | 5.2 |
| Unstructured SWL (h/sem)<br>الحمل الدراسي غير المنتظم للطالب خلال الفصل | 97 | Unstructured SWL (h/w)<br>الحمل الدراسي غير المنتظم للطالب أسبوعيا | 6.46 |
| Total SWL (h/sem)<br>الحمل الدراسي الكلي للطالب خلال الفصل | 150 | | |

## Module Evaluation
## تقييم المادة الدراسية

| | | Time/Number | Weight (Marks) | Week Due | Relevant Learning Outcome |
|---|---|---|---|---|---|
| Formative assessment | Quizzes | 5 | 15% (15) | 5,7, 9,10 and 12 | LO #1, #3, #5, #6,and #7 |
| | Assignments | 10 | 20% (20) | Continuous | LO#3,4,5,6,7,8,9,10,11, and 12 |
| | Seminar | 1 | 5% (5) | 7 | LO #6 |
| Summative assessment | Mid Term exam | 2 hr | 10% (10) | 8 | LO # 1-4 |
| | Final Exam | 3 hr | 50% (50) | 16 | All |
| 100% (100 Marks) | | | | | |

## Delivery Plan (Weekly Syllabus)
## المنهاج الأسبوعي النظري

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| Week 1 | Introduction of vectors |
| Week 2 | Vectors: general introduction to vectors in space – equation of straight line and an equation for a plane in space – plane, tangent and perpendicular line – vector function |

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| Week 3 | Infinite Sequences and Series |
| Week 4 | Convergence and Divergence |
| Week 5 | Convergence tests |
| Week 6 | Power series |
| Weeks 7 | Chain rule for partial derivative – gradient and directional derivative – maximum and minimum values for tow variable functions |
| Weeks 8 | Mid-Term Exam |
| Week 9 | Partial derivatives of higher order |
| Week 10 | The chain rule for function of three variables |
| Week 11 | Directional derivatives and gradient vectors |
| Week 12 | Tangent planes and normal lines |
| Week 13 | Extreme values and saddle points |
| Week 14 | Polar coordinates |
| Week 15 | Preparing for the final Exam |

## Learning and Teaching Resources
## مصادر التعلم والتدريس

| | Text | Available in the Library? |
|---|---|---|
| Required Texts | " Calculus " , Ford , S.R. and Ford , J.R. , (1963) McGrawHill | Yes |
| Recommended Texts | “Advanced Engineering Mathematics”, Erwin Kreyszig et al., (2006)<br>George B. Thomas, Jr., "Thomas 'Calculus | No |
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## Grading Scheme
## 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 |

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| | 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 |
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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.

| **Code** | Course/Module Title | ECTS | Semester |
|---|---|---|---|
| COGTEK 200 | Advanced Mathematics | **6** | 3 |
| **Class (hr/w)** | Lect/lab./prac./Tutor | SSWL (hr/sem) | USWL (hr/sem) |
| **3** | 1 | 63 | 87 |

**Description**

The proficiencies of Understanding, Fluency, Problem Solving and Reasoning are fundamental to learning mathematics and working mathematically and are applied across all three strands Number and Algebra, Measurement and Geometry, and Statistics and Probability.

Understanding refers to students building a robust knowledge of adaptable and transferable mathematical concepts and structures. Students make connections between related concepts and progressively apply the familiar to develop new ideas. They develop an understanding of the relationship between the ‘why’ and the ‘how’ of mathematics. Students build understanding when they:

- connect related ideas
- represent concepts in different ways
- identify commonalities and differences between aspects of content
- describe their thinking mathematically
- interpret mathematical information