



COURSE SYLLABUS

I-Course Information :

Title of the course	Calculus
Department	Data Science
Specialization	
Academic Year	2020-2021
Semester Duration	3 months
Credit Number	4
Number of Hours	40
Course Instructor	Rabih Assaf
Email	rabih.assaf@ul.edu.lb rabih.assaf@ul.edu.lb
Office Hours	Friday 8:00 to 12:00

II- Course Description

This course introduces fundamental mathematical concepts relevant to computer science and provides a basis for further study in data science. Topics covered include function of a real variable, elementary functions, Taylor's expansion, simple integral and methods of integration, differential equations, multivariable functions, continuity, partial derivative, the chain rule, differential, introduction to double integrals, methods of integration and power series.

III-Course Objectives

This course aims to provide students with/allows students to:

- ❖ Analyze the behavior and locate discontinuities of a function using limits.
- ❖ Apply the differentiation rules to solve problems related to economics, business, life and social sciences.
- ❖ Develop basic mathematical modeling skills by solving optimization problems.
- ❖ Evaluate integrals of polynomials, rational, trigonometric, exponential, and logarithmic functions.
- ❖ Use anti-differentiation to solve simple initial-value problems.
- ❖ introduce the theory behind integration and use integrals to calculate areas. Explain the terms integrand, limits of integration, and variable of integration.
- ❖ Developing theory behind multivariable calculus, gradient, partial derivatives, and matrices differentiation;
- ❖ Solving first and second order differential equations.



In order to achieve the objectives of the course, the following requirements must be met by the student:

- Scientific activities
- Academic regulations
- Academic work and perseverance
- 70% attendance and participation

IV- Course Outline and Calendar

Learning Objective	Session(s)	Learning Content	Pedagogical Strategy & Tools
Chapter 1 – Functions, graphs and limits	1-2-3-4	• Review of Functions • Trigonometric Functions • Inverse Functions • Exponential and Logarithmic Functions • The Limit of a Function • The Limit Laws Infinite Limits. • Continuity. • Intermediate Value Theorem	Explanations of definitions, theorems and methods with direct applications, then solving a work sheet of exercises at the end of the course, real life applications + extra exercises as homework.
Chapter 2 – Derivatives and its applications	5-6-7-8	• Interpretations of the Derivative • Differentiation Formulas. • Product and Quotient Rule • Derivatives of Trig Functions • Derivatives of Exponential and Logarithm Functions • Derivatives of Inverse Trig Functions • Derivatives of Hyperbolic Functions • Chain Rule • Implicit Differentiation • Higher Order Derivatives	Explanations of definitions, theorems and methods with direct applications, then solving a work sheet of exercises at the end of the course, real life applications + extra exercises as homework.



		• Linear Approximations and Differentials • Maxima and Minima • The Mean Value Theorem • Derivatives and the Shape of a Graph • Limits at Infinity and Asymptotes. • Applied Optimization Problems • Hôpital's Rule • Newton's Method • Antiderivatives	
Chapter 3 – Integrals	9-10-11-12	• Approximating Areas • Riemann sum • The Definite Integral • The Fundamental Theorem of Calculus • Integration Formulas and the Net Change Theorem • Substitution • Integrals Involving Exponential and Logarithmic Functions • Integrals Resulting in Inverse Trigonometric Functions	Explanations of definitions, theorems and methods with direct applications, then solving a work sheet of exercises at the end of the course, real life applications + extra exercises as homework.
Midterm			
Chapter 4 – Application of integration	13-14	• Average Function Value • Area Between Curves • Volumes of Solids of Revolution / Method of Rings • Approximation of integrals. • Simpson's Rules • Volumes of Solids of Revolution / Method of Cylinders.	Explanations of definitions, theorems and methods with direct applications, then solving a work sheet of exercises at the end of the course, real life applications + extra exercises as homework.
Chapter 5 – Multivariable calculus	15-16-17-18	• Partial Differentiation and gradients	Explanations of definitions, theorems and methods with



		• Basic rules of partial differentiation • Chain Rule • Optimization • Gradient of vector valued functions • Gradient of matrices • Decent gradient optimization • Multivariable integration	direct applications, then solving a work sheet of exercises at the end of the course, real life applications + extra exercises as homework.
Chapter 5 – Sequences, Series, and Power Series	19-20-21-22	• Sequences and Convergence • Infinite Series • Geometric Series • Some Theorems About Series • Convergence Tests for Positive Series • The integral Test • Using Integral Bounds to Estimate the Sum of a Series • Comparison Tests • Using Geometric Bounds to Estimate the Sum of a Series • Absolute and Conditional Convergence • The Alternating Series Test • Power Series: Algebraic Operations on Power Series • Differentiation and Integration of Power Series • Taylor and Maclaurin Series • Applications of Taylor and Maclaurin Series • Approximating the Values of Functions • Functions Defined by Integrals	Explanations of definitions, theorems and methods with direct applications, then solving a work sheet of exercises at the end of the course, real life applications + extra exercises as homework.



Chapter 6 – Ordinary Differential Equations	23-24-25-26	• Classifying Differential Equations • Solving First-Order Equations • Separable Equations • First-Order Linear Equation • First-Order Homogeneous Equation • Exact Equations and Integrating Factors • Differential Equations of Second Order • Linear Differential Equation with Constant Coefficients	Explanations of definitions, theorems and methods with direct applications, then solving a work sheet of exercises at the end of the course, real life applications + extra exercises as homework.
Final Exam			

P.S.: The course outline above may be modified during the semester.

V- Teaching approach & methods

The goal in my classroom is to have a lively, open, and educational environment. Therefore, the use of many methods and strategies of modern learning will be concentrated in class:

- Emphasizing class participation.
- Encouraging discussion and interaction
- Bringing excitement and a storyline to classes, using energy and enthusiasm to teach ideas while guiding students along a path where each new concept is a natural consequence of the previous and a natural precursor to the following.
- Focusing on higher order thinking skills and promoting students' critical thinking in self-directed and safe learning environments.
- Providing active learning: showing problem-solving techniques, and making mistakes, getting stuck, and trying different strategies.
- Combination of theoretical and practical parts of the course
- Active learning outside the class room providing homeworks and online resources.
- Focusing on the importance of the course in the major and its relation with other courses.
- Showing real life and practical examples of the development of inferential statistics tools in the world of Data Science.
- Continuous assessments thought the learning schedule.

VI- Assessment Methods

The success of the student in this course is based on:

- 1- His/her active participation in class.
- 2- His/her scientific contribution through research done outside the classroom.
- 3- His/her reading notes, research reports and practical applications as requested by course instructor.



The assessment of the student is carried out according to the following grid:

Assessment Type	Final Grade Weighting (%)	Dates/Deadlines
Participation (assignments with short deadlines, projects, research paper, etc.)	20%	
Midterm Exam	20%	January
Final exam	60%	End of February
Total	100%	

VII- Specific Course Requirements

1- Regulations concerning deadlines for written and applied work submissions

The teacher has the right to:

- Refuse to receive written applied work outside the deadlines.
- Give the student additional time after omitting up to 25% of the mark awarded to the concerned activity.

2- Academic measures in case of plagiarism

The student shall be liable to the following penalties in case of any attempt of illicit scientific citation:

- Cancellation of the student's contribution, activity or scientific article and reduction of the final mark.
- If the same offense is reported in other courses, cancellation of the final exam and failure in the relevant course(s).

VIII- Reference Books

- George B. Thomas, Joel R. Hass, Christopher Heil, Maurice D. Weir, Thomas's Calculus, Pearson, 14th Edition, 2018.
- Mark Deisenroth, Aldo Faisal, Cheng Soon Ong, mathematics for machine learning, Cambridge University, 2020.

IX- Bibliography& Additional Sources

- Jean Gallier, Jocelyn Quaintance, Algebra, Topology, Differential Calculus, and optimization theory for computer sciences and machine learning, university of Pennsylvania, 2020.
- Samuel Watson, math for data science, 2020.
- Thomas M. Apostol, Calculus, Wiley, 2nd Edition, 1991, ISBN 960-07-0067-2. 3.
- Michael Spivak, Calculus, Publish or Perish, 2008, ISBN 978-0914098911.



- Ross L. Finney, Maurice D. Weir, and Frank R. Giordano, Thomas's Calculus, Pearson, 12th Edition, 2009.
- College Mathematics for Business, Economics, Life Sciences and Social Sciences, Global Edition, 13/e - Barnett, Ziegler & Byleen – Pearson.