Ghulam Ishaq Khan Institute of Engineering Sciences and Technology

Faculty of Engineering Sciences (FES)

MT-101Calculus I

Pre-Requisite(s): None
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Monday - Friday (10:00 am – 11:00 am)
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Course Introduction

This is an introductory course of 'Calculus' required for all engineering students. The pre-requisite is the mathematics taught at intermediate/A level to students in Pakistan. There will be a quick review of the Calculus studied by the students in their intermediate (F.Sc./A level) classes but at a much-advanced level, with introduction of many new topics and material. The emphasis will be on the application of 'Differential and Integral Calculus' to problems of physical sciences and engineering. At the end of the course, the students should be able to tackle the problems in other disciplines that require calculus tools for
their solution.

Course Contents

- **Functions:** Real numbers; Functions and their graphs; Basic elementary functions; Combining functions; Elementary functions; Domain and range of functions; Shifting and scaling of graphs.
- **Limit and Continuity:** Limit of a function; Calculation of limits and limit laws; Limits involving infinity; One-sided limits; Continuous and discontinuous functions; Types of discontinuity; Asymptotes of graphs.
- **Differential Calculus I:** Rate of change and tangents to curves; Derivative at a point; Geometric interpretation; Differentiation rules; Derivative as rate of change; Derivatives of basic elementary functions; The chain rule; Implicit differentiation; Related rates; Linearization and differentials.
- **Differential Calculus II:** Derivatives of transcendental functions; Inverse functions and their derivatives; Exponential and logarithmic functions; Trigonometric and inverse trigonometric functions; Hyperbolic functions; Logarithmic differentiation; Intermediate forms and L'Hopital's rule.
- **Applications of Derivatives:** Mean value theorem; Monotonic functions and the first derivative test; Extreme values of functions; Concavity and the second derivative test; Applied optimization.
- **Integral Calculus:** Anti-derivatives and indefinite integrals; Elementary integration techniques; Sigma notation and limits of finite sums; The definite integral; The fundamental theorem of calculus; Elementary properties and calculation of definite integrals.
- **Applications of Integral Calculus:** Area under a curve and between curves; Volumes using cross-sections; Volumes using cylindrical shells; Arc length; Areas of surfaces of revolution; Calculation of work; Center of gravity of plane laminas.
- **Techniques of Integration:** Use of basic integration formulas; integration by substitution and by parts; Trigonometric integrals; Trigonometric substitutions; Integration of rational functions by partial fractions; Numerical integration; Improper integrals.

- **Infinite Series:** Definitions, convergence, properties. Integral test, basic and limit comparison tests, ratio and root tests. Alternating series and absolute convergence. Power series. McLaurin and Taylor series. Applications of power series.

Mapping of Class Learning Outcome (CLOs) to Program Learning Outcomes (PLOs)

S. No	CLOs	PLOs	Bloom Taxonomy
Upon completion of this course, students will be able to:			
CLO-1	Solve problems related to limit and continuity of a function and their inter-relationship.	PLO-1	C3 (Applying)
CLO-2	Calculate the derivative and differential of a function and apply them in different applied problems.	PLO-1	C3 (Applying)
CLO-3	Use different techniques of integration to solve different applied problems.	PLO-1	C3 (Applying)
CLO-4	Apply different tests to discuss the convergence of sequences and series.	PLO-1	C3 (Applying)

Direct Assessment tools based on CLOs (subject to change on class performance)

Assessment Tools	CLO-1	CLO-2	CLO-3	CLO-4
Quizzes	30%	25%	20%	20%
Assignments	5%	25%	20%	20%
Midterm Exam	40%	30%	20%	20%
Final Exam	25%	20%	40%	40%

Grading Policy

Assessment Items		% Marks
1.	Announced Quizzes	25% = (5 + 10 + 10)%
2.	Assignments	10%
3.	Mid-Term Exam	25%
4.	Final Exam	40%

Text and Reference Books

Text books:

- **"Thomas' Calculus: Early Transcendentals"** by George B. Thomas, Jr., Joel Hass, Christopher Heil, Maurice D. Weir. 13th Edition 2024. Pearson, USA.

Reference books:

- **"Calculus: Early Transcendentals"** by James Stewart. 6th Edition 2008. Brooks/Cole USA.
- **"Calculus"** by Swokowski, Olinick, Pence. 6th Edition 1994. PWS, USA.

Administrative Instruction

- According to institute policy, 80% attendance is *mandatory* to appear in the final examination.
- All quizzes/examinations will be closed book. No calculators and mobile phones will be allowed.
- In any case, there will be no retake of scheduled/surprise quizzes.
- Students may work on home assignments in collaboration with each other, but they must submit their own work; no copying from others. Violation of this will adversely affect their quiz/exam results.

Lecture Breakdown		
Lecture	**Topic**	**Chapter**
01	Real numbers and points. Constants and variables. Absolute values and inequalities. Intervals.	1
02	Functions and graphs. Direct and inverse functions. Symmetry.	1
03	Shifting and scaling of graphs. Classification of functions. Basic elementary functions. Composite function. Elementary functions.	1
04	Intuitive concepts of limit and continuity. Limits involving infinity. Right and left limits.	2
05	Continuity of functions. Properties of continuous functions.	2
06	Checking for continuity at a point and on an interval. Types of discontinuities.	2
07	Quick review of differentiation. Algebraic and geometric interpretations.	3
08	Derivatives of basic elementary functions. Differentiation rules	3
09	Differentiation of composite functions and chain rule. Implicit differentiation.	3
10	Differentiation of trigonometric, inverse trigonometric, hyperbolic and inverse hyperbolic functions	7
11	Quick review of functions of 2 & 3 variables and their partial derivatives	14
12	Quick review of functions of 2 & 3 variables and their partial derivatives. Continue	14
13	Indeterminate forms and L'Hopital rule	7
14	Applied maximum and minimum problems: first derivative test.	4
15	Applied maximum and minimum problems: second derivative test. Points of inflection.	4
16	Intervals of convexity and concavity. Points of Inflection.	4
17	Applied maximum and minimum problems: applications.	4
18	Applied maximum and minimum problems: applications (continued…).	4
19	Indefinite integrals and basic techniques of integration.	5
20	Basic techniques of integration continued.	5
21	Riemann sums and definite integrals.	5
22	The fundamental theorem of calculus. Area under a curve.	5
23	Properties of definite integrals.	5
24	Calculation of areas bounded by continuous curves.	5
25	Volume of solids of revolution: disk method.	6
26	Volume of solids of revolution: cylindrical shell method.	6

27	Calculation of length of an arc and surface areas of solids of revolution.	6
28	Calculation of work by definite integrals.	6
29	Calculation of work by definite integrals.	6
30	Centre of gravity and centroid of plane laminas.	6
31	Calculation of moments of inertia of solids of revolution.	6
32	Techniques of integration.	8
33	Techniques of integration (continued…).	8
34	Techniques of integration (continued…).	8
35	Convergent and divergent sequences.	10
36	Convergent and divergent series; their basic properties.	10
37	Positive term series; geometric and p-series.	10
38	Integral test and basic comparison test.	10
39	Ratio and root tests.	10
40	Alternating series and its properties.	10
41	Conditional and absolute convergence.	10
42	Power series and radius of convergence.	10
43	Power series representation of function.	10
44	McLaurin and Taylor series.	10
45	Convergent and divergent sequences.	10

Note: This outline serves only as a rough guidance of the course. It may be changed or modified as and when deemed necessary by the instructor. The Instructor is at liberty to best distribute number of lectures and/or change the sequence of topics to cover the entire course.