MATH-I CALCULUS AND LINEAR ALGEBRA
Course Code: MATH SH 101

Lecturer: 3   **Year: 1**
Tutorial: **Part: I**
Practical: **Course Credit: 3**

Objectives of the Course:

- Understanding the key concepts of limits and continuity and mastering techniques of differentiation and integration to use them solving geometrical and physical applications
- Understanding convergence and divergence of series and applying series expansions in engineering contexts
- Understanding matrices techniques to solve system of linear equations. Developing the concepts of vectors, vector space and vector subspace and their properties. Computing eigen-values and eigen-vectors of a matrix.

Credit Hours	Teaching Schedule Hours/Week			Evaluation Scheme				Total
				Internal Evaluation		**Final Evaluation**		
	Lecture	Tutorial	Practical	Theory	Practical	Theory	Practical	100
3	3	2	-	40	-	60	-	

Course Contents:

Unit 1: Function, Limit and continuity   [6 Hours]
1.1 Function, domain and range, graphs of few elementary functions
1.2 Piece-wise functions and their graphs
1.3 even and odd functions and their symmetric natures
1.4 Shifting and scaling a graph of a function
1.5 Limit of a function, Evaluating limits algebraically and graphically
1.6 One-sided limits, continuity and discontinuity, types of discontinuity,
1.7 Limits involving infinity, asymptotes, types of asymptotes lines (Horizontal, Vertical and oblique). Graphing of rational functions using asymptotes

Unit 2: Differentiation and its applications   [8 Hours]

2.1 Derivative at a point and its geometrical and physical interpretations
2.2 Proof of differentiability implies continuity
2.3 Second and higher order derivatives, Implicit differentiations
2.4 Tangent and normal lines on the curve, angles between the curves, Motion along a straight line, Related rates problems
2.5 Increasing/decreasing functions and first derivative test,
2.6 Local and absolute extreme values of a function

2.7 first derivative test of finding local extreme value(s) of a function

2.8 Concavity and second derivative test, second derivative test of finding local extreme value(s) of a function

2.9 Finding global extreme values(s) of a function

2.10 Statements of Rolle's and Mean value theorems and their geometrical interpretation and problems related to these theorems

2.11 Optimization problems

Unit 3: Integration and Its applications [8 Hours]

3.1 Indefinite integrals and integration techniques.

3.2 Integration of involving $a^2 + x^2$, $\sqrt{a^2 + x^2}$, $a^2 - x^2$, $\sqrt{a^2 - x^2}$, $\sqrt{x^2 - a^2}$, $ax^2 + bx + c$, $\sqrt{ax^2 + bx + c}$, integration by partial fractions

3.3 Definite integrals and Definite integral as a Riemann sum.

3.4 Statements of the Fundamental Theorems of integral Calculus part I and part II and related problems

3.5 Solving first order and second order differential equations of types $\frac{dy}{dx} = f(x)$ with initial condition $y(x_0) = y_0$ and $\frac{d^2y}{dx^2} = g(x)$ with initial conditions $y(x_0) = y_0$ and $y'^{(x_0)} = y_1$

3.6 Area under curves, area between the curves

3.7 Solid of revolution, Volumes of solid of revolution by disk method and washer method

3.8 Length of a curves, arc length of a curve, area of surface of revolution

3.9 Improper integrals of Type I and Type II

3.10 Beta and Gamma functions, Properties of the beat and gamma functions, reduction formulas

Unit 4: Infinite Sequences and Series [6 Hours]

4.1 Infinite Sequence, convergence and divergence of an infinite sequence, calculating the limit of a sequence

4.2 Bounded and unbounded sequence, non-decreasing and non-increasing sequence, monotonic sequence

4.3 Infinite series and partial sums, convergence and divergence of an infinite series, nth term test for divergent series

4.4 Integral test for convergent or divergent series (statement only), convergence or divergence of p-series

4.5 Convergence test of an infinite series: Direct comparison test, Limit comparison test, ratio and root test, absolute convergent and absolute convergence test theorem,

4.6 Taylor and Maclaurin series of a function, Taylors polynomial of order n

Unit 5: System of Linear Equations [5 Hours]

5.1 System of linear equations in the matrix form, consistent and inconsistent system, Elementary row operations and solution of the system using row operations methods

5.2 Row and reduced echelon forms of a matrix, pivot position and row reduction algorithm to convert the matrix into echelon forms

5.3 Existence and unique solution of the system, Parametrically represented solution of a system, homogeneous linear system of equations and unique and parametric solution representation

Unit 6: Vector Spaces [7 Hours]

6.1 Vectors in $\mathbb{R}^2$ and geometrical description of $\mathbb{R}^2$, vectors in $\mathbb{R}^3$ and $\mathbb{R}^n$, algebraic properties of vectors in $\mathbb{R}^n$

6.2 Linear combination and span of the vectors in $\mathbb{R}^n$, Geometrical descripting of span of vectors

6.3 Vector space and vector subspace, subspace spanned by a set of vectors, linearly independent and linearly dependent set of vectors, Basis and dimension of vector space

6.4 Linear transformation, kernel and range, null space, column space of a matrix, bases for null and column space, rank of a matrix

Unit 7:   Eigen-values and Eigen-vectors   **[5 Hours]**

7.1 Eigen-values and eigen-vectors of a matrix, characteristic equations, eigen-values of triangular and diagonal matrices, Eigen-spaces

7.2 Diagonalization of a matrix

Text Books:

1. "Thomas' Calculus" by George B. Thomas Jr., Maurice D. Weir, and Joel R. Hass, Pearson India

2. Linear Algebra and Its Applications by David C. Lay, Pearson, India

Reference Books:

1. Advanced Engineering Mathematics" by Erwin Kreyszig, Wiley

2. Calculus: Early Transcendentals" by James Stewart, Publisher: Cengage Learning India

3. Introduction to Matrices and Linear Transformations by D. T. Finkbeiner, 3rd Edition CBS Publisher and Distributors, Delhi.

4. A Text Book of Calculus I by Narayan Prasad Pahari, Santosh Ghimire, Dr. Jeevan Kafle, Arun Kumar Bhandari, Madav Prasad Poudel, Prem Gurung, Durgesh Ojha, Publisher: Asmita Publication, Kathmandu, Nepal

5. A Text Book of Algebra and Geometry by Narayan Prasad Pahari, Santosh Ghimire, Dr. Jeevan Kafle, Arun Kumar Bhandari, Madav Prasad Poudel, Prem Gurung, Durgesh Ojha, Publisher: Asmita Publication, Kathmandu, Nepal

6. A Text Book of Linear Algebra by Tulasi Pradad Nepal, Tek Bahadur, Budhathoki, Jeevan Kafle. Publisher: Heritage Publishers and Distributors Pvt. Ltd., Kathmandu, Nepal

7. A Text Book on Engineering Mathematics Volume I by S. P. Shrestha, H. D. Chaudhary, P. R. Pokharel. Publisher: Vidyarthi Pustak Bhandar, Kathmandu, Nepal

8. A Text Book on Engineering Mathematics Volume III by P. R. Pokharel, H. D. Chaudhary, S. P. Shrestha. Publisher: Vidyarthi Pustak Bhandar, Kathmandu, Nepal

Evaluation Scheme:

The final evaluation will have questions from all the units. The marks distribution for all the units will be as follows:

Units	Topics	Scheduled Hours	Marks
1	Function, Limit and Continuity	6	8
2	Differentiation and Its Applications	8	11
3	Integration and Its Applications	8	11
4	Infinite Sequences and Series	6	8
5	System of Linear Equations	5	7
6	Vector Spaces	7	8
7	Eigenvalues and Eigenvectors	5	7
Total		**45 Hours**	**60 Marks**

Note: The marks distribution shown in the table above might be subjected to minor changes.