LESSON PLAN: BS-M101(Mathematics-1A for CSE & IT)

<table>
<tr><td colspan="2">

Module-I

CALCULUS (INTEGRATION) (8 lectures)

</td></tr>
<tr><td colspan="2">

CONTENTS

Calculus (Integration):

Evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions.

</td></tr>
<tr><td colspan="2">

Module Objectives:

Broad Objectives of this module is to

i) learn evaluation techniques and use of integrals.

</td></tr>
<tr><th>Lecture Serial</th><th>Topics of Discussion</th></tr>
<tr><td>Lecture-1.</td><td><u>Evolutes and Involutes</u> – Formula for radius of curvature in Cartesian equation (Explicit Function: y=f(x) or x=f(y)) and Equation of circle of curvature with co-ordinate of centre of curvature (Cartesian coordinates only). Discussion with related problems.</td></tr>
<tr><td>Lecture-2.</td><td><u>Evolutes and Involutes</u> – Concept of Evolute and Involute and their determination. Related problems (Cartesian Coordinates only)</td></tr>
<tr><td>Lecture-3.</td><td><u>Evaluation of Definite Integral and Improper Integrals</u> – Review of basic properties of definite integral. Introduction to Improper Integral. Types of Improper Integral. Necessary and sufficient condition for convergence of Improper integral (Statement only). Related problems.</td></tr>
<tr><td>Lecture-4.</td><td><u>Beta and Gamma Functions-</u> Definition of Gamma Function. Proof of basic properties of Gamma function : Γ(1) = 1, Γ(x+1) = x Γ(x), Γ(n+1) = n! and other properties(proof not required). Problems on gamma function.</td></tr>
<tr><td>Lecture-5.</td><td><u>Beta and Gamma Functions-</u> Definition of Beta Function. Derivation of various forms of Beta function. [B(x,y) = B(y,x), B(x,y)= $\int_0^\infty \frac{t^{x-1}}{(1+t)^{x+y}}\,dt$, B(x,y)= 2 $\int_0^{\frac{\pi}{2}} \sin^{2x-1}\theta \cos^{2y-1}\theta \, d\theta$ and other properties(proof not required). Relation between Beta and Gamma function (Statement only). Problems on Beta and Gamma functions.</td></tr>
<tr><td>Lecture-6.</td><td><u>Reduction Formulae</u> for both indefinite and definite integrals of types
• $\int \sin^n x \, dx$, $\int_0^{\frac{\pi}{2}} \sin^n x \, dx$.
• $\int \cos^n x \, dx$, $\int_0^{\frac{\pi}{2}} \cos^n x \, dx$.
• $\int \sin^m x cosnx \, dx$ & $\int_0^{\frac{\pi}{2}} \sin^m x \, cosnx \, dx$</td></tr>
</table>

	• $\int \cos^m x \sin nx\, dx$ & $\int_0^{\frac{\pi}{2}} \cos^m x \sin nx\, dx$ and related problems.
Lecture-7.	**Surface areas** - Quadrature of Plane area: Cartesian coordinates. Calculation of area of some standard curves in Cartesian coordinates. (e.g. Circle, Parabola, Ellipse, Hyperbola, Catenary, Folium of Descartes, Astroid, Cycloid).
Lecture-8.	**Volume of revolution:** Volumes of solids of revolution: Rotation of a curve around x-axis/ y-axis. Problems on Volume of sphere, ellipsoid, paraboloid, catenary (Cartesian forms only).

Tutorial Assignment—1

Module-II

CALCULUS (Differentiation) (6 lectures)

CONTENTS

Calculus (Differentiation):

Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders; indeterminate forms and L'Hospital's rule; Maxima and minima.

Broad Objectives of this module is:

i) Solve and model many core engineering problems with applications of one variable differential calculus.

Lecture Serial	Topics of Discussion
Lecture-1.	**Leibnitz's Theorem:** Successive differentiation, Leibnitz theorem and related problems.
Lecture-2.	**Laws of Mean**- Rolle's Theorem, Lagrange's and Cauchy's Mean Value theorems (statement only) and geometrical interpretations.
Lecture-3.	**Laws of Mean(contd.)-** Discussion of problems and applications.
Lecture-4.	**Taylor's Theorem-** Taylor's theorem with Lagrange's and Cauchy's form of remainders and its applications. Maclaurin's Theorem with problems.
Lecture-5.	**Indeterminate form-** L'Hospital's Rule. Different indeterminate forms e.g. $\frac{0}{0}$, $\frac{\infty}{\infty}$, 1^∞ , $0\times\infty$, $\infty-\infty$, 0^0 , ∞^∞ . Related problems.
Lecture-6.	**Maxima and Minima-** Concept of local and global Maxima and Minima. Necessary and sufficient conditions for the existence of extreme value at a particular point. Applications.

Tutorial Assignment—2

Module-III

Matrices [7 Lectures]

CONTENTS

Matrices:

Matrices, vectors: addition and scalar multiplication, matrix multiplication; Linear systems of equations, linear Independence, rank of a matrix, determinants, Cramer's Rule, inverse of a matrix, Gauss elimination and Gauss-Jordan elimination.

Broad Objectives of this module is:

i) Acquire knowledge of matrices and determinants and its evaluation
ii) to learn and apply techniques of matrices to find solution of system of equations.

Lecture Serial	Topics of Discussion
Lecture-9.	**Determinant of a square matrix**-Minors and Cofactors, Laplace's method of expansion of determinant- elementary properties of determinant and their applications towards evaluation of determinants-solution to related problems. Product of two determinants. Cramer's Rule.
Lecture-10.	**Inverse of a non-singular Matrix**- Properties of invertible matrices- Adjoint of a determinant. Singular and Non-Singular Matrix, Adjoint of a matrix, –. Determination of inverse of a non-singular matrix by finding Adjoint.
Lecture-11.	**Introduction to special Matrices-** • Symmetric and skew symmetric matrices. • Orthogonal matrices. • Idempotent matrices. • Unitary matrices • Hermitian& skew Hermitian matrices
Lecture-12.	**Rank of a matrix-** Elementary row and Column operation of matrices. Determination of rank by reducing it to triangular matrix –different approaches for introduction of the notion of rank. Rank-nullity theorem..

Lecture-13.	**<u>System of simultaneous linear equations:</u>** Consistency and inconsistency-Solution of system of linear equations by matrix inversion method.
Lecture-14.	**<u>Matrix inversion:</u>** Gauss elimination method and Gauss Jordan elimination method. Solving problems using these two processes.
Lecture-15.	**<u>Matrix Algebra</u>** – Introduction to Matrix Algebra-Related Problems. Identification of matrix as vectors with respect to addition and scalar multiplication.

<u>Tutorial Assignment—3</u>

<u>Module-IV</u>

Vector Spaces: (9 lectures)

CONTENTS

Vector Spaces:

Vector Space, linear dependence of vectors, basis, dimension; Linear transformations (maps), range and kernel of a linear map, rank and nullity, Inverse of a linear transformation, rank-nullity theorem, composition of linear maps, Matrix associated with a linear map.

Broad Objectives of this module is to be

1. familiar with the linear spaces, its basis and dimension
2. to learn and apply the technique of linear transformation and its associated matrix form for solving system of linear equations.

Lecture Serial	Topics of Discussion
Lecture-16.	**<u>Vector spaces:</u>** Concept of internal and external law of compositions. Definition of vector spaces over a real field. Examples of vector spaces (R^n, C, P_n, R_{mxn} etc.) Elementary properties of vector spaces.
Lecture-17.	**<u>Subspace:</u>**Subspaces. Criterion for a vector space to be a subspace (statement only). Examples. Notion of some important subspace of a vector space.
Lecture-18.	**<u>Linear dependence of vectors:</u>** Linear combination of vectors and linear span. Linearly dependent and independent set of vectors. Elementary properties and related problems.
Lecture-19.	**<u>Basis and dimension:</u>** Definition of basis and dimension. Replacement theorem. Related problems. Dimension of finite and infinite vector spaces. Related problems.
Lecture-20.	**<u>Basis and dimension (Contd.):</u>** Any two bases of a finite dimensional vector space have same number of vectors. Extension theorem (statement only). Related problems.
Lecture-21.	**<u>Linear Transformation:</u>**Definition of linear transformation. Examples. Kernel and Image of a linear map. Dimension of Ker T and Image T. Nullity and Rank of linear map. Statement of nullity of T + Rank of T = dim V. Related problems.

Lecture-22.	**Composition of Linear map:** Composition of two linear maps is linear. Definition of inverse transformation. Existence of inverse map. Related problems.
Lecture-23.	**Matrix representation:** Matrix associated to linear map relative to chosen ordered bases. Rank of a linear map T = rank of matrix of T. (statement only). Related problems.
Lecture-24.	**Matrix representation (Contd.):** Matrix of the composite map. Matrix of the inverse map. Algebraic operation on the set of linear map. Related problems.

Tutorial Assignment—4

Module-V

Vector Spaces (Continued)(10 lectures)

CONTENTS

Vector Spaces:

Eigenvalues, eigenvectors, symmetric, skew-symmetric, and orthogonal Matrices, eigenbases. Diagonalization; Inner product spaces, Gram-Schmidt orthogonalization.

Broad Objectives of this module is to:

iii) Acquire knowledge of eigen values and eigen vectors for symmetric, skew-symmetric and orthogonal matrices.

iv) to learn and apply techniques of diagonalization for solving problems.

v) to learn and apply techniques of orthogonalization for solving problems.

Lecture Serial	Topics of Discussion
Lecture-25.	**Eigen values and Eigen vectors:** Characteristic equation. Cayley-Hamilton Theorem-and its applications.Related problems.
Lecture-26.	**Eigen values and Eigen vectors (Contd.):** Eigen values of a matrix. Related properties of Eigen values. Problems.
Lecture-27.	**Eigen values and Eigen vectors (Contd.):** Eigen vectors of a matrix. Properties of eigen vectors for symmetric, skew-symmetric and orthogonal matrices. Geometric and algebraic multiplicity of eigen vectors. Related problems.
Lecture-28.	**Diagonalisation of matrices:** Diagonalisation of square matrix. A matrix is diagonalisable if it has n linearly independent eigen vectors. Related problems.
Lecture-29.	**Diagonalisation of matrices:** Orthogonal diagonalisation of real matrices. A square matrix is orthogonally diagonalisableiff it is symmetric. Related problems.
Lecture-30.	**Eigen bases:** Definition and concept of eigen bases. Determination of eigen bases of a diagonalizable matrix, Related problems.
Lecture-31.	**Inner product space:** Definition of real inner product space, Euclidean space, Complex inner product space, Unitary space. Examples. Norm of a vector and its properties. Related problems.
Lecture-32.	**Inner product space (Contd.):** Schwarz's inequality, Triangle inequality, Pythagoras theorem and Parallelogram law. Orthogonal and orthonormal set of vectors. Examples and related problems.

Lecture-33.	**Inner product space (Contd.):** Projection of vectors. Bessel's inequality. Parseval's theorem. Orthogonal basis and orthonormal basis. Any orthogonal set of vectors can be extended to orthogonal basis (statement only). Related problems.
Lecture-34.	**Gram-Schmidt orthogonalisation:** Gram-Schmidt orthogonalisation process. Related problems.

Tutorial Assignment—5

LESSON PLAN OF MATHEMATICS 1B (BS-M102) For all streams except CSE & IT

Module-I

CALCULUS (INTEGRATION) (8 lectures)

CONTENTS

Calculus (Integration):

Evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions.

Module Objectives:

Broad Objectives of this module is to learn evaluation techniques and use of integrals.

Lecture Serial	Topics of Discussion
Lecture-1.	**Evolutes and Involutes** – Formula for radius of curvature in Cartesian equation (Explicit Function: y=f(x) or x=f(y)) and Equation of circle of curvature with co-ordinate of centre of curvature (Cartesian coordinates only). Discussion with related problems.
Lecture-2.	**Evolutes and Involutes** – Concept of Evolute and Involute and their determination. Related problems (Cartesian Coordinates only)
Lecture-3.	**Evaluation of Definite Integral and Improper Integrals** – Review of basic properties of definite integral. Introduction to Improper Integral. Types of Improper Integral. Necessary and sufficient condition for convergence of Improper integral (Statement only). Related problems.
Lecture-4.	**Beta and Gamma Functions-** Definition of Gamma Function. Proof of basic properties of Gamma function : $\Gamma(1) = 1$, $\Gamma(x+1) = x\,\Gamma(x)$, $\Gamma(n+1) = n!$ and other properties(proof not required). Problems on gamma function.
Lecture-5.	**Beta and Gamma Functions-** Definition of Beta Function. Derivation of various forms of Beta function. [B(x,y) = B(y,x), B(x,y)= $\int_0^\infty \frac{t^{x-1}}{(1+t)^{x+y}}\,dt$, B(x,y)= $2\int_0^{\frac{\pi}{2}} \sin^{2x-1}\theta\cos^{2y-1}\theta\,d\theta$ and other properties(proof not required). Relation between Beta and Gamma function (Statement only). Problems on Beta and Gamma functions.
Lecture-6.	**Reduction Formulae** for both indefinite and definite integrals of types • $\int \sin^n x\,dx$, $\int_0^{\frac{\pi}{2}} \sin^n x\,dx$. • $\int \cos^n x\,dx$, $\int_0^{\frac{\pi}{2}} \cos^n x\,dx$.

	• $\int \sin^m x \cos nx\, dx$ & $\int_0^{\frac{\pi}{2}} \sin^m x \cos nx\, dx$ • $\int \cos^m x \sin nx\, dx$ & $\int_0^{\frac{\pi}{2}} \cos^m x \sin nx\, dx$ and related problems.
Lecture-7.	**Surface areas -** Quadrature of Plane area: Cartesian coordinates. Calculation of area of some standard curves in Cartesian coordinates. (e.g. Circle, Parabola, Ellipse, Hyperbola, Catenary, Folium of Descartes, Astroid, Cycloid).
Lecture-8.	**Volume of revolution:** Volumes of solids of revolution: Rotation of a curve around x-axis/ y-axis. Problems on Volume of sphere, ellipsoid, paraboloid, catenary (Cartesian forms only).

Tutorial Assignment—1

Module-II

CALCULUS (Differentiation) (6 lectures)

CONTENTS

Calculus (Differentiation):

Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin's theorems with remainders; Indeterminate forms and L'Hospital's rule; Maxima and minima.

Broad Objectives of this module is:

i) Solve and model many core engineering problems with applications of differential calculus of one variable.

Lecture Serial	Topics of Discussion
Lecture-1.	**Leibnitz's Theorem:** Successive differentiation, Leibnitz theorem and related problems.
Lecture-2.	**Laws of Mean-** Rolle's Theorem, Lagrange's and Cauchy's Mean Value theorems (statement only) and geometrical interpretations.
Lecture-3.	**Laws of Mean(contd.)-** Discussion of problems and applications.
Lecture-4.	**Taylor's Theorem-** Taylor's theorem with Lagrange's and Cauchy's form of remainders and its applications. Maclaurin's Theorem with problems.
Lecture-5.	**Indeterminate form-** L'Hospital's Rule. Different indeterminate forms e.g. $\frac{0}{0}$, $\frac{\infty}{\infty}$, 1^∞ , $0\times\infty$, $\infty-\infty$, 0^0 , ∞^∞ . Related problems.

Lecture-6.	**Maxima and Minima-** Concept of local and global Maxima and Minima. Necessary and sufficient conditions for the existence of extreme value at a particular point. Applications.

Tutorial Assignment—2

Module-III
Sequence and Series [11 Lectures]

CONTENTS

Sequence and Series:

Convergence of sequence and series, tests for convergence; Power series, Taylor's series, series for exponential, trigonometric and logarithm functions; Fourier series: Half range sine and cosine series, Parseval's theorem.

Broad Objectives of this module is to:

i) learn and apply techniques of convergence of infinite series.
ii) know methods of finding series expansion of standard continuous function in Power series form.
iii) know techniques for finding Fourier series expansion of continuous/discontinuous function with given periodicity and its applications.

Lecture Serial	Topics of Discussion
Lecture-9.	**Sequence-** Basic ideas on sequence: Concept of monotonic and bounded sequence- Convergence and divergence of Sequence-Algebra of Sequences (Statement only).
Lecture-10.	**Series**–Basic idea of an infinite series –Series of positive term- Notion of Convergence and Divergence-Illustrations by examples. Convergence of infinite G.P. series and p-series (Statement only).
Lecture-11.	**Tests of Convergence of Infinite Series of positive terms**-Different form of Comparison test and related problems.

Lecture-12.	**<u>Tests of Convergence of Infinite Series of positive terms</u>**- Cauchy's Root test, D'Alembert's ratio test and Rabbe's test [Statement only] and related problems.
Lecture-13.	**<u>Alternating Series-</u>** Leibnitz's test [Statement only] with Illustrations, Concept of absolutely convergent series and conditionally convergent series. Related Problems.
Lecture-14.	**<u>Expansions of Functions</u>** by Taylor's and Maclaurin's theorems-Maclaurin's infinite series expansion of the functions - $\sin x, \cos x, e^x, \log(1+x), ¿(a+x)^m$.
Lecture-15.	**<u>Fourier Series-</u>** Even function, odd function. Periodic function, Euler's formula for Fourier coefficient over [-π, π], [-L, L], [a,b].
Lecture-16.	**<u>Fourier Series-(Continued):</u>** Dirichlet's conditions. Sum of the Fourier series at the point of discontinuity and end points of an interval.
Lecture-17.	**<u>Fourier Series-</u>** Introduction to typical wave form like Periodic square wave, Saw-toothed wave, Triangular wave, Half wave rectifier, Full wave rectifier, Unit step function etc. and their corresponding Fourier series expansions.
Lecture-18.	**<u>Half range series-</u>** Half range sine and cosine series expansions. Related problems.
Lecture-19.	**<u>Perseval's theorem-</u>** Statement and related problems.

<u>Tutorial Assignment—3</u>

<u>Module-IV</u> ***Multivariate Calculus (Differentiation): (9 lectures)***
CONTENTS ***Multivariate Calculus:*** Limit, continuity and partial derivatives, directional derivatives, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers; Gradient, curl and divergence.
Broad Objectives of this module is to 1. be familiar with limit, continuity and differentiability of function of two variable. 2. learn and apply techniques of calculus of multivariate function for finding extrema. 3. be familiar with the calculus of vector valued function.

Lecture Serial	**Topics of Discussion**
Lecture-20.	**<u>Introduction to the concept of functions of several variables</u>** - domain of definition with examples- developing ideas of simultaneous and repeated limits –Continuity.
Lecture-21.	**<u>Partial derivatives</u>** –first order and higher order Partial derivatives-Counter examples to show that • Existence of partial derivatives does not ensure continuity.

	• It is not always true that $\frac{\partial^2 f}{\partial x \partial y} = \frac{\partial^2 f}{\partial y \partial x}$.
Lecture-22.	**Differentiation:** Total differentiation-Higher order differentials—Examples to show that existence of all partial derivatives even their equality never ensures their total differentiability.
Lecture-23.	**Differentiation of composite functions**- Homogeneous functions and Euler's Theorem (for two and three variable function)-several applications.
Lecture-24.	**Chain Rule:** Chain rules and differentiation of implicit functions-related problems-Jacobians of transformation. Higher order Composite differentiation.
Lecture-25.	**Maxima and Minima:** Maxima and minima of a function of two variables and determination of saddle point. Related Problems.
Lecture-26.	**Maxima and Minima (Continued): M**ethod of Lagranges Multiplier for determination of extreme points of a function of two/three variables subject to given constraints.
Lecture-27.	**Gradient, Divergence and Curl:** Definition of Gradient, Divergence and Curl. Concept and interpretation of Directional derivative. Related problems.
Lecture-28.	**Gradient, Divergence and Curl (Contd.):** Properties of Gradient, Divergence and Curl and physical interpretation. Related problems.

Tutorial Assignment—4

Module-V ***Matrices (8 lectures)***	
CONTENTS ***Matrices:*** Inverse and rank of a matrix, rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Determinants; Eigenvalues and eigenvectors; Diagonalization of matrices; Cayley-Hamilton Theorem, and Orthogonal transformation.	
Broad Objectives of this module is to: i) acquire knowledge of matrices and determinants and its evaluation. ii) to learn and apply techniques of matrices to find solution of system of equations.	
Lecture Serial	**Topics of Discussion**
Lecture-29.	**Determinant of a square matrix**-Minors and Cofactors, Laplace's method of expansion of determinant- elementary properties of determinant and their applications towards evaluation of determinants-solution to related problems. Product of two determinants.
Lecture-30.	**Inverse of a non-singular Matrix**- Properties of invertible matrices- Adjoint of a determinant. Singular and Non-Singular Matrix, Adjoint of a matrix, Determination of inverse of a non-singular matrix by finding out its adjoint.
Lecture-31.	**Introduction to Special Matrices-** • Symmetric and skew symmetric matrices. • Orthogonal matrices. • Idempotent matrices.

	• Unitary matrices • Hermitian & skew Hermitian matrices
Lecture-32.	**<u>Rank of a matrix</u>-** Elementary row and Column operation of matrices. Determination of rank by reducing it to triangular matrix –different approaches for introduction of the notion of rank. Rank-nullity theorem..
Lecture-33.	**<u>Characteristics Equation of a matrix</u>-** Eigen values and Eigen vectors of a matrix. Properties of Eigen values and Eigen vectors.
Lecture-34.	**<u>Characteristics Equation of a matrix(Contd.)</u>-** Problems on Eigen values and Eigen vectors. Cayley-Hamilton Theorem-and its applications.
Lecture-35.	**<u>System of simultaneous linear equations</u>-**Consistency and inconsistency of the system of equations, Solution of system of linear equations by matrix inversion method.
Lecture-36.	**<u>Transformation of matrices</u> –**Diagonalisation of square matrix. Definition of orthogonal transformation.

Tutorial Assignment—5

LESSON PLAN OF MATHEMATICS-IIA (BS-M201) For CSE & IT

<table>
<tr><td colspan="2" align="center"><u>Module-I</u>
<u>BASIC PROBABILITY: (11 Lectures)</u></td></tr>
<tr><td colspan="2">CONTENTS:
Basic Probability: Probability spaces, conditional probability, independence; Discrete random variables, Independent random variables, the multinomial distribution, Poisson approximation to the binomial distribution, infinite sequences of Bernoulli trials, sums of independent random variables; Expectation of Discrete Random Variables, Moments, Variance of a sum, Correlation coefficient, Chebyshev's Inequality.</td></tr>
<tr><td colspan="2">Module Objectives:
Broad Objectives of this module is to
i) learn basic concepts of probability, discrete random variables and some associated distributions.</td></tr>
<tr><th>Lecture Serial</th><th>Topics of Discussion</th></tr>
<tr><td>Lecture-1.</td><td><u>Probability Space and related definitions:</u> Definitions of random experiment, sample space, events space and probability function with examples, Mathematical concept of a probability space (Ω, B, P), where the symbols represents the sample space, event space, and probability function respectively.</td></tr>
<tr><td>Lecture-2.</td><td><u>Probability Space and related definitions (Continued):</u> Deduction of Classical Definition and elementary results from the definition of Probability Function, Addition Law and its generalization, Boole’s Inequality, Conditional Probability, Independent Event, Multiplicative Law.</td></tr>
<tr><td>Lecture-3.</td><td><u>Conditional Probability and its Applications:</u> Applications of Conditional Probability and Baye’s Theorem, Related problems.</td></tr>
<tr><td>Lecture-4.</td><td><u>Random Variables:</u> Definition of Random Variable, Discrete and Continuous Random Variables with examples. Probability mass function and probability distribution function related to a discrete random variable with examples.</td></tr>
<tr><td>Lecture-5.</td><td><u>Random Variables (Continued):</u> Expectation of a discrete random variable: Mean, Variance and Moments. Related problems.</td></tr>
<tr><td>Lecture-6.</td><td><u>Random Variables (Continued):</u> Bernoullean Sequence of Trials, Binomial Probability Distribution, Mean and Variance of Binomial Distribution, Related Problems.</td></tr>
<tr><td>Lecture-7.</td><td><u>Random Variables (Continued):</u> Multinomial Distribution as a generalization of Binomial distribution, Related sums, Poisson Distribution.</td></tr>
<tr><td>Lecture-8.</td><td><u>Random Variables (Continued):</u> Poisson approximation of Binomial Distribution (Statement only), Mean and Variance of Poisson Distribution, Problems related to Poisson Distribution.</td></tr>
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Lecture-9.	**Random Variables (Continued):** Distribution of sum of independent discrete random variables with emphasis on Binomial and Poisson variates (Results only), Covariance and Correlation Coefficient between two random variables,
Lecture-10.	**Random Variables (Continued):** Properties of correlation Coefficient, Variance of sums of random variables, Related sums.
Lecture-11.	**Random Variables (Continued):** Chebyshev's Inequality (Statement only) and related sums, Concept of convergence in probability, Central limit theorem and Weak law of large numbers (Statement only).

ASSIGNMENT ON MODULE-1

Module-II
Continuous Probability Distributions: (4 lectures)

CONTENTS

Continuous random variables and their properties, distribution functions and densities, normal, exponential and gamma densities.

Broad Objectives of this module is to:

i) learn about the concept of continuous random variables and some corresponding distributions.

Lecture Serial	Topics of Discussion
Lecture-1.	**Random Variables (Continued):** Definition of Continuous Random Variables, Probability density function and probability distribution function related to a continuous random variable with examples.
Lecture-2.	**Random Variables (Continued):** Expectation of a continuous random variable: Mean, Variance and Moments. Related problems. Exponential Distribution and its Mean and Variance.
Lecture-3.	**Random Variables (Continued):** Gamma Distribution and its properties, Related sums.
Lecture-4.	**Random Variables (Continued):** Normal Distribution and its Properties, Related sums.

ASSIGNMENT ON MODULE-II

Module-III
Bivariate Distributions: (5 lectures)

CONTENTS

Bivariate distributions and their properties, distribution of sums and quotients, conditional densities, Bayes' rule.

Broad Objectives of this module is to: i) learn about the joint and conditional probability distribution of two random variables.	
Lecture Serial	**Topics of Discussion**
Lecture-12.	**<u>Bivariate Distributions:</u>** Concept and definition of joint density and distribution functions f(x,y) and F(x,y) of two random variables (discrete and continuous) X and Y, Examples.
Lecture-13.	**<u>Bivariate Distributions (Continued):</u>** Properties of bivariate distributions: Monotonic property of F(x, y) with respect to both arguments, Right continuity property with respect to both arguments, $F(-\infty, y)=0, F(x, -\infty)=0, F(+\infty, +\infty)=1$ etc. (Statements only).
Lecture-14.	**<u>Bivariate Distributions (Continued):</u>** Definition of probability mass function of a two dimensional discrete random variable with examples, Definition of Marginal distributions and its determination in case two dimensional discrete random variables and related examples.
Lecture-15.	**<u>Bivariate Distributions (Continued):</u>** Definition of Marginal distributions and their determination in case two dimensional continuous random variables and related examples.
Lecture-16.	**<u>Bivariate Distributions (Continued):</u>** Determination of conditional distributions with examples.

ASSIGNMENT ON MODULE-III

<u>Module-IV</u> ***Basic Statistics (8 lectures)***	
CONTENTS ***Basic Statistics:*** Measures of Central tendency, Dispersion, Moments, skewness and Kurtosis, Probability distributions: Binomial, Poisson and Normal and evaluation of statistical parameters for these three distributions, Correlation and regression – Rank correlation.	
Broad Objectives of this module is to be 1. Familiar with frequency distribution and basic measures of central tendency, dispersion and correlation from given data sets.	
Lecture Serial	**Topics of Discussion**

Lecture-17.	**Basic Concepts:** Concepts of population and sample, quantitative and qualitative data, discrete and continuous data, scales of measurement nominal, ordinal, interval and ratio.
Lecture-18.	**Basic Concepts (Continued):** Frequency distribution and its representations, tabular and graphical, including histogram and ogives.
Lecture-19.	**Measures of Central Tendency:** Determination of Mean, Median and Mode, related examples.
Lecture-20.	**Measures of Dispersion:** Range, Mean deviation, Standard deviation, Coefficient of variation
Lecture-21.	**Measures of Dispersion (Continued):** Moments, skewness and kurtosis and their interpretations, related examples.
Lecture-22.	**Bivariate data:** Scatter diagram, Determination of correlation coefficient.
Lecture-23.	**Bivariate data (Continued):** Determination of Rank correlation. Concept of linear regression.
Lecture-24.	**Bivariate data (Continued)**: Concept and determination of regression lines (Formulas only), Properties of regression coefficients and related sums.

ASSIGNMENT ON MODULE-IV

Module-V

Applied Statistics (8 lectures)

CONTENTS

Applied Statistics:

Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves. Test of significance: Large sample test for single proportion, difference of proportions, single mean, difference of means, and difference of standard deviations.

Broad Objectives of this module is to

i) learn and apply different statistical techniques to the given data set.

Lecture Serial	Topics of Discussion
Lecture-25.	**Curve Fitting:** Principle of least squares, Fitting of straight lines by the method of least squares, Related sums.
Lecture-26.	**Curve Fitting(Continued):** Fitting of polynomials (2^{nd} degree) and exponential curves.

Lecture-27.	**Sampling Distributions:** Definitions of random sample, Parameter and statistic, Sampling distribution of a statistic, Sampling distribution of sample mean,.
Lecture-28.	**Sampling Distributions(Continued):** Definitions of standard errors of sample mean (SRSWR and SRSWOR), Sample variance and sample proportion.
Lecture-29.	**Sampling Distributions(Continued):** Definitions of Null and alternative hypotheses, level of significance, Type I and Type II errors, their probabilities and critical region.
Lecture-30.	**Sampling Distributions(Continued):** Large sample tests: use of CLT for testing single proportion, difference of two proportions.
Lecture-31.	**Sampling Distributions(Continued):** Tests for single mean, difference of two means.
Lecture-32.	**Sampling Distributions(Continued):** Tests for standard deviation and difference of standard deviations.

ASSIGNMENT ON MODULE-V

Module-VI ***Small Samples (4 lectures)***	
CONTENTS ***Small samples:*** Test for single mean, difference of means and correlation coefficients, test for ratio of variances - Chi-square test for goodness of fit and independence of attributes.	
Broad Objectives of this module is to ii) learn and apply different statistical techniques to the given data set using small sized samples.	
Lecture Serial	**Topics of Discussion**
Lecture-33.	**Small Sampling Theory:** Basic concepts of Student's t, Chi-square and F Distributions.
Lecture-34.	**Small Sampling Theory (Continued):** Use of t-statistic for testing the hypothesis regarding a population mean and difference between two population means.
Lecture-35.	**Small Sampling Theory (Continued):** Use of F-Distribution for testing the hypothesis regarding comparison of two population variances.
Lecture-36.	**Small Sampling Theory (Continued):** Use of Chi-square test to determine the goodness of fit of some theoretical distributions to the sample data set. Use of Chi-square test to check the independence of attributes from a given contingency table.

ASSIGNMENT ON MODULE-VI

LESSON PLAN OF MATHEMATICS-IIB (BS-M202) for all sreams except CSE & IT

Module-I MULTIVARIATE CALCULUS (INTEGRATION) (11 lectures)
CONTENTS ***Multivariate Calculus (Integration):*** Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, Change of variables (Cartesian to polar), Applications: areas and volumes, Center of mass and Gravity (constant and variable densities); Triple integrals (Cartesian), orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds; Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Theorems of Green, Gauss and Stokes.
Module Objectives: Broad Objectives of this module is to i) learn evaluation techniques and use of multiple integrals.

Lecture Serial	Topics of Discussion
Lecture-1.	**Multiple Integrals:** Basic concepts of double and triple integration, Computation of double integrals via iterated integrals(over rectangles and general regions).
Lecture-2.	**Double Integrals (Continued)-** Jacobian of transformation, Use of transformation (Cartesian to polar) for evaluation of double integrals.
Lecture-3.	**Double Integrals (Continued)-** Change of order of integration of double integral and its evaluation.
Lecture-4.	**Application of double integrals:** Volume under surface z=f(x,y), Area of 2D region, Determination of Center of mass and centroid in cases of constant and variable densities.
Lecture-5.	**Triple Integrals:** Computation of triple integrals via iterated integrals(over rectangular parallelepiped, cube and sphere)
Lecture-6.	**Orthogonal Curvilinear Coordinates:** Introduction to cylindrical polar coordinates and spherical polar coordinates. Computation of triple integrals in Cartesian form (simple cases) by using transformation from rectangular to cylindrical polar or spherical polar coordinates.
Lecture-7.	**Scalar and Vector line integrals:** Line integrals of scalar functions with respect to arc length ds, Line integrals of scalar functions with respect to coordinate variables dx, dy, etc., Line integrals of vector fields with respect to dr.
Lecture-8.	**Surface integrals: a)** Evaluation of Scalar surface integrals of the types $\iint_S f(x,y)\,dxdy$ over a surface S.

	b) Evaluation of vector surface integrals of the types $\iint_S \vec{F}.\vec{ds}$
Lecture-9.	**Integral Theorems:** Green's theorem [Statement only] with examples.
Lecture-10.	**Integral Theorems (Continued):** Gauss Theorem on divergence [Statement only] with examples.
Lecture-11.	**Integral Theorems (continued):** Stoke's Theorem [Statement only] and it's applications.

ASSIGNMENT ON MODULE-1

Module-II

Ordinary Differential equation- [ODE] [5 Lectures]

[1st Order-1st Degree] & [1st Order-Higher Degree]

CONTENTS

First order ordinary differential equations:

Exact, linear and Bernoulli's equations; Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.

Broad Objectives of this module is to:

i) model many core engineering problems with applications of ODE of first order first degree and first order higher degree and its techniques of solution.

Lecture Serial	Topics of Discussion
Lecture-1.	**Exact Equations** – Definition of exact equation, Necessary & sufficient condition of exactness of a 1st order and 1st degree ODE (Statement only), Illustrations with examples,
Lecture-2.	**Exact equations [continued]**- Rules of finding integrating factors—Illustrations on each rule by examples.
Lecture-3.	**Exact equations [continued]** Solution of linear and Bernoulli's equation with examples.
Lecture-4.	**1st order higher degree equations [Continued]** Equations solvable for p, Solution by factorization method, Solution of equations which are solvable for the dependent variable y, Solution of equations which are solvable for the independent variable x
Lecture-5.	**1st order higher degree equations [Continued]** General and Singular solution of Clairaut's equation and related examples. Equations reducible to Clairaut's form.

ASSIGNMENT ON MODULE-II

Module-III **Higher order linear ordinary differential equations [9 Lectures]**
CONTENTS ***Ordinary differential equations of higher orders:*** Second order linear differential equations with constant coefficients, Use of D-operators, Second order linear differential equations with variable coefficients, method of variation of parameters, Cauchy-Euler equation; Power series solutions; Legendre polynomials, Bessel functions of the first kind and their properties.
Broad Objectives of this module is to: i) learn and apply techniques of solutions of higher order differential equations (with constant/variable coefficients). ii) know methods of finding power series solutions of higher order ODE with special reference to Legendre's and Bessel's equations.

Lecture Serial	**Topics of Discussion**
Lecture-12.	**Higher order linear ODE** – General form of linear [higher order] ODE with constant coefficients-associated homogeneous form –Complementary functions and particular integrals.
Lecture-13.	**Higher order linear ODE [continued]**- Use of D-operator for finding particular integrals, Illustrations.
Lecture-14.	**Higher order linear ODE [continued]**- Linearly Independence of solutions of second order ODE using Wronskians, Method of variation of parameters with examples.
Lecture-15.	**Higher order linear ODE [continued]-** Solution of Cauchy Euler homogeneous equation, Equations reducible to Cauchy-Euler form.

Lecture-16.	**Power Series solutions of Higher order linear ODE:-** Concept of power series and it's interval/radius of convergence, Ordinary and singular point of an ODE upto second order, Determination of power series solution of a given ODE (up to second order) about an ordinary point.
Lecture-17.	**Power Series solutions of Higher order linear ODE [Continued]:-** Determination of power series solution of a given ODE (up to second order) about a regular singular point. Frobenius method, **Discussion** about different cases regarding nature of roots of the indicial equation and solution for roots not differing by an integer.
Lecture-18.	**Power Series solutions of Higher order linear ODE [Continued]:-** Introduction of Legendre's polynomial ($P_n(x)$¿ as solution of Legendre's equation, Properties of $P_n(x)$: Generating function, Orthogonal Properties and related problems.
Lecture-19.	**Power Series solutions of Higher order linear ODE [Continued]:-** Rodrigue's formula, Location of Zeros of $P_n(x)$ within [-1, 1], Recurrence relations and related problems.
Lecture-20.	**Power Series solutions of Higher order linear ODE [Continued]:-** Introduction of Bessel's function of first kind $J_n(x)$ as solution of Bessel's equation, Simple properties of $J_n(x)$ and recurrence relations.

ASSIGNMENT ON MODULE-III

Module-IV
Complex Variable – Differentiation: (6 lectures)

CONTENTS

Differentiation of complex functions, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithmic) and their properties; Conformal mappings, Mobius transformations and their properties.

Broad Objectives of this module is to be

1. familiar with differentiability of complex functions at a point and also in a region and related topics.
2. familiar with different types of mappings or transformations.

Lecture	**Topics of Discussion**

Serial	
Lecture-21.	**Function of a complex variable:** Function of a complex variable: Definition and examples, Concept of existence of limit and continuity of a function of complex variable with illustrations.
Lecture-22.	**Function of a complex variable [Continued]:** Existence of derivative of the function of a complex variable, Concept of analytic function and its examples including exponential, trigonometric, logarithmic functions, Statement of Cauchy-Riemann equations (Cartesian and polar form) viewed as a set of necessary conditions for a function to be analytic.
Lecture-23.	**Function of a complex variable [Continued]:** Sufficient conditions for differentiability, Examples on C-R equations, Definition of Harmonic Functions and to show that if $f(z)=u(x,y)+iv(x,y)$ is analytic in a domain D, then $u(x,y)$ and $v(x,y)$ are harmonic functions, related examples.
Lecture-24.	**Function of a complex variable [Continued]:** Determination of harmonic conjugates using C-R equations and using Milne's method with related examples.
Lecture-25.	**Function of a complex variable [Continued]:** Concept of transformation or mapping $w=f(z)$ from Z-plane to W-plane with examples. Definition of Conformal mapping, Sufficient condition for a mapping to be conformal in a domain D, related examples, Definition of Bilinear or M $\acute{o}$ bius Tranformations and related examples.
Lecture-26.	**Function of a complex variable [Continued]:** Determination of bilinear transformation under the condition when three distinct points of z-plane are transformed to three distinct points of w-plane. Determination of fixed points of bilinear transformations.

ASSIGNMENT ON MODULE-IV

Module-V ***Complex Variable – Integration: (8 lectures)***
CONTENTS Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper

integrals using the Bromwich contour.

Broad Objectives of this module is to:

i) Acquire knowledge of contour integration and its evaluation

ii) Learn evaluation techniques of some particular real definite integrals using contour integration.

Lecture Serial	**Topics of Discussion**
Lecture-27.	**<u>Contours:</u>** Rectifiable Curve, Jordan Curve, Positively oriented curves, Simply and Multiply connected regions, Parametric representation of contours, Evaluation of complex line integrals along a given curve C.
Lecture-28.	**<u>Integral Theorems:</u>** Statement of Cauchy/Cauchy-Goursat theorem with examples, Some consequences of Cauchy's theorem: $\oint_{C_1} f(z)\,dz = \oint_{C_2} f(z)\,dz$ when f(z) is analytic within the region bounded by simple closed contours C_1 and C_2 and generalization of the result.
Lecture-29.	**<u>Integral Theorems (Continued):</u>** Statement of Cauchy's integral formula and its generalization for simply connected regions, Related examples. Statement and explanation of Lioville's and Maximum-Modulus theorems.
Lecture-30.	**<u>Power series representation of a function f(z):</u>** Taylor's series expansion of f(z) about the point z_0 within the region $\lvert z-z_0\rvert < R_0$, Laurent series expansion of f(z) about the point z_0 within the annular region $R_0 < \lvert z-z_0\rvert < R_1$, statement and discussions. Related examples.
Lecture-31.	**<u>Power series representation of a function f(z) (Continued):</u>** Determination of Taylor's series and Laurent's series of some given functions within specified regions as examples. Definition of zeros of order n of an analytic function with related examples.
Lecture-32.	**<u>Singular points:</u>** Idea of Singular points of a function, Concept and identification of different types of singularities (Removable and Isolated singular points, Pole and Essential singularities) with proper examples.
Lecture-33.	**<u>Residues and corresponding results:</u>** Definition of Residues and its determination at specified poles, Statement of Cauchy's Residue theorem with examples.
Lecture-34.	**<u>Residues and corresponding results (Continued):</u>** Applications of Cauchy's Residue theorem: Evaluation of simple contour integrals, Evaluation of some real definite integral involving sine and cosine by converting them into contour integrals.

Lecture-35.	**Residues and corresponding results (Continued):** Illustration of Bromwich contours and its modification in case of existence of branch points, Evaluation of certain improper integrals using the Bromwich contour.

ASSIGNMENT ON MODULE-V