KAVAYITRI BAHINABAI CHAUDHARI

NORTH MAHARASHTRA UNIVERSITY JALGAON

SYLLABUS of

F.Y. B. Sc. (MATHEMATICS)

(Semester System 60+40 Pattern)

UNDER CHOICE BASED CREDIT SYSTEM (CBCS)

Effective from June 2022

Scheme for B. Sc. (Mathematics) under Choice Based Credit System pattern with

F.Y. B. Sc. Syllabus

Effective from June 2022

Sem.	Course	Paper	Course Code with Title	Credit	No. Periods in Hour /week	No. Periods of 45 min.
I	MTHCC- A	Paper - 1	MTH 101: Matrix Algebra	2	2	3
		Paper - 2	MTH 102: Calculus of Single Variable	2	2	3
		Paper - 3	MTH 103 (A): Co-ordinate Geometry **or** MTH 103 (B): Discrete Mathematics	2	2	3
II	MTHCC- B	Paper-1	MTH 201: Ordinary Differential Equations	2	2	3
		Paper- 2	MTH 202: Theory of Equations	2	2	3
		Paper - 3	MTH 203 (A): Laplace Transforms **or** MTH 203 (B): Numerical Methods	2	2	3

SEMESTER - I

MTHCC- A
MTH 101: Matrix Algebra

Course Description:

This course provides an elementary level knowledge of Rank and adjoint of matrix, Applications of matrices to system of linear equations, Eigen values and Eigen vectors of matrices and also the transformation of matrices.

Prerequisite Course(s): 11 and 12 standard Mathematics.

General Objective:

A primary need for the establishment of this course is to understand the basic knowledge and applications of matrices in various fields. So, the main objective is to teach mathematical approaches and models to grow mathematical skill, to improve mathematical thinking and to improve choice making power of the students.

Learning Outcomes:

Upon successful completion of this course the student will be able to:

a) understand concepts on matrix operations and rank of the matrix.
b) understand use of matrix for solving the system of linear equations.
c) understand basic knowledge of the eigen values and eigen vectors.
d) apply Cayley-Hamilton theorem to find the inverse of the matrix.
e) know the matrix transformation and its applications in rotation, reflection, translation.

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Unit 1: Adjoint and Inverse of a Matrix. (Marks 15, 08 hours)

Elementary operations on matrices, Adjoint of a matrix, Inverse of matrix, Existence, uniqueness and properties of inverse of a matrix.

Unit 2: Rank of a Matrix. (Marks 15, 08 hours)

Elementary matrix, Rank and Normal form of a matrix. Reduction of matrix to its normal form. Rank of product of two matrices.

Unit 3: System of Linear Equations and Eigen Values. (Marks 15, 07 hours)

A homogeneous and non-homogeneous system of linear equations. Consistency of system of linear equations. Application of matrices to solve the system of linear equations. Eigen values, Eigen vectors, Characteristic equation of a matrix, Cayley Hamilton theorem, (Statement only) and its use to find the inverse of a matrix.

Unit IV: Orthogonal Matrices and Quadratic Forms. (Marks 15, 07 hours)

Orthogonal matrices. Properties of orthogonal matrices. Quadratic forms: matrix representation. Elementary congruent transformations. Diagonal form of a quadratic form. Canonical forms.

REFERENCE BOOKS:

1. Matrix and Linear Algebra, by K. B. Datta, Prentice Hall of India Pvt. Ltd. New Delhi,2000.
2. A Text Book of Matrices, by Shanti Narayan, S. Chand Limited, 2010.
3. Schaum's Outline of Theory and Problems of MATRICES, by Richord Bronson, McGraw-Hill, New York, 1989.

MTH 102 –Calculus of Single Variable

Course Description: This course provides fundamental knowledge of limits and continuity, Differentiations, Mean value theorem, Rolle's theorem, Cauchy's Mean value theorem and Geometrical interpretations.

Prerequisite Course(s): 11 and 12 standard Mathematics.

General Objective: Use the fact that the derivative is the slope of the tangent line to the curve at a given point to help determine the derivatives of simple linear functions. The basic need of this course is to understand the concepts Limits, Derivative and applications of calculus. Use the Intermediate Value Theorem to identify an interval where a continuous function has a root. Use the fact that the derivative is the slope of the tangent line to the curve at a given point to help determine the derivatives of simple linear functions. Also, this course will improve problem solving and logical thinking abilities of the students. By learn this course students can use the concepts of calculus to develop different mathematical models.

Learning Outcomes: Upon successful completion of this course the student will be able to:

a) understand basic concepts on limits and continuity.
b) understand use of differentiations in various theorems.
c) know the Mean value theorems and its applications.
d) make the applications of Taylor's, Maclaurin's theorem.
e) know the applications of calculus.
f) Determine the derivative of a function using the limit definition.
g) Interpret the derivative as the slope of a tangent line to a graph, the slope of a graph at a point, and the rate of change of a dependent variable with respect to an independent variable
h) Use the first and second derivatives to analyze and sketch the graph of a function, intervals on which the graph is increasing, decreasing.

Unit-1 Limit and Continuity (Marks 15, 08hours)

Epsilon-delta definition of limit of a function, Basic properties of limit, Indeterminate form, L-Hospitals rule, Examples of limit, Continuous function.

Properties of continuous function on closed and bounded interval.

i. Boundedness.
ii. Attains its bounds
iii. Indeterminate mean value theorem.
iv. Uniform continuity.

Unit-2 Mean Value Theorems (Marks 15, 08 hours)

Differentiability, Definition of derivative ,Theorem on continuity and examples, Roll's theorem, Langrage's Mean value theorem, Cauchy's mean value theorem, Examples on Roll's theorem, Langrage's Mean value theorem & Cauchy's mean value theorem, Geometrical interpretation and application, Increasing and Decreasing function.

Unit-3. Successive Differentiation (Marks 15, 07 hours)

The nth derivative of some standard functions:

$e^{ax+b}, x^m, (ax+b)^m, \frac{1}{ax+b}, \log(ax+b), \sin(ax+b), \cos(ax+b),$

$e^{ax}\sin(ax+b), e^{ax}\cos(ax+b)$

Leibnitz's Theorem and examples on it.

Unit-4. Application of differential Calculus. (Marks 15, 07 hours)

Taylor's theorem with Lagrange's form of remainder and related examples.

Maclaurin' theorem with Lagrange's form of remainder and related examples.

Reduction formulae

i. $\int_0^{\pi/2}(\sin x)^n\,dx$

ii. $\int_0^{\pi/2}(\cos x)^n\,dx$

iii. $\int_0^{\pi/2}(\sin x)^m(\cos x)^n dx$

iv. $\int(\frac{\sin nx}{\sin x})\,dx$ and examples on it.

REFERENCE BOOKS:

1. Theory and Problems of Advanced Calculus, by Robert Wrede and Murray R. Spiegel, McGraw-Hill Company, New York, Second Edition, 2002.
2. Text Book on Differential calculus, by Gorakh Prasad, Pothishala Private Ltd., Allahabad, 1959.
3. Integral calculus, by Gorakh Prasad, Pothishala Private Ltd., Allahabad
4. Problems in Calculus of One Variable, by I. A. Maron CBS Publishers & Distributors

MTH 103(A): Coordinate Geometry

Course Description: This course provides an elementary level knowledge of two- and three dimensional geometries especially sphere, cone and cylinders.

Prerequisite Course(s): 11 and 12 standard Mathematics.

General Objective: General objectives are to study two-dimensional geometry, translation and rotation of axes and its use to convert in standard 2-d forms. Also, to study three-dimensional geometry, Sphere, Cone and Cylinder along with their properties and interpretations.

Learning Outcomes:

Students can visualize geometrical concepts and draw two dimensional figures and can find their standard forms by shifting and rotation of axes. Students also can draw three dimensional figures and their equations particularly Sphere, Cone and Cylinder.

Unit-I Analytical Geometry **(Marks 15, 08 hours)**

Change of axes, Translation and Rotation,Invariant, Conic section, General equation of second degree in two variables and its reduction to standard form.

Unit-II Sphere **(Marks 15 , 08 hours)**

Equation of sphere in different forms, Plane section of sphere, Tangent line and Tangent plane to sphere,

Condition of tangency and point of contact, Interpretation of $S + \lambda S' = 0$, and $S + \lambda U = 0$ with usual notations.

Unit-III Cone **(Marks 15, 07 hours)**

Equation of cone with vertex at origin, Equation of cone with vertex at (α, β, γ), Right circular cone, Enveloping cone of sphere.

Unit-IV Cylinder **(Marks 15, 07 hours)**

Definition of cylinder, Equation of cylinder, Right circular cylinder, Enveloping cylinder.

REFERENCE BOOKS:

1. The Elements of Coordinate Geometry, By S. L. Loney, Mc-Millan and Company, London, 1895.
2. Text Book of Coordinate Geometry, By Gorakh Prasad and H. C. Gupta, Pothishala Pvt. Ltd. Allahabad,2000.
3. Analytical Solid Geometry, By Shanti Narayan, S. Chand and Co., 1959.

MTH 103(B): Discrete Mathematics

Course Description: This course provides fundamental knowledge of discrete mathematics.

Prerequisite Course(s): 11 and 12 standard Mathematics.

General Objective: To study

- Partition and Relations
- Coding Theory
- Mathematical logic
- Boolean Circuit and Algebra

Learning Outcomes:

Students are able to understand the concepts of relations, coding and decoding, mathematical logic, Boolean algebra.

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Unit-1. Relation **(Marks 15, 08 hours)**

1.1 Partition of sets

1.2 Cartesian product of two sets

1.3 Relation: Domain and range of relation

1.4 Inverse relation

1.5 Reflexive, Symmetric, Anti-Symmetric, Transitive relations, equivalences relation

1.6 Equivalence Classes

Unit-2. Coding Theory **(Marks 15, 08 hours)**

2.1 Weight of word, Hamming Distance, Message

2.2 Encoding Function, Detection of k or Fewer Errors, Parity Check Code

2.3 Minimum Distance of Encoding Function

2.4 Parity Check Matrix

2.5 Decoding Function, Maximum Likelyhood Decoding Function (Only Theory)

Unit-3. Mathematical Logic **(Marks 15, 07 hours)**

3.1 Statement

3.2 Logical Connectives: Conditional, Bi-conditional, Converse, Inverse, Contrapositive

3.3 Tautology, Contradiction, Satisfiable

3.4 Duality Law

3.5 Algebra of Proposition

3.6 Exclusive OR, NAND, NOR

Unit-4. Boolean Algebra **(Marks 15, 07 hours)**

4.1 Gates: NOT, AND, OR, NOR, NAND, XOR, XNOR

4.2 Combinatorial Circuit

4.3 Boolean Expression

4.4 Equivalence Combinatorial Circuits

4.5 Boolean Algebra

REFERENCE BOOKS:

1. Fundamental Approach to Discrete Mathematics by D. P. Achariya Sreekumar, New Age International Publishers, New Delhi.
2. Discrete Mathematical Structures by Bernard Kolman, Robert C Busby and Ross, Prentice Hall of India New Delhi, Eastern Economy Edition.

SEMESTER - II

MTH 201: Ordinary Differential Equations

Course Description: This course provides fundamental knowledge of Ordinary Differential Equations and their applications.

Prerequisite Course(s): 11 and 12 standard Mathematics.

General Objective: The basic need of this course is to understand the different methods of solving differential equations and their applications to solve problems arrives in engineering and technology.

Learning Outcomes: After successful completion of this course the student will be able to:

a) understand basic concepts in differential equations.

b) understand method of solving differential equations

c) understand use of differential equations in various fields.

Unit-I Differential Equations of First Order and First Degree (Marks 15, 08 hours)

a) Partial derivatives of first order.

b) Exact differential equations. Condition for exactness.

c) Integrating factor.

d) Rules for finding integrating factors.

e) Linear differential equations.

f) Bernoulli's Equation. Equation reducible to linear form.

Unit-II Differential Equations of First Order and Higher Degree (Marks 15, 07 hours)

a) Differential equations of first order and higher degree.

b) Equation solvable for p.

c) Equation solvable for y.

d) Equation solvable for x.

e) Clairaut's form.

Unit-III Linear Differential Equations with Constant Coefficients (Marks 15, 08 hours)

a) Linear differential equations with constant coefficients.

b) Complementary functions.

c) Particular integrals of $f(D)y = X$, where $X = e^{ax}$, $cos(ax)$, $sin(ax)$, x^n, $e^{ax}V$ & xV with usual notations.

Unit-IV Homogeneous Linear Differential Equations (Marks15, 07hours)

a) Homogeneous linear differential equations (Cauchy's differential equations).

b) Example of Homogeneous linear differential equations.

c) Equations reducible to homogeneous linear differential equations (Legendre's equations)

d) Example of Equations reducible to homogeneous linear differential equations

REFERENCE BOOKS:

1. Introductory Course in Differential Equations, by D. A. Murray, Orient Congman (India) 1967.
2. Differential Equations, by G. F. Simmons, Tata McGraw Hill, 1972.

MTH 202: Theory of Equations

Course Description: This course provides fundamental knowledge of Theory equations.

Prerequisite Course(s): 11 and 12 standard Mathematics.

General Objective: To study

- Divisibility of numbers and Roots of polynomial equations.
- Relations between roots and coefficients of polynomials.
- Roots of cubic equations by using Cardon's method, biquadratic equations by Descarte's method and roots of polynomial equation s by Newton's method.

Learning Outcomes:

Students can find out roots of any equation of degree less than or equal to five. Theory of equations is highly useful in various subjects like algebra, linear algebra, calculus, ordinary and partial differential equations etc.

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Unit-1. Divisibility of Integers (Marks15, 08 hours)

Number Systems. Well ordering principle (statement only). Principle of Mathematical Induction. Divisibility of integers and theorems. Division algorithm. GCD and LCM. Euclidean algorithm. Unique factorization

Unit-2. Polynomials (Marks15, 08 hours)

Revision of Polynomials, Horner's method of synthetic division, Existence and uniqueness of GCD of two polynomials, Polynomial equations, Factor theorem and generalized factor theorem for polynomials, Fundamental theorem of algebra (Statement only), Methods to find common roots of polynomial equation, Descarte's rule of signs, Newton's method of divisors for the integral roots.

Unit-3. Theory of Equations-I (Marks15, 07 hours)

Relation between roots and coefficient of general polynomial equation in one variable. Relation between roots and coefficient of quadratic, cubic and biquadratic equations. Symmetric functions of roots.

Unit-4. Theory of Equations–II (Marks15, 07 hours)

Transformation of equations. Cardon's method of solving cubic equations. Biquadratic equations. Descarte's method of solving biquadratic equations.

REFERENCE BOOKS:

1. Elementary Number Theory, by David M. Burton, W. C. Brown publishers, Dubuquolowa, 1989.
2. Higher Algebra, by H. S. Hall and S. R. Knight, H. M. Publications, 1994.
3. Matrix and Linear Algebra, by K. B. Datta, Prentice Hall of India Pvt. Ltd. New Delhi, 2000.
4. Theory of Equations, by D. R. Sharma, Sharma Publications, Jalandar, 2003.

MTH 203(A): Laplace Transforms

Course Description: This course offers an introduction to the concepts of Laplace transforms, Inverse Laplace transforms along with some important properties, and solution of an ordinary differential equations using Laplace transform.

Prerequisite Course: 11 and 12 standard Mathematics.

General Objective: The basic need of this course is to understand the concepts and applications of Laplace transforms. The concepts and methods are useful for solving Differential Equations.

Course Outcomes:

Upon successful completion of this course the student will be able to:

- Know about piecewise continuous functions, Dirac delta function, Laplace transform and its properties.
- Know about Unit step, Periodic, Error, Gamma and Null functions.
- Understand Laplace and Inverse Laplace transforms.
- Know the basic properties of Laplace and inverse Laplace transforms.
- Calculate the Laplace transform of basic functions using the definition.
- Find the Laplace transform of derivatives of functions.
- Compute inverse Laplace transforms.
- Solve ordinary differential equations using Laplace transforms.

UNIT-I: Laplace Transform and Their Basic Properties (Marks15, 08 hours)

1. Basic concept & Definition of Integral Transform.
2. Definition of the Laplace transform, Kernel of Laplace Transform
3. Definition of Sectional or piecewise continuity& Functions of exponential order
4. Sufficient conditions for existence of Laplace transform.
5. Laplace transforms of elementary functions
6. Some important properties of Laplace transforms: Linearity property, First translation or shifting property, Second translation or shifting property, Change of scale property, Laplace transform of derivatives, Laplace transform of integrals, Multiplication by t^n, Division by t.

UNIT-II: Laplace Transform of Some special functions (Marks15, 08 hours)

1. Periodic functions.
2. The Gamma function.
3. The Error &Complementary Error function.
4. Unit step function.
5. Unit impulse or Dirac delta function.
6. Null functions.
7. Evaluation of integrals by Laplace transform.

UNIT-III: Inverse Laplace Transform (Marks15, 07 hours)

1. Definition of inverse Laplace transform, Uniqueness of inverse Laplace transform.
2. Inverse Laplace transform of some functions.
3. Some important properties of inverse Laplace transforms: Linearity property, First translation or shifting property, Second translation or shifting property, Change of scale property, Inverse Laplace transform of derivatives, Inverse Laplace transform of integrals, Multiplication by s^n, Division by s.
4. Convolution Theorem(Without Proof)
5. Partial fraction Method.

UNIT-IV: Applications to Differential Equations (Marks15, 07 hours)

1. Ordinary differential equations with constant coefficients.
2. Ordinary differential equations with variable coefficients.
3. Simultaneous ordinary differential equations of first order.

REFERENCE BOOKS:

1. Murray R. Spiegel, Schaum's Outline Series,Theory and Problems of Laplace Transforms, Mc Graw Hill Ltd, New York, 1965.
2. Lokenath Debnath and Dambaru Bhatta,Integral Transforms and Their Applications, Second Edition, C. R. C. Press, London, 2007.

3. Phil Dyke, An Introduction to Laplace Transforms and Fourier Series, Second Edition, Springer-Verlag London, 2014.

MTH-203(B) Numerical Methods

Course Description: This course provides fundamental knowledge of different methods of solution of equations, basics of interpolation and curve fitting for set of dada Also it provides methods for solving differential equations.

Prerequisite Course(s):11th and 12thstandard Mathematics.

General Objective: The students will be able to understand the basic numerical analysis which is applicable to problems like finding of zeroes of algebraic equations, interpolation, curve fitting and solution of first order differential equations. Students will also understand that when exact solutions are difficult to obtain, then approximate solutions can be obtained by using numerical methods.

Learning Outcomes: Students will be able to

- Understand basic concepts of methods of solutions of equations viz. bisection, iteration, Newton-Raphson methods and method of false position.
- Understand methods of curve fitting viz. Gauss's forward and backward difference formulae and Lagrange's interpolation formula.
- Use of curve fitting such as least square, polynomials and exponential fittings for set of given dada.
- Use Taylor's series, Euler's method, Modified Euler's methods, RangeKutta methods for solving ordinary differential equations.

Unit-1: Solutions of Algebraic and Transcendental Equations (15 marks, 08 hours)

1.1: Errors and their computation: Algebraic equations, transcendental equations, root of equations, Exact and Approximate numbers, significant digits or significant figures, rounding off Numbers, Type of errors: Inherent errors, Truncation errors.

1.2: Absolute error, Relative error and percentage error, Absolute accuracy, Relative accuracy.

1.3: The bisection method.

1.4: The iteration method.

1.5: The method of false position.

1.6: Newton-Rapson method.

Unit-2: Interpolation (15 marks, 08 hours)

2.1: Finite Differences: forward differences, backward differences,central differences.

2.2: Symbolic relations and separation of symbols: Forward difference operator, Backward difference operator, Central difference operator, Averaging (Mean) operator, Shift operator.

2.3: Gauss's forward central difference formula.(without proof)

2.4:Gauss's backward central difference formula.(without proof)

2.5: Interpolation with unevenly spaced point, Lagrange's interpolation formula.

Unit-3: Curve fitting **(15 marks, 07 hours)**

3.1: Least squares curve fitting procedures.

3.2: Fitting of straight line $y = a + bx$.

3.3: Nonlinear curve fitting: Power function $y = ax + c$

3.4: Fitting of polynomial of degree two $y = a + bx + cx^2$

3.5: Fitting of exponential function $y = ae^{bx}$

Unit-4: Numerical solutions of ordinary differential equations: **(15 marks, 07 hours)**

Solution by

4.1: Taylor's series

4.2: Euler's method

4.3: Modified Euler's method

4.4: RungeKutta second order formula

4.5: RungeKutta fourth order formula.

REFERENCE BOOKS:

1. Numerical Methods by V.N.Vedamurty and N.Ch.S.N.Iyehgar, Vikas Publishing House, India.
2. Introductory Methods of Numerical Analysis by S. S. Sastry, Prentice Hall India Learning Private Limited, Fifth edition, 2012.

Equivalences for F. Y. B. Sc. (Mathematics)

Effective from June 2022

New Paper				Old Paper	
Sem.	**Course**	**Paper**	**Course Code with Title**	**Paper**	**Course Code with Title**
I	MTHCC- A	Paper - 1	MTH 101: Matrix Algebra	Paper - 1	MTH 101: Matrix Algebra
		Paper – 2	MTH 102: Calculus of Single Variable	Paper – 2	MTH 102: Calculus
		Paper – 3	MTH 103 (A): Co-ordinate Geometry	Paper – 3	MTH 103 (A): Co-ordinate Geometry
			MTH 103 (B): Graph Theory	Paper – 3	MTH 103 (B): Discrete Mathematics
II	MTHCC- B	Paper-1	MTH 201: Ordinary Differential Equations	Paper-1	MTH 201: Ordinary Differential Equations
		Paper- 2	MTH 202: Theory of Equations	Paper- 2	MTH 202: Theory of Equations
		Paper – 3	MTH 203 (A): Laplace Transforms	Paper – 3	MTH 203 (A): Laplace Transform
			MTH 203 (B): Numerical Methods		MTH 203 (B): Numerical Analysis