NORTH MAHARASHTRA UNIVERSITY, JALGAON

'A' Grade
NAAC Re-Accredited
(3rd Cycle)

STRUCTURE of B.Sc. and SYLLABUS of

F.Y. B. Sc. (MATHEMATICS)

UNDER CHOICE BASED CREDIT SYSTEM (CBCS)

Effective from June 2018

North Maharashtra University, Jalgaon
Scheme for B. Sc. (Mathematics) under Choice Based Credit System pattern with F.Y. B. Sc. Syllabus
Effective from June 2018

Sem.	Course	Paper	Course Code with Title	Credit	No. Periods in Hour /week	No. Periods of 45 min.
I	AECC-1	AECC-1	English/Marathi/Hindi/MIL Communication	2	2	3
	MTHCC- A	Paper - 1	MTH 101: Matrix Algebra	2	2	3
		Paper - 2	MTH 102: Calculus	2	2	3
		Paper - 3	MTH 103 (A): Co-ordinate Geometry or MTH 103 (B): Graph Theory	2	2	3
II	AECC-2	AECC-2	English/Marathi/Hindi/MIL Communication	2	2	3
	AECC-3	AECC-3	Environmental Science	2	2	3
	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 Transform or MTH 203 (B): Numerical Analysis	2	2	3
III	MTHCC- C	Paper - 1	MTH 301: Calculus of Several Variables	2	2	3
		Paper - 2	MTH 302: Group Theory	2	2	3
		Paper - 3	MTH 303: Practical paper based on MTH 301 and MTH 302	2	2	3
	SEC-1	SEC-1	Set Theory and Logic	2	2	3
IV	MTHCC- D	Paper - 1	MTH 401: Complex Variables	2	2	3
		Paper - 2	MTH 402: Differential Equations	2	2	3
		Paper - 3	MTH 403: Practical paper based on MTH 401 and MTH 402	2	2	3
	SEC-2	SEC-2	Vector Calculus	2	2	3
V	DSE-1A	Paper - 1	MTH 501: Metric Spaces	2	2	3
		Paper - 2	MTH 502: Real Analysis	2	2	3
		Paper - 3	MTH 503: Practical paper based on MTH 501 and MTH 502	2	2	3
	DSE-2A	Paper - 4	MTH 504: Algebra	2	2	3
		Paper - 5	MTH 505: Integral Transforms		2	3
		Paper - 6	MTH 506: Practical paper based on MTH 504 and MTH 505	2	2	3
	DSE-3A	Paper - 7	MTH 507: Number Theory	2	2	3
		Paper - 8	MTH 508: Programming in C	2	2	3

		Paper - 9	MTH 509: Practical paper based MTH MTH 507 and MTH 508	2	2	3
	SEC-3	SEC-3	Mathematical Modeling	2	2	3
VI	DSE-1B	Paper - 1	MTH 601- Advanced Real Analysis	2	2	3
		Paper - 2	MTH 602 – Measure Theory	2	2	3
		Paper - 3	MTH 603- Practical paper based on MTH 601 and MTH 602	2	2	3
	DSE-2B	Paper - 4	MTH 604- Linear Algebra	2	2	3
		Paper - 5	MTH 605 – Numerical Methods	2	2	3
		Paper - 6	MTH 606- Practical paper based on MTH 604 and MTH 605	2	2	3
	DSE-2C	Paper - 7	MTH 607- Statics	2	2	3
		Paper - 8	MTH 608 – Dynamics	2	2	3
		Paper - 9	Practical paper based on MTH 607 and MTH 608	2	2	3
	SEC-4	SEC-4	Boolean Algebra	2	2	3

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-I: Rank of Matrix: **No. of Periods – 12**

a. Elementary operations on matrices.
b. Adjoint of a matrix & Inverse of a matrix.
c. Existence & uniqueness theorem of inverse of a matrix.
d. Properties of inverse of a matrix, Elementary matrices.
e. Rank and normal form of a matrix, Reduction of a matrix to its normal form, Rank of product of two matrices.

UNIT-II: System of Linear Equations   **No. of Periods – 12**

a. A homogeneous and non-homogeneous system of linear equations.
b. Consistency of system of linear equations.
c. Application of matrices to solve the system of linear equations.

UNIT-III: Eigen Values & Eigen Vectors   **No. of Periods – 11**

a. Orthogonal Matrices and Properties of Orthogonal Matrices.
b. Characteristic equation, Eigen Values and Eigen Vectors of Matrices.
c. Cayley Hamilton theorem (statement only) and its use to find the inverse of a Matrix.

UNIT-IV: Matrix Transformation   **No. of Periods – 10**

a. Two & Three-dimensional Matrix Transform.
b. Application of matrices to Scaling & Shearing.
c. Application of Matrices to Reflection, Rotation & Translation.

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.
4. Mathematics for Computer Graphics, by Vince, John A., Springer-Verlag London, 2010.
5. Fundamental of Computer Graphics, by Peter Shirley, A. K. Peters, Wellesley, Massachutusetts.
6. Schaum's Outline of Computer Graphics 2/E 2nd edition, by Zhigang Xiang and Roy A. Plastock, Hall of India Pvt. Ltd., New Delhi, 2015.
7. Matrices & Transformation by Anthony J. Pettofrezzo, Dover Publications, Revised edition, 1978.

MTH 102: Calculus

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: The basic need of this course is to understand the concepts and applications of calculus. Also, this course will improve problem solving and logical thinking abilities of the students. By learning 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.

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UNIT-I: Limits and Continuity: No. of Periods – 12
a) Epsilon-delta definition of limit of a function.
b) Basic properties of limits, Indeterminate forms & L-Hospitals rule.
c) Continuous functions. Properties of continuous functions on closed and bounded intervals.
d) Theorems on Boundedness of continuous functions, including Intermediate value theorem.
e) Uniform continuity.

UNIT-II: Mean Value Theorems: No. of Periods – 12
a) Differentiability.
b) Rolle's Theorem.
c) Lagrange's Mean Value Theorem.
d) Cauchy's Mean Value Theorem.
e) Geometrical interpretation and applications.

UNIT-III: Successive Differentiation: No. of Periods – 11
a) The nth derivative of some standard functions: $e^{ax+b}, (ax+b)^m, x^m, \frac{1}{(ax+b)},$
   $\log(ax+b), \sin(ax+b), \cos(ax+b), e^{ax}\sin(bx+c), e^{ax}\cos(bx+c).$
b) Leibnitz's theorem & Examples.

UNIT-IV: Applications of Calculus   No. of Periods – 10
a) Taylor's theorem with Lagrange's form of remainder and related examples.
b) Maclaurin' theorem with Lagrange's form of remainder and related examples
c) Reduction Formulae 1) $\int_0^{\frac{\pi}{2}} \sin^n x\, dx$, 2) $\int_0^{\frac{\pi}{2}} \cos^n x\, dx$, 3) $\int_0^{\frac{\pi}{2}} \sin^m x\, \cos^n x\, dx$,
   4) $\int \frac{\sin nx}{\sin x}\, dx$.

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.

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.

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Unit-I   Analytical Geometry: **No. of Periods – 12**

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

Unit-II   Sphere: **No. of Periods – 12**

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: **No. of Periods – 12**

Equation of cone with vertex at origin, Equation of cone with vertex at (α, β, γ), Right circular cone, Enveloping cone of sphere, Tangent line and Tangent plane to the cone.

Unit-IV   Cylinder: **No. of Periods – 12**

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): Graph Theory

Unit-I. Graphs   **No. of Periods – 12**

Graph, Simple graph, Multigraph, Hand shaking lemma, Types of Graphs, Operations on graphs, Subgraphs, Isomorphism of graphs, Walk, path, cycles (circuits).

Unit-2. Connected Graphs   **No. of Periods – 12**

Connected and disconnected Graphs, bridges, Cut vertices, edge connectivity and vertex connectivity, Eulerian graph, Hamiltonian Graph, Planer Graph, Euler's Formula for planer graphs, Kuratowski's two graph, Geometrical dual

Unit-3. Trees and Directed Graphs   **No. of Periods – 11**

Definition and some properties of trees, Distance and Centre in a tree, Definitions of Rooted and Binary trees, Spanning trees, Minimal Spanning trees, Directed graphs, some types of digraphs.

Unit-4. Applications of the Graphs   **No. of Periods – 10**

Existence of Graphs for given number of Vertices and Edges, Coloring of the graphs, Konigsberg Seven Bridge Problem, Travelling salesman Problem, Dijkstra's algorithm, Warshall's algorithm, formation of flowchart using rooted trees.

Reference books:
1. Graph Theory with Applications to Engineering and Computer science. by Narsingh Deo, Prentice Hall of India Pvt. Ltd. 1979.
   (Unit I: 1.1, 1.4, 1.5, 2.1, 2.2, 2.4, 2.7; Unit II: 2.5, 2.6, 2.9, 5.2, 5.3, 5.4, 5.5, 5.6; Unit III: 3.1, 3.2, 3.4, 3.5, 3.7, 9.1, 9.2; Unit IV: 1.4, 8.1, 1.2, 2.10, 3.4,11.4, 3.5).
2. Theory and Problems of Discreate Mathematics by Seymour Lipschitz and Marc Lars Lipson, Schaum's outline series, McGraw-Hill Ltd., New York, 2007.

MTHCC- B
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: Upon 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.

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Unit-I Differential equations of first order and first degree   **No. of Periods – 12**
   a) Partial derivatives of first order & second orders and Examples.
   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   **No. of Periods – 12**
   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 of second and higher order   **No. of Periods – 11**
   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   **No. of Periods – 10**
   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
1. Divisibility of numbers and Roots of polynomial equations.
2. Relations between roots and coefficients of polynomials of degree ≤ 4.
3. 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   **No. of Periods – 12**

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

Unit-2. Polynomials   **No. of Periods – 12**

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   **No. of Periods – 11**

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   **No. of Periods – 10**

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, Dubuquo lowa 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.

MTH 203(A): Laplace Transform

Course Description: This course provides fundamental knowledge of Laplace transform and their applications in solving differential Equations.
Prerequisite Course(s): 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.
Learning Outcomes: Upon successful completion of this course the student will be able to:
a) understand basic concepts on Laplace and Inverse Laplace transforms.
b) Understand convolution theorem.
c) understand use of Laplace transform in solving Differential Equations.

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UNIT-I Laplace Transforms   No. of Periods – 12
   a) Definition and existence of Laplace transform.
   b) Laplace transforms of elementary functions and validity.
$$f(t) = 1, e^{kt}, cosh(kt), sinh(kt), cos(kt), sin(kt), tn \ (t > 0, n > 1).$$
   c) Idea of sectionally continuous functions and of exponential order.
   d) Properties of Laplace transform.
   e) Laplace transforms of derivatives.
   f) Laplace transforms of real integrals.
   g) Multiplication by tn.
   h) Division by t.
   i) Definition and simple properties of Beta and Gamma functions (without proof).

UNIT-II Inverse Laplace Transform   No. of Periods – 12
   a) Definition and use of table.
   b) Properties of inverse Laplace Transforms :
   c) Linearity, first and second translation, Change of scale.
   d) Inverse Laplace transforms of derivatives.
   e) Inverse Laplace transforms of integrals.
   f) Multiplications by s .
   g) Division by s.

UNIT-III Convolution Theorem   No. of Periods – 12
   a) Laplace transforms of periodic functions.
   b) Convolution theorem (without proof).
   c) Evaluation of inverse Laplace transform by convolution theorem.
   d) Use of partial fractions.

UNIT-IV Applications to Differential Equations   No. of Periods – 12
   a) Solution of linear differential equation with constant coefficients by using
   b) Laplace transforms.
   c) Laplace transforms of Heaviside unit step functions.
   d) Laplace transforms of Dirac-Delta functions.
   e) Applications to Mechanics
   f) Applications to electrical circuits,
   g) Applications to beams.

Reference books:
1. Theory and problems of Laplace transforms, by Murry R. Spiegel, Schaum's Outline Series, Mc Graw Hill Ltd, New York, 1965.
2. Integral transforms, by A. R. Vasishtha and R. K. Gupta, Krishna Prakashan Media (P) Ltd.

MTH 203(B): Numerical Analysis

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

Prerequisite Course(s): 11 and 12 standard 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: Student will be able to:

a) understand basic concepts of methods of solutions of equations viz. bisection, iteration, Newton-Raphson methods and method of false position.

b) understand methods of curve fitting viz. Gauss's forward and backward difference formulae and Lagrange's interpolation formula.
c) use of curve fitting such as least square, polynomial and exponential fittings for set of given data.
d) use Taylor's series, Euler's method. Modified Euler's method., Runge Kutta methods for solving ordinary differential equations.

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UNIT-I Solution of Algebraic and Transcendental Equations   **No. of Periods – 12**

Errors and their computation. Absolute, relative and percentage errors. The Bisection method. The iteration method. The method of false position. Newton-Raphson method.

UNIT-II Interpolation   **No. of Periods – 12**

Finite differences: Forward differences, backward differences, central differences, Symbolic relations and separation of symbols. Gauss's forward difference formula. Gauss's backward difference formula. Interpolations with unevenly spaced points. Lagrange's interpolation formula. Inverse Lagrange's Formula.

UNIT-III Curve Fitting   **No. of Periods – 11**

Least squares curve fitting procedures. Fitting of straight line. Non-linear curve fitting: power function $y = ax + c$. Fitting of polynomial of degree two $y = a + bx + cx^2$. Fitting of exponential function $y = ae^{bx}$.

UNIT-IV Numerical Solutions of Ordinary Differential Equations   **No of Periods – 10**

Numerical solution of first order ODE by Taylor's series, Euler's method and Modified Euler's method. Runge–Kutta methods Runge–Kutta second and fourth order formulae.

Reference books:
1. Introductory Methods of Numerical Analysis, by S. S. Sastry, Prentice Hall India Learning Private Limited; Fifth edition, 2012.
2. Introduction to Numerical Analysis, by Carl-Erik Froberg, Addison-Wesley, Second edition, 1979.
3. Numerical Methods by V.N. Vedamurty and N. Ch. S. N. Iyehgar, Vikas Publishing House, India, 1995.
4. Numerical methods for scientific and engineering computation, by M. K. Jain, S. R. K. Iyenger and R. K. Jain. New Age International Publisher Pvt. Ltd., 1999.