Academic Council Meeting No. and Date : April 21, 2023

Agenda Number : 4 Resolution Number : 23,24 / 4.4 & 4.11

Vidya Prasarak Mandal's

B. N. Bandodkar College of Science (Autonomous), Thane

Syllabus for

Programme : Bachelor of Science

Specific Programme : Mathematics

[T.Y.B.Sc. (Mathematics)]

Revised under Autonomy

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Preamble

VPM'S B. N. Bandodkar College of Science Autonomous has changed the syllabus of S.Y.B.Sc. Mathematics from the academic year 2022-23.

Mathematics is the most fundamental subject and an essential tool in the field of Science and Technology. The syllabus has been developed to prepare the students in pursuing research in Mathematics as well as to enhance their analytical skills and knowledge of mathematical tools and techniques required in industry for employment.

The present syllabi of T. Y. B. Sc. for Semester V and Semester VI has been designed as per U. G. C. Model curriculum so that the students learn Mathematics needed for these branches, learn basic concepts of Mathematics and are exposed to rigorous methods gently and slowly. The syllabi of T. Y. B. Sc. would consist of two semesters and each semester would comprise of four Mathematics courses, One Applied component and two practical courses for T. Y. B. Sc. Mathematics.

1. Aims and Objectives:

(i) Give the students a sufficient knowledge of fundamental principles, methods and a clear perception of innumerous power of mathematical ideas and tools and know how to use them by modeling, solving and interpreting.

(ii) Reflecting the broad nature of the subject and developing mathematical tools for continuing further study in various fields of science.

(iii) Enhancing students' overall development and to equip them with mathematical modeling abilities, problem solving skills, creative talent and power of communication necessary for various kinds of employment.

(iv) A student should get adequate exposure to global and local concerns that explore them many aspects of Mathematical Sciences.

2. Programme Outcomes:

(i) Enabling students to develop positive attitude towards mathematics as an interesting and valuable subject

(ii) Enhancing students overall development and to equip them with mathematical modeling, abilities, problem solving skills, creative talent and power of communication.

(iii) Acquire good knowledge and understanding in advanced areas of mathematics and physics.

3. Course outcomes:

(i) Multivariable Calculus II (Sem V): In this course students will learn the basic ideas, tools and techniques of integral calculus and use them to solve problems from real-life ap- plications including science and engineering problems involving areas, volumes, centroid, Moments of mass and center of mass Moments of inertia. Examine vector fields and define and evaluate line integrals using the Fundamental Theorem of Line Integrals and Green's Theorem; compute arc length.

(ii) Complex Analysis (Sem VI): Students Analyze sequences and series of analytic func- tions and types of convergence, Students will also be able to evaluate complex contour integrals directly and by the fundamental theorem, apply the Cauchy integral theorem in its various versions, and the Cauchy integral formula, they will also be able to represent functions as Taylor, power and Laurent series, classify singularities and poles, find residues and evaluate complex integrals using the residue theorem.

(iii) Group Theory, Ring Theory (Sem V, Sem VI) Students will have a working knowl- edge of important mathematical concepts in abstract algebra such as definition of a group, order of a finite group and order of an element, rings, Euclidean domain, Principal ideal domain and Unique factorization domain. Students will also understand the connection and transition between previously studied mathematics and more advanced mathematics. The students will actively participate in the transition of important concepts such homo- morphisms & isomorphisms from discrete mathematics to advanced abstract mathematics.

(iv) Topology of metric spaces (Sem V), Topology of metric spaces and real analysis (Sem VI):

This course introduces students to the idea of metric spaces. It extends the ideas of open sets, closed sets and continuity to the more general setting of metric spaces along with concepts such as compactness and connectedness. Convergence concepts of sequences and series of functions, power series are also dealt with. Formal proofs are given a lot of emphasis in this course. This course serves as a foundation to advanced courses in analysis. Apart from understanding the concepts introduced, the treatment of this course will enable the learner to explain their reasoning about analysis with clarity and rigour.

(v) Partial Differential equations (Sem V: Paper IV: Elective A):

a. Students will able to understand the various analytical methods for solving first order partial differential equations.
b. Students will able to understand the classification of first order partial differential equations.
c. Students will able to grasp the linear and non linear partial differential equations.

(vi) Integral Transforms (Sem VI: Paper IV- Elective A):

a. Students will able to understand the concept of integral transforms and their corre-sponding inversion techniques.
b. Students will able to understand the various applications of integral transforms.

c. Identify certain number theoretic functions and their properties. Investigate perfect numbers and Mersenne prime numbers and their connection. Explore the use of arithmetical functions, the Mobius function, and the Euler function.

(vii) Graph Theory (Sem V: Paper IV- Elective B)

Upon successful completion of Graph Theory course, a student will be able to:

a. Demonstrate the knowledge of fundamental concepts in graph theory, including prop-erties and characterization of graphs and trees.
b. Describe knowledgeably special classes of graphs that arise frequently in graph theory
c. Describe the concept of isomorphic graphs and isomorphism invariant properties of graphs
d. Describe and apply the relationship between the properties of a matrix representation of a graph and the structure of the underlying graph
e. Demonstrate different types of algorithms including Dijkstra's, BFS, DFS, MST and Huffman coding.
f. Understand the concept of Eulerian graphs and Hamiltonian graphs.
g. Describe real-world applications of graph theory.

(viii) Graph Theory and Combinatorics (Sem VI: Paper IV -Elective B)

a. Understand and apply the basic concepts of graph theory, including colouring of graph, to find chromatic number and chromatic polynomials for graphs
b. Understand the concept of vertex connectivity, edge connectivity in graphs and Whit-ney's theorem on 2-vertex connected graphs.
c. Derive some properties of planarity and Euler's formula, develop the under-standing of Geometric duals in Planar Graphs
d. Know the applications of graph theory to network flows theory.
e. Understand different applications of system of distinct representative and matching theory.
f. Use permutations and combinations to solve counting problems with sets and multi-sets.
g. Set up and solve a linear recurrence relation and apply the inclusion/exclusion prin-ciple.
h. Compute a generating function and apply them to combinatorial problems.

VPM's B.N. Bandodkar College of Science (Autonomous), Thane

T.Y.B.Sc. (MATHEMATICS)

Structure of Program

Course Code	Course Title	No. of lectures	Credits
	SEMESTER V		
BNBUSMT5T1	Multivariable Calculus II	**45**	**2**
BNBUSMT5T2	Group Theory	**45**	**2**
BNBUSMT5T3	Topology of Metric Spaces	**45**	**2**
BNBUSMT5T4A	Partial Differential equations (Elective A)	**45**	**2**
BNBUSMT5T4B	Graph Theory (Elective B)	**45**	**2**
BNBUSMT5T5	Computer programming and system analysis	**60**	**3**
BNBUSMT5P1	Practical based on BNBUSMT5T1, BNBUSMT5T2	**35**	**3**
BNBUSMT5P2	Practical based on BNBUSMT5T3, BNBUSMT5T4	**35**	**3**
BNBUSMT5P3	Practical based on BNBUSMT5T5	**30**	**3**
	SEMESTER VI		
BNBUSMT6T1	Basic Complex Analysis	**45**	**2**
BNBUSMT6T2	Ring Theory	**45**	**2**
BNBUSMT6T3	Topology of Metric Spaces and Real Analysis	**45**	**2**
BNBUSMT6T4A	Integral Transform (Elective A)	**45**	**2**
BNBUSMT6T4B	Graph Theory and Combinatorics (Elective B)	**45**	**2**
BNBUSMT6T5	Computer programming and system Analysis	**60**	**3**
BNBUSMT6P1	Practical based on BNBUSMT6T1, BNBUSMT6T2	**35**	**3**
BNBUSMT6P2	Practical based on BNBUSMT6T3, BNBUSMT6T4	**35**	**3**

BNBUSMT6P3	Practical Based on BNBUSMT6T5	**30**	**3**
Total			

Semester V

SEMESTER V

Course Code	Course Title	Credits	No. of lectures
BNBUSMT5T1	**Multivariable Calculus II**	**2**	**45**

Course Outcomes: Upon completion of this course, students will learn about

- In this course students will learn the basic ideas, tools and techniques of integral calculus and use them to solve problems from real-life applications including science and engineering problems involving areas, volumes, centroid, Moments of mass and center of mass Moments of inertia. Examine vector fields and define and evaluate line integrals using the Fundamental Theorem of Line Integrals and Green's Theorem; compute arc length.

Unit I:	**Multiple Integrals** Definition of double (resp: triple) integral of a function and bounded on a rectangle (resp:box). Geometric interpretation as area and volume. Fubini's Theorem over rectangles and any closed bounded sets, Iterated Integrals. Following basic properties of double and triple integrals proved using the Fubini's theorem: (1) Integrability of the sums, scalar multiples, products, and (under suitable conditions) quotients of integrable functions. Formulae for the integrals of sums and scalar multiples of integrable functions. (2) Integrability of continuous functions. More generally, Integrability of functions with a "small" set of (Here, the notion of "small sets" should include finite unions of graphs of continuous functions.) (3) Domain additivity of the integral. Integrability and the integral over arbitrary bounded domains. Change of variables formula (Statement only).Polar, cylindrical and spherical coordinates, and integration using these coordinates. Differentiation under the integral sign. Applications to finding the center of gravity and moments of inertia.	**15**
Unit II:	**Line Integrals** Review of Scalar and Vector fields on R^n, Vector Differential Operators, Gradient, Curl, Divergence. Paths (parametrized curves) in R^n (emphasis on R^2 and R^3), Smooth and piecewise smooth paths. Closed paths. Equivalence and orientation preserving equivalence of paths. Definition of the line integral of a vector field over a piecewise smooth path. Basic properties of line integrals including linearity, path-additivity and behaviour under a change of parameters. Examples. Line integrals of the gradient vector field, Fundamental Theorem of Calculus for Line Integrals, Necessary and sufficient conditions for a vector field to be conservative. Green's Theorem (proof in the case of rectangular domains). Applications to evaluation of line integrals.	**15**

Unit III:	**Surface Integrals** Parameterized surfaces. Smoothly equivalent parameterizations. Area of such surfaces. Definition of surface integrals of scalar-valued functions as well as of vector fields defined on asurface. Curl and divergence of a vector field. Elementary identities involving gradient, curl and divergence. Stoke's Theorem (proof assuming the general from of Green's Theorem). Examples.Gauss' Divergence Theorem (proof only in the case of cubical domains). Examples.	**15**

Course Code **BNBUSMT5P6**	**Course Title** **Practical based on BNBUSMT5T1 and BNBUSMT5T2**	**Credits** **3**	**No. of lectures** **21**
	Practical based on BNBUSMT5T1		
Practical 1	Evaluation of double and triple integrals.		**3**
Practical 2	Change of variables in double and triple integrals and applications		**3**
Practical 3	Line integrals of scalar and vector fields		**3**
Practical 4	Green's theorem, conservative field and appli		**3**
Practical 5	Evaluation of surface integrals		**3**
Practical 6	Stoke's and Gauss divergence theorem		**3**

Practical 7	Miscellaneous theory questions on units 1, 2 and 3.	**3**

Books and References: Semester V Paper I					
Sr. No.	**Title**	**Author/s**	**Publisher**	**Edition**	**Year**
1.	Calculus, Vol. 2, Second Ed	Apostol	John Wiley, New York	second	1969
2.	Calculus with early transcendental Functions	James Stewart			
3.	Marsden and Jerrold E. Tromba	Vector Calculus	W.H. Freeman and Co	Fourth	1996
4	Mathematical Analysis	T. Apostol	Narosa, New Delhi	Second	1947
5	Calculus and Analytic Geometry	G. B. Thomas and R.L Finney	Springer-Verlag	Ninth	1998

SEMESTER V

Course Code	Course Title	Credits	No. of lectures
BNBUSMT5T2	**Group Theory**	**2**	**45**

Course Outcomes: Upon completion of this course, students will learn about

- Students will have a working knowledge of important mathematical concepts in abstract algebra such as definition of a group, order of a finite group and order of an element, Normal Subgroups, Cyclic subgroups.
- The students will actively participate in the transition of important concepts such homomorphisms & isomorphisms from discrete mathematics to advanced abstract mathematics

Unit I:	**Groups and Subgroups** (1) Definition and elementary properties of a group. Order of a group. Subgroups. Criterion for a subset to be a subgroup. Abelian groups. Center of a group. Homomorphisms and isomorphisms. (2) Examples of groups including Z, Q, R, C, Klein 4-group, symmetric and alternating groups, S^1(= the unit circle in C), GL_n(R), SL_n(R), O_n (the group of $n \times n$ nonsingular orthogonal matrices), B_n (= the group of $n \times n$ nonsingular upper triangular matrices), and groups of symmetries of plane figures. (3) Order of an element. Subgroup generated by a subset of the group.	**15**
Unit II:	**Cyclic groups and cyclic subgroups** (1) Examples of cyclic groups such as Z and the group μ_n of the n−th roots of unity. Properties of cyclic groups and cyclic subgroups. (2) Finite cyclic groups, infinite cyclic groups and their generators. Properties of generators. (3) The group Z/nZ of residue classes (mod n). Characterization of cyclic groups (as being isomorphic to Z or Z/nZ for some n ∈ N).	**15**
Unit III:	**Normal subgroups, Direct products and Cayley's Theorem** (1) Cosets of a subgroup in a group. Lagrange's Theorem. Normal subgroups. Alternating group An. Listing normal subgroups of A4, S3. Quotient (or Factor) groups. Fundamental Theorem of homomorphisms of groups. (2) External direct products of groups. (3) Cayley's Theorem for finite groups.	**15**

Course Code BNBUSMT5P1	Course Title Practical based on BNBUSMT5T1 and BNBUSMT5T2	Credits 3	No. of lectures 21
	Practical based on BNBUSMT5T2		
Practical 1	Examples of groups and groups of symmetries of equilateral triangle, square and rectangle		**3**
Practical 2	Examples of determining centers of different groups. Examples of subgroups of various groups and orders of elements in a group.		**3**
Practical 3	Left and right cosets of a group and Lagrange's theorem.		**3**
Practical 4	Normal subgroups and quotient groups. Direct products of groups		**3**
Practical 5	Finite cyclic groups and their generators		**3**
Practical 6	Infinite cyclic groups and their properties		**3**
Practical 7	Miscellaneous Theory Questions		**3**

Books and References: Semester V Paper II

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Topics in Algebra	I. N. Herstein	Wiley Eastern Limited	Second	
2.	Abstract Algebra	P. B. Bhattacharya, S.K. Jain, S. Nagpaul	Foundation Books, New Delhi	second	1995
3.	University Algebra	N. S. Gopalkrishnan	Wiley Eastern Limited		
4.	Algebra	M. Artin	Prentice Hall of India, New Delhi		

5	A first course in Abstract Algebra	J. B. Fraleigh	Narosa, New Delhi	Third	
6	Contemporary Abstract Algebra	J. Gallian	Narosa, New Delhi		

SEMESTER V

Course Code	Course Title	Credits	No. of lectures
BNBUSMT5T3	**TOPOLOGY OF METRIC SPACES**	**2**	**45**

Course Outcomes: Upon completion of this course, students will learn about

- the idea of metric spaces with a lot of examples
- open sets, closed sets and their properties
- convergence of sequence in a metric space and complete metric space
- compact sets and properties

Unit I:	**Metric Spaces** Definition and examples of metric spaces such as $\mathbb{R}, \mathbb{R}^2, \mathbb{R}^n$ with its Euclidean, sup and sum metrics. $\mathbb{C}$ (complex numbers). l_1 and l_2 spaces of sequences. $C[a,b]$ the space of real valued continuous functions on $[a,b]$. Discrete metric space. Metric induced by the norm. Translation invariance of the metric induced by the norm. Metric subspaces. Product of two metric spaces. Open balls and open sets in a metric space. Examples of open sets in various metric spaces. Hausdorff property. Interior of a set. Properties of open sets. Structure of an open set in $\mathbb{R}$. Equivalent metrics. Distance of a point from a set, Distance between sets. Diameter of a set. Bounded sets. Closed balls. Closed sets. Examples. Limit point of a set. Isolated point. Closure of a set. Boundary of a set.	**15**
Unit II:	**Sequences and Complete metric spaces** Sequences in a metric space. Convergent sequence in metric space. Cauchy sequence in a metric space. Subsequences. Examples of convergent and Cauchy sequences in different metric spaces. Characterization of limit points and closure points in terms of sequences. Definition and examples of relative openness/closeness in subspaces. Dense subsets in a metric space and Separability. Definition of complete metric spaces. Examples of complete metric spaces. Completeness property in subspaces. Nested Interval theorem in $\mathbb{R}$. Cantor's Intersection Theorem. Applications of Cantors Intersection Theorem: (i) $\mathbb{R}$ is uncountable. (ii) Density of rational numbers. (iii) Intermediate Value Theorem.	**15**
Unit III:	**Compact spaces** Definition of a compact metric space using open cover. Examples of compact sets in different metric spaces such as $\mathbb{R}, \mathbb{R}^2, \mathbb{R}^n$ with Euclidean metric. Properties of compact sets: A compact set is closed and bounded, (Converse is not true). Every infinite bounded subset of compact metric space has a limit point. A closed subset of a compact set is compact. Union and Intersection of Compact sets. Sequentially compactness property. Bolzano-Weierstrass property.	**15**

Course Code **BNBUSMT5P2**	**Course Title** **Practical based on BNBUSMT5T3 and BNBUSMT5T4**	**Credits** **3**	**No. of lectures** **21**
	Practical based on BNBUSMT5T3		
Practical 1	Examples of Metric Spaces, Normed Linear Spaces		**3**
Practical 2	Sketching of Open Balls in $\mathbb{R}^2$, Open and Closed sets, Equivalent Metrics		**3**
Practical 3	Subspaces, Interior points, Limit Points, Dense Sets and Separability, Diameter of a set, Closure		**3**
Practical 4	Limit Points, Sequences, Bounded, Convergent and Cauchy Sequences in a Metric Space		**3**
Practical 5	Complete Metric Spaces and Applications		**3**
Practical 6	Examples of Compact Sets		**3**
Practical 7	Miscellaneous Theoretical Questions based on full paper		**3**

Books and References: Semester V Paper III					
Sr. No.	**Title**	**Author/s**	**Publisher**	**Edition**	**Year**
1.	Topology of Metric spaces	S. Kumaresan	Narosa		
2.	Metric Spaces	E. T. Copson	Universal Book Stall, New Delhi		1996
3.	Metric Spaces	P. K. Jain, K. Ahmed	Narosa, New Delhi		1996

<table>
<tr><th>Course Code

BNBUSMT5T4A</th><th>Course Title

Partial Differential Equations</th><th>Credits

2</th><th>No. of lectures
45</th></tr>
<tr><td colspan="4">Course Outcomes: Upon completion of this course, students will learn about
Students will able to understand the various analytical methods for solving first order partial differential equations.
Students will able to understand the classification of first order partial differential equations.
Students will able to grasp the linear and nonlinear partial differential equations.</td></tr>
<tr><td>Unit I:</td><td colspan="2">First Order Partial Differential Equations

Curves and Surfaces, Genesis of first order PDE, Classification of first order PDE, Classification of integrals, The Cauchy problem, Linear Equation of first order, Lagrange’s equation, Pfaffian differential equations</td><td>15</td></tr>
<tr><td>Unit II:</td><td colspan="2">Compatible system of first order Partial Differential Equations

Definition, Necessary and sufficient condition for integrability, Charpit’s method, Some standard types, Jacobi’s method, The Cauchy problem.</td><td>15</td></tr>
<tr><td>Unit III:</td><td colspan="2">Quasi-Linear Partial Differential Equations

Semi linear equations, Quasi-linear equations, first order quasi-linear PDE, Initial value problem for quasi-linear equation, Non linear first order PDE, Monge cone, Analytic expression for Monge’s cone, Characteristics strip, Initial strip.</td><td>15</td></tr>
</table>

Course Code BNBUSMT5P4 A	Course Title Practical based on	Credits 3	No. of lectures 21
	Practical based on BNBUSMT5T4A		
Practical 1	Find general solution of Langrange's equation.		3
Practical 2	Show that Pfaffian differential equation are exact and find corresponding integrals.		3
Practical 3	Find complete integral of first order PDE using Charpit's Method.		3
Practical 4	Find complete integral using Jacobi's Method		3
Practical 5	Solve initial value problem for quasi-linear PDE.		3
Practical 6	Find the integral surface by the method of characteristics.		3
Practical 7	Miscellaneous Theoretical Questions		3
	Total		21

Books and References: Semester V paper IV					
Sr. No.	**Title**	**Author/s**	**Publisher**	**Edition**	**Year**
1.	An Elementary Course in Partial Differential Equations; 2nd edition	T. Amaranath	Narosa Publishing house		
2.	Elements of Partial Differential Equations	Ian Sneddon	McGraw Hill book.		
3.	Ordinary and Partial Differential Equations; Springer, First Edition (2009)	Ravi P. Agarwal and Donal O' Regan			
4.	Partial Differential Equations	W. E. Williams	Clarendon Press, Oxford		1980
5.	Introduction to Partial Differential l Equations; Third Edition,	K. Sankara Rao	PHI.		

Course Code	Course Title	Credits	No. of lectures
BNBUSMT5T4B	**Graph Theory**	**2**	**45**

Course Outcomes: Upon completion of this course, students will learn about

a. Demonstrate the knowledge of fundamental concepts in graph theory, including properties and characterization of graphs and trees.
b. Describe knowledgeably special classes of graphs that arise frequently in graph theory
c. Describe the concept of isomorphic graphs and isomorphism invariant properties of graphs
d. Describe and apply the relationship between the properties of a matrix representation of a graph and the structure of the underlying graph
e. Demonstrate different types of algorithms including Dijkstra's, BFS, DFS, MST and Huffman coding.
f. Understand the concept of Eulerian graphs and Hamiltonian graphs.
g. Describe real-world applications of graph theory.

Unit I:	Basics of Graphs Definition of general graph, Directed and undirected graph, Simple and multiple graph, Types of graphs- Complete graph, Null graph, Complementary graphs, Regular graphs Sub graph of a graph, Vertex and Edge induced sub graphs, Spanning sub graphs. Basic terminology- degree of a vertex, Minimum and maximum degree, Walk, Trail, Circuit, Path, Cycle. Handshaking the- orem and its applications, Isomorphism between the graphs and consequences of isomorphism between the graphs, Self complementary graphs, Connected graphs, Connected components. Matrices associated with the graphs – Adjacency and Incidence matrix of a graph- properties, Bipartite graphs and characterization in terms of cycle lengths. Degree sequence and Havel- Hakimi theorem, Distance in a graph- shortest path problems, Dijkstra's algorithm.	**15**
Unit II:	Trees Cut edges and cut vertices and relevant results, Characterization of cut edge, Definition of a tree and its characterizations, Spanning tree, Recurrence relation of spanning trees and Cayley formula for spanning trees of K_n , Algorithms for spanning tree- BFS and DFS, Binary and m-ary tree, Prefix codes and Huffman coding, Weighted graphs and minimal spanning trees - Kruskal's algorithm for minimal spanning trees.	**15**
Unit III:	Eulerian and Hamiltonian graphs Eulerian graph and its characterization- Fleury's Algorithm-(Chinese postman problem), Hamiltonian graph, Necessary condition for Hamiltonian graphs using $G\backslash S$ where S is a proper subset of $V(G)$, Sufficient condition for Hamiltonian graphs- Ore's theorem and Dirac's theorem, Hamiltonian closure of a graph, Cube	**15**

	graphs and properties like regular, bipartite, Connected and Hamiltonian nature of cube graph, Line graph of graph and simple results.	

Course Code BNBUSMT5P4B	Course Title Practical based on	Credits 3	No. of lectures 21
	Practical based on BNBUSMT5T4B		
Practical 1	Handshaking Lemma and Isomorphism.		**3**
Practical 2	Degree sequence and Dijkstra's algorithm		**3**
Practical 3	Trees, Cayley Formula		**3**
Practical 4	Applications of Trees		**3**
Practical 5	Eulerian Graphs.		**3**
Practical 6	Hamiltonian Graphs.		**3**
Practical 7	Miscellaneous Problems		**3**
	Total		**21**

Books and References: Semester V paper IV					
Sr. No.	**Title**	**Author/s**	**Publisher**	**Edition**	**Year**
1.	Graph Theory with Applications.	Bondy and Murty			
2.	Graph theory and applications	Balkrishnan and Ranganathan			
3.	Introduction to Graph Theory	Douglas B. West,	Pearson	2nd Ed	2000
4.	Graph theory.	Behzad and Chartrand			
5.	Introductory Graph theory	Choudam S. A			

SEMESTER VI

Course Code	Course Title	Credits	No. of lectures 45
BNBUSMT6T1	**Basic Complex Analysis**	**2**	

Course Outcomes: Upon completion of this course, students will learn about

- Students Analyze sequences and series of analytic func- tions and types of convergence, Students will also be able to evaluate complex contour integrals directly and by the fundamental theorem, apply the Cauchy integral theorem in its various versions, and the Cauchy integral formula, they will also be able to represent functions as Taylor, power and Laurent series, classify singularities and poles, find residues and evaluate complex integrals using the residue theorem

Unit I:	**Introduction to Complex Analysis** Review of complex numbers: Complex plane, polar coordinates, exponential map, powers and roots of complex numbers, De Moivre's formula, C as a metric space, bounded and unbounded sets, point at infinity-extended complex plane, sketching of set in complex plane (No questions to be asked). Convergence of sequences of complex numbers and related results. Limit of a function $f : C \longrightarrow C$, real and imaginary part of functions, continuity at a point and algebra of continuous func- tions. Derivative of $f : C \longrightarrow C$, comparison between differentiability in real and complex sense, Cauchy-Riemann equations, sufficient conditions for differentiability, analytic function, if f, g analytic then $f + g, f - g, fg$ and f/g are analytic, chain rule. Theorem: If $f'(z) = 0$ everywhere in a domain D, then $f(z)$ must be constant throughout D. Harmonic functions and harmonic conjugate	**15**
Unit II:	**Cauchy Integral Formula** Evaluation the line integral and Cauchy integral formula Taylor's theorem for analytic function. Mobius transformations: definition and examples. Exponential function, its properties. trigonometric functions and hyperbolic functions	**15**
Unit III:	**Complex power series, Laurent series and isolated singularities** Power series of complex numbers and related results. Radius of convergences, disc of conver-gence, uniqueness of series representation, examples. Definition of Laurent series , Definition of isolated singularity, statement (without proof) of ex- istence of Laurent series expansion in neighbourhood of an isolated singularity, type of isolated singularities viz. removable, pole and essential defined using Laurent series expansion, examples Statement of Residue theorem and calculation of residue.	**15**

Course Code **BNBUSMT6P7**	**Course Title** **Practical based on BNBUSMT6T1 and BNBUSMT6T2**	**Credits** **3**	**No. of lectures** **21**
	Practical based on BNBUSMT6T1		
Practical 1	Limits, continuity and derivatives of functions of complex variables.		**3**
Practical 2	Steriographic Projection, Analytic function, finding harmonic conjugate.		**3**
Practical 3	Contour Integral, Cauchy Integral Formula, Mobius transformations.		**3**
Practical 4	Taylors Theorem, Exponential, Trigonometric, Hyperbolic functions.		**3**
Practical 5	Power Series , Radius of Convergence, Laurents Series		**3**
Practical 6	Finding isolated singularities- removable, pole and essential, Cauchy Residue theorem.		**3**
Practical 7	Miscellaneous theory questions		**3**

Books and References: Semester VI Paper I					
Sr. No.	**Title**	**Author/s**	**Publisher**	**Edition**	**Year**
1.	Complex analysis and Applications	J.W. Brown and R.V. Churchill			
2.	Function theory of one complex variable	Robert E. Greene and Steven G. Krantz			
3.	Complex analysis	T.W. Gamelin			

Course Code	Course Title	Credits	No. of lectures
BNBUSMT6T2	Ring Theory	2	45

Course Outcomes: Upon completion of this course, students will learn about

- Students will have a knowledge of important mathematical concepts in abstract algebra such as definition of a Ring, Quotient Rings, Ideals, Prime Ideals, Maximal Ideals, Euclidean domain, Principal ideal domain and Unique factorization domain.

Unit I:	**Rings** (1) Definition and elementary properties of rings (where the definition should include the existence of unity, commutative rings, integral domains and fields. Examples. (2) Units in a ring. The multiplicative group of units in a ring *R*. Description of the units in Z/*n*Z. Results such as: A finite integral domain is a field. Z/*p*Z, where *p* is a prime, as an example of a finite field. (3) Characteristic of a ring. Examples. Elementary facts such as: the characteristic of an integral domain is either 0 or a prime number	**15**
Unit II:	**Ideals and special Rings** (1) Ideals in a ring. Sums and products of ideals. Quotient rings. Examples. Prime ideals and maximal ideals. Characterization of prime ideals and maximal ideals in a commutative ring in terms of their quotient rings. Description of the ideals and the prime ideals in Z, R[*X*] and C[*X*]. (2) Homomorphisms and isomorphism of rings. Kernel and the image of a homomorphism. Fundamental Theorem of homomorphism of a ring. (3) Construction of the quotient field of an integral domain (Emphasis on Z, Q). A field contains a subfield isomorphic to Z/*p*Z or Q.	**15**
Unit III:	Factorization (1) Notions of euclidean domain (ED), principal ideal domain (PID). Examples such as Z, Z[*i*], and polynomial rings. Relation between these two notions (ED =⇒ PID).	**15**

	(2) Divisibility in a ring. Irreducible and prime elements. Examples (3) Division algorithm in $F[X]$ (where F is a field). Monic polynomials, greatest common divisor of $f(x), g(x) \in F[X]$ (not both 0). Theorem: Given $f(x)$ and $g(x) \neq 0$, in $F[X]$ then their greatest common divisor $d(x) \in F[X]$ exists; moreover, $d(x) = a(x)f(x) + b(x)g(x)$ for some $a(x), b(x) \in F[X]$. Relatively prime polynomials in $F[X]$, irreducible polynomial in $F[X]$. Examples of irreducible polynomials in $(\mathbb{Z}/p\mathbb{Z})[X]$ (p prime), Eisenstein Criterion (without proof). (4) Notion of unique factorization domain (UFD). Elementary properties. Example of a non- UFD. Relation between the three notions (ED ⇒ PID ⇒ UFD). Examples such as Z[X] of UFD that are not PID. Theorem (without proof): If R is a UFD, then R[X] is a UFD.	

Course Code **BNBUSMT6P1**	**Course Title** **Practical based on BNBUSMT6T1 and BNBUSMT6T2**	**Credits** **3**	**No. of lectures** **21**
	Practical based on BNBUSMT6T2		
Practical 1	Examples of rings (commutative and non-commutative), integral domains and fields		**3**
Practical 2	Units in various rings. Determining characteristics of rings		**3**
Practical 3	Prime Ideals and Maximal Ideals, examples on various rings		**3**
Practical 4	Euclidean domains and principal ideal domains (examples and non-examples)		**3**
Practical 5	Examples of irreducible and prime elements		**3**

Practical 6	Applications of division algorithm and Eisenstein's criterion	**3**
Practical 7	Miscellaneous Theoretical questions on Unit 1, 2 and 3.	**3**

Books and References: Semester VI Paper II					
Sr. No.	**Title**	**Author/s**	**Publisher**	**Edition**	**Year**
	Contemporary Abstract Algebra	J. Gallian	Narosa, New Delhi		
1.	Topics in Algebra	I. N. Herstein	Wiley Eastern Limited	Second	
2.	Abstract Algebra	P. B. Bhattacharya, S.K. Jain, S. Nagpaul	Foundation Books, New Delhi	second	1995
3.	University Algebra	N. S. Gopalkrishnan	Wiley Eastern Limited		
4.	Algebra	M. Artin	Prentice Hall of India, New Delhi		
5	A first course in Abstract Algebra	J. B. Fraleigh	Narosa, New Delhi	Third	

SEMESTER VI

Course Code	Course Title	Credits	No. of lectures
BNBUSMT6T3	**TOPOLOGY OF METRIC SPACES AND REAL ANALYSIS**	**2**	**45**

Course Outcomes: Upon completion of this course, students will learn about

- continuous and uniformly continuous functions on metric spaces
- characterization of continuity at a point in terms of sequences, open sets and closed sets and examples
- concept of connectedness and path connectedness
- convergence concepts of sequences and series of functions and power series

Unit I:	**Continuous Functions on Metric Spaces** Epsilon-delta definition of continuity of a function at a point from one metric space to another. Characterization of continuity at a point in terms of sequences, open sets and closed sets and examples. Algebra of continuous real valued functions on a metric space. Continuity of composite function. Continuous image of compact set is compact, Uniform continuity in a metric space, examples (emphasis on $\mathbb{R}$). Results such as: every continuous function from a compact metric space is uniformly continuous. Contraction mapping and fixed-point theorem.	**15**
Unit II:	**Connected Spaces** Separated sets - Definition and examples. Connected and disconnected sets. Connected and disconnected metric spaces. Results such as: A subset of $\mathbb{R}$ is connected if and only if it is an interval. A continuous image of a connected set is connected. Characterization of a connected space, viz. a metric space is connected if and only if every continuous function from X to $\{1, -1\}$ is a constant function. Path connectedness in $\mathbb{R}^n$, definition and examples. A path connected subset of $\mathbb{R}^n$ is connected, convex sets are path connected. An example of a connected subset of $\mathbb{R}^n$ which is not path connected.	**15**
Unit III:	**Sequence and Series of functions** Sequence of functions - pointwise and uniform convergence of sequences of real-valued functions, examples. Uniform convergence implies pointwise convergence, example to show converse not true, series of functions, convergence of series of functions, Weierstrass M-test (statement only). Examples. Properties of uniform convergence: Continuity of the uniform limit of a sequence of continuous function, conditions under which integral and the derivative of sequence of functions converge to the integral and derivative of uniform limit on a closed and bounded interval (statements only). Examples. Consequences of these properties for series of functions, term by term differentiation and integration (statements only). Power series in $\mathbb{R}$ centered at origin and at some point in $\mathbb{R}$, radius of convergence, interval of convergence, uniform convergence, term by-term differentiation and integration of power series, Examples. Uniqueness of series representation, functions represented by power series, classical functions defined by power series such as exponential, cosine and sine functions, the basic properties of these functions.	**15**

Course Code	Course Title	Credits	No. of lectures
BNBUSMT6P2	**Practical based on BNBUSMT6T3 and BNBUSMT6T4**	**3**	**21**
	Practical based on BNBUSMT6T3		
Practical 1	Continuity in a Metric Spaces		**3**
Practical 2	Uniform Continuity, Contraction maps, Fixed point theorem		**3**
Practical 3	Connected Sets, Connected Metric Spaces		**3**
Practical 4	Path Connectedness, Convex sets, Continuity and Connectedness		**3**
Practical 5	Pointwise and uniform convergence of sequence functions, properties		**3**
Practical 6	Point wise and uniform convergence of series of functions and properties		**3**
Practical 7	Miscellaneous Theoretical Questions based on full paper		**3**

Books and References: Semester VI Paper III

Sr. No.	Title	Author/s	Publisher	Edition	Year
1.	Topology of Metric spaces	S. Kumaresan	Narosa		
2.	Metric Spaces	E. T. Copson	Universal Book Stall, New Delhi		1996
3.	Methods of Real Analysis	R. R. Goldberg	Oxford and International Book House (IBH) Publishers		
4.	Introduction to Real Analysis	Robert Bartle and Donald R. Sherbert	John Wiley and Sons	Second Edition	

Semester VI

Course Code	Course Title	Credits	No. of lectures 45
BNBUSMT6T4A	**Intergral Transforms**	2	

Learning Outcomes: Students would gain enough knowledge of

a. Students will able to understand the concept of integral transforms and their corresponding inversion techniques.
b. Students will able to understand the various applications of integral transforms.

Unit I:	**The Laplace Transform** Definition of Laplace Transform, theorem, Laplace transforms of some elementary functions, Properties of Laplace transform, LT of derivatives and integrals, Initial and final value theorem, Inverse Laplace Transform, Properties of Inverse Laplace Transform, Convolution Theorem, In- verse LT by partial fraction method, Laplace transform of special functions: Heaviside unit step function, Dirac-delta function and Periodic function.	**15**
Unit II :	**The Fourier Transform** Fourier integral representation, Fourier integral theorem, Fourier Sine & Cosine integral representation, Fourier Sine & Cosine transform pairs, Fourier transform of elementary functions, Properties of Fourier Transform, Convolution Theorem, Parseval's Identity.	**15**
Unit III:	**Applications of Integral Transforms** Relation between the Fourier and Laplace Transform. Application of Laplace transform to evaluation of integrals and solutions of higher order linear ODE. Applications of LT to solution of one dimensional heat equation & wave equation. Application of Fourier transforms to the solution of initial and boundary value problems, Heat conduction in solids (one dimensional problems in infinite & semi infinite domain).	**15**

Course Code **BNBUSMT6P4A**	**Course Title** **Practical based on**	**Cred its** **3**	**No. of lectures** **21**
	Practical based on BNBUSMT6T4		
Practical 1	**Find the Laplace transform of differential and integral equations.**		**3**
Practical 2	**Find the inverse Laplace transform by the partial fraction method.**		**3**
Practical 3	**Find the Fourier integral representation of given functions.**		**3**
Practical 4	**Find the Fourier Sine / Cosine integral representation of given functions.**		**3**
Practical 5	**Solve higher order ODE using Laplace transform.**		**3**
Practical 6	**Solve one dimensional heat and wave equation using Laplace transform.** **Solve initial and boundary value problems using Fourier transform.**		**3**
Practical 7	**Miscellaneous Theoretical Questions**		**3**

	Total	**21**

Books and References: Semester VI paper IV					
Sr. No.	**Title**	**Author/s**	**Publisher**	**Edition**	**Year**
1.	Integral Transforms and their Applications	Lokenath Debnath and Dambaru Bhatta	CRC Press Taylor & Francis		
2.	Use of Integral Transforms	I. N. Sneddon	Tata-McGraw Hill.		
3.	Integral Transforms for Engineers	L. Andrews and B. Shivamogg	Prentice Hall of India		

Semester VI

Course Code	Course Title	Credits	No. of lectures 45
BNBUSMT6T4B	Graph Theory and Combinatorics	2	

Learning Outcomes: Students would gain enough knowledge of

a. Understand and apply the basic concepts of graph theory, including colouring of graph, to find chromatic number and chromatic polynomials for graphs

b. Understand the concept of vertex connectivity, edge connectivity in graphs and Whit-ney's theorem on 2-vertex connected graphs.

c. Derive some properties of planarity and Euler's formula, develop the under-standing of Geometric duals in Planar Graphs

d. Know the applications of graph theory to network flows theory.

e. Understand different applications of system of distinct representative and matching theory.

f. Use permutations and combinations to solve counting problems with sets and multi-sets.

g. Set up and solve a linear recurrence relation and apply the inclusion/exclusion prin-ciple.

Compute a generating function and apply them to combinatorial problems

Unit I:	Colorings of graph Vertex coloring- evaluation of vertex chromatic number of some standard graphs, critical graph. Upper and lower bounds of Vertex chromatic Number- Statement of Brooks theorem. Edge colouring- Evaluation of edge chromatic number of standard graphs such as complete graph, complete bipartite graph, cycle. Statement of Vizing Theorem. Chromatic polynomial of graphs-Recurrence Relation and properties of Chromatic polynomials. Vertex and edge cuts, vertex and edge connectivity and the relation between vertex and edge connectivity. Equality of vertex and edge connectivity of cubic graphs. Whitney's theorem on 2-vertex connected graphs.	**15**
Unit II :	Planar graph Definition of planar graph. Euler formula and its consequences. Non planarity of K_5; $K(3; 3)$. Dual of a graph. Polyhedran in R^3 and existence of exactly five regular polyhedron- (Platonic solids) Colorabilty of planar graphs- 5 color theorem for planar graphs, statement of 4 color theorem. flows in Networks, and cut in a network- value of a flow and the capacity of cut in a network, relation between flow and cut. Maximal flow and minimal cut in a network and Ford- Fulkerson theorem.	**15**
Unit III:	Combinatorics Applications of Inclusion Exclusion Principle- Rook polynomial, Forbidden position problems. Introduction to partial fractions and Newton's binomial theorem for real power series, series expansion of some standard functions. Forming recurrence relation and getting a generating function. Solving a recurrence relation using ordinary generating functions. System of Distinct Representatives and Hall's theorem of SDR.	**15**

Course Code **BNBUSMT6P4B**	**Course Title** **Practical based on**	**Cred its** **3**	**No. of lectures** **21**
	Practical based on BNBUSMT64B		
Practical 1	Coloring of Graphs		**3**
Practical 2	Chromatic polynomials and connectivity		**3**

Practical 3	Planar graphs	**3**
Practical 4	Flow theory	**3**
Practical 5	Application of Inclusion Exclusion Principle, rook polynomial. Recurrence relation	**3**
Practical 6	Generating function and SDR.	**3**
Practical 7	Miscellaneous Theoretical Questions	**3**
	Total	**21**

Books and References: Semester VI paper IV					
Sr. No.	**Title**	**Author/s**	**Publisher**	**Edition**	**Year**
1.	Graph Theory with Applications.	Bondy and Murty;			
2.	Graph theory and applications	Balkrishnan and Ranganathan;			
3.	Introduction to Graph Theory, 2nd Ed.,	Douglas B. West,			

Evaluation Scheme

Internals

			Attendance & Leadership qualities	**Total**
10	**10**	**10**	**10**	**40**
Certification of Swayam / NPTEL in concern course **Class test 20** **Assignment/Project/courses/achievements 10**				

Internal Examination: **Based on Unit 1 / Unit 2 / Unit 3**

Duration: 1 Hour **Total**

Marks: 20

	Answer the following	**20**

Q. 1		
Q. 2		
Q. 3		
Q. 4		
Q. 5		

Theory Examination: Suggested Format of Question paper

Duration: 2 Hours Total Marks: 60

- **All questions are compulsory**

Q. 1	Answer ***any two*** of the following		**16**
	A	Based on Unit I	
	B	Based on Unit I	
	C	Based on Unit I	
	D	Based on Unit I	
Q. 2	Answer ***any two*** of the following		**16**
	A	Based on Unit II	
	B	Based on Unit II	
	C	Based on Unit II	
	D	Based on Unit II	
Q. 3	Answer ***any two*** of the following		**16**
	A	Based on Unit III	
	B	Based on Unit III	
	C	Based on Unit III	

	D	Based on Unit III	
Q. 4	Answer ***any two*** of the following		**12**
	A	Based on Unit I	
	B	Based on Unit II	
	C	Based on Unit III	
	D	Based on Unit I, II, III, IV	

** (4 questions of 8 marks each / 8 questions of 4 marks can be asked with 50% options)

Marks Distribution and Passing Criterion for Each Semester

Theory					Practical		
Course Code	Internal	Min marks for passing	Theory Examination	Min marks for passing	Course Code	Practical Examination	Min marks for passing
BNBUSMT5T1	**40**	**16**	**60**	**24**	BNBUSMT5P5	**100**	**40**
BNBUSMT5T2	**40**	**16**	**60**	**24**	BNBUSMT5P6	**100**	**40**
BNBUSMT5T3	**40**	**16**	**60**	**24**	**-**	**-**	**-**

BNBUSMT5T 4A	**40**	**16**	**60**	**24**	**-**	**-**	**-**
BNBUSMT5T 4B	**40**	**16**	**60**	**24**	**-**	**-**	**-**

Theory					**Practical**		
Course Code	Interna l	Min marks for passing	Theory Examination	Min marks for passing	Course Code	Practical Examination	Min marks for passing
BNBUSMT6T 1	**40**	**16**	**60**	**24**	BNBUSMT6 P7	**100**	**40**
BNBUSMT6T 2	**40**	**16**	**60**	**24**	BNBUSMT6 P8	**100**	**40**
BNBUSMT6T 3	**40**	**16**	**60**	**24**			
BNBUSMT6T 4A	**40**	**16**	**60**	**24**			
BNBUSMT6T 4B	**40**	**16**	**60**	**24**			

List of paper Setters

Aided Staff

1. **Mrs. Minal T Wankhede**
2. **Mrs. Akanksha Shinde**
3. **Mrs. Umalaxmi Patne**

List of Moderators

1. **Mrs. Minal T Wankhede**
2. **Mrs. Veena Shinde Deore (External)**
3. **Mrs. Santosh Tikre (External)**
4. **Mr. Prakash Sansare (External)**

List of Examiners

Aided Staff

1. **Mrs. Minal T Wankhede**
2. **Mrs. Akanksha Shinde**
3. **Mrs. Umalaxmi Patne**

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Syllabus for

Semester V and Semester VI

Program: B.Sc.

Course: Computer Programming and data base management

(APPLIED

COMPONENT)

(CBCS)

With effect from 2023-24

Course Code BNBUSMT5T5

UNIT I RELATIONAL DATA BASE MANAGEMENT SYSTEM – 15 Lectures

1. **Introduction to Data base Concepts**: Database, Overview of data base managementsystem. Data base Languages- Data Definition Languages (DDL) and Data Manipulation Languages (DML).

2. Entity Relation Model: Entity, attributes, keys, relations, Designing ER diagram, integrity Constraints over relations, conversion of ER to relations with and withoutconstrains.

3. SQL Commands and functions

    a) Creating and altering tables: CREATE statement with constraints like KEY,CHECK, DEFAULT, ALTER and DROP statement.
    b) Handling data using SQL: selecting data using SELECT statement, FROMclause, WHERE clause, HAVING clause, ORDERBY, GROUP BY, DISTINCT and ALL predicates, adding data with INSERT statement, changing data with UPDATE statement, removing data with DELETE statement.
    c) Functions: Aggregate functions- AVG, SUM, MIN, MAX and COUNT, Datefunctions- ADD_MONTHS (), CURRENT_DATE (), LAST_DAY (), MONTHS_BETWEEN (), NEXT_DAY (). String functions- LOWER (), UPPER (), LTRIM (), RTRIM (), TRIM (), INSERT (), RIGHT(), LEFT(), LENGTH(), SUBSTR(). Numeric functions: ABS (), EXP (), LOG(), SQRT(), POWER(), SIGN(), ROUND(number).
    d) Joining tables: Inner, outer and cross joins, union.

UNIT II INTRODUCTION TO PL/SQL – 15 Lectures

1. **Fundamentals of PL/SQL:** Defining variables and constants, PL/SQL expressionsand comparisons: Logical Operators, Boolean Expressions, CASE Expressions Handling, Null Values in Comparisons and Conditional Statements,
2. **PL/SQL Data Types:** Number Types, Character Types, Boolean Type. Date time andInterval types.
3. **Overview of PL/SQL Control Structures:** Conditional Control: IF and CASE Statements, IF-THEN Statement, IF-THEN-ELSE Statement, IF-THEN-ELSIF Statement, CASE Statement,
4. **Iterative Control:** LOOP and EXIT Statements, WHILE-LOOP, FOR-LOOP, Sequential Control: GOTO and NULL Statements.

UNIT III INTRODUCTION TO JAVA PROGRAMMING – 15 Lectures

1. **Object-Oriented approach:** Features of object-orientations: Abstraction,Inheritance, Encapsulation and Polymorphism.
2. **Introduction:** History of Java features, different types of Java programs,Differentiate Java with C. Java Virtual Machine.
3. **Java Basics:** Variables and data types, declaring variables, literals numeric, Boolean, character and string literals, keywords, type conversion and casting.Standard default values. Java Operators, Loops and Controls
4. **Classes:** Defining a class, creating instance and class members: creating object of a class, accessing instance variables of a class, creating method, naming method of a class, accessing method of a class, overloading method,'this' keyword, constructor and Finalizer: Basic Constructor, parameterizedconstructor, calling another constructor, finalize() method, overloading constructor.
5. **Arrays:** one and two – dimensional array, declaring array variables, creatingarray objects, accessing array elements.
6. **Access control:** public access, friendly access, protected access, privateaccess.

UNIT IV Inheritance, Exception Handling

a) **Inheritance:** Various types of inheritance, super and sub classes, keywords- 'extends', 'super', over- riding method, final and abstract class: final variables andmethods, final classes, abstract methods and classes. Concepts of inter- face.

b) **Exception Handling and Packages:** Need for Exceptional Handling, Exception Handling techniques: try and catch, multiple catch statements, finally block, usage ofthrow and throws. Concept of packages. Inter class method: parseInt().

References:

1. Data base management system, RamKrishnam, Gehrke, McGraw-Hill
2. Ivan Bayross, "SQL, PL/SQL – The Programming languages of Oracle" B.P.B. Publications, 3rd Revised Edition.
3. George Koch and Kevin Loney, ORACLE "The complete Reference", Tata McGraw Hill, New Delhi.

4. Elsmasri and Navathe, "Fundamentals of Database Systems" Pearson Education.
5. Peter Roband Coronel, "Database System, Design, Implementation andManagement", Thomson Learning.
6. C.J. Date, Longman, "Introduction database system", Pearson Education.
7. Jeffrey D. Ullman, Jennifer Widsom, "A First Course in Database Systems", Pearson Education.
8. Martin Gruber, "Understanding SQL", B.P.B. Publications.
9. Michael Abbey, Micheal. Corey, Ian Abramson, Oracle8i- A Beginner's Guide, Tata McGraw- Hill.
10. Programming with Java: a Primer 4th Edition by E. Balagurusamy, Tata McGrawHill.
11. Java the complete Reference, 8th Edition, Herbert Schildt, Tata McGraw Hill.

Additional References:

1. Eric Jend rock, Jennifer Ball, D Carson and others, The Java EE5 Tutorial,Pearson Education, Third Edition 2003.
2. Ivan Bayross, Web Enabled Commercial Applications Development usingJava 2, BPB Publications. Revised Edition, 2006.
3. Joe Wiggles worth and Paula Mc Millan, Java Programming: AdvancedTopics, Thomson Course Technology (SPPD), Third Edition 2004.

The Java Tutorials of Sun Microsystems Inc .http://docs.oracle.com/javase/tutorial

Suggested Practicals

1. Creating a single table with/without constraints and executing queries.Queriescontaining aggregate, string and date functions fired on a single table.
2. Updating tables, altering table structure and deleting table Creating and altering a singletable and executing queries. Joining tables and processing queries.
3. Writing PL/SQL Blocks with basic programming constructs.
4. Writing PL/SQL Blocks with control structures.
5. Write a Java program to create a Java class:(a)without instance variables and methods,(b)with instance variables and without methods,(c)with out instance variablesand with methods.(d) with instance variables and methods.
6. Write a Java program that illustrates the concepts of one, two dimension arrays.
7. Write a Java program that illustrates the concepts of Java class that includes(a)constructor with and without parameters (b) Over loading methods.
8. Write a Java program to demonstrate inheritance by creating suitable classes.
9. Write a program that illustrates the error handling using exception handling.

Course code BNBUSMT6T5 SEMESTER VI

UNIT I JAVA APPLETS AND GRAPHICS PROGRAMMING- 15 LECTURES

1. **Applets:** Difference of applet and application, creating applets, applet life cycle,passing parameters to applets.
2. **Graphics, Fonts and Color:** The graphics class, painting, repainting and updating an applet, sizing graphics. Font class, draw graphical figures-lines and rectangle, circle and ellipse, drawing arcs, drawing polygons. Working with Colors: Color methods, setting the paint mode.
3. **AWT package:** Containers: Frame and Dialog classes, Components: Label;Button; Checkbox; Text Field, Text Area.

UNIT II   PYTHON 3.x   15 LECTURES

1. **Introduction**: The Python Programming Language, History, features, Installing Python.
   Running Code in the Interactive Shell, IDLE. Input, Processing, and Output, Editing, Saving, and Running a Script, Debugging: Syntax Errors, Runtime Errors, Semantic Errors, Experimental Debugging.
2. **Data types and expressions**: Variables and the Assignment Statement, Program Comments and Docstrings. Data Types-Numeric integers & Floating-point numbers. Boolean, string. Mathematical operators +, - *, ** , %. PEMDAS.Arithmetic expressions, Mixed-Mode Arithmetic and type Conversion, type( ). Input( ), print( ), program comments. id( ), int( ), str( ), float( ).
3. **Loops and selection statements**: Definite Iteration: The for Loop, Executing statements a given number of times, Specifying the steps using range( ) , Loops that count down, Boolean and Comparison operators and Expressions, Conditional and alternative statements- Chained and Nested Conditionals: if, if-else, if-elif-else, nestedif, nested if-else. Compound Boolean Expressions, Conditional Iteration: The while Loop –with True condition, the break Statement. Random Numbers. Loop Logic, errors, and testing.

Reference Fundamentals of Python First programs 2nd edition by Kenneth A Lambertchapter 1,2,3

Unit III STRINGS, LIST AND DICTIONARIES. 15 LECTURES

1. **Strings, Lists, Tuple, Dictionary**: Accessing characters, indexing, slicing, replacing. Concatenation (+), Repetition (*).Searching a substring with the 'in' Operator, Traversing string using while and for. String methods- find, join, split, lower, upper. len( ).
2. Lists – Accessing and slicing, Basic Operations (Comparison, +), List membership andfor loop.Replacing element (list is mutable). List methods- append, extend, insert, pop, sort. Max( ), min( ). Tuples.
   Dictionaries-Creating a Dictionary, Adding keys and replacing Values, dictionary -key( ), value( ), get( ), pop( ) , Traversing a Dictionary.
   Math module: sin(), cos(),exp(), sqrt(), constants- pi, e.
3. **Design with functions**: Defining Simple Functions- Parameters and Arguments, the return Statement, tuple as return value. Boolean Functions. Defining a mainfunction. Defining and tracing recursive functions.
4. **Exception handling**: try- except.

Reference Fundamentals of Python First programs 2nd edition by Kenneth A Lambertchapter 4,5,6.

UNIT IV DOING MATH WITH PYTHON 15 LECTURES

1. **Working with Numbers:** Calculating the Factors of an Integer, Generating Multiplication Tables, converting units of Measurement, Finding the roots of a Quadratic Equation
2. **Algebra and Symbolic Math with SymPy:** symbolic math using the SymPy library.
   Defining Symbols and Symbolic Operations, factorizing and expanding expressions, Substituting in Values, Converting strings to mathematical expressions. Solving equations, Solving Quadratic equations, Solving for one variable in terms of others, Solving a system of linear equations, Plotting using SymPy , Plotting expressions input by the user, Plotting multiple functions .

Reference Doing math with Python by Amit Saha (Internet source) chapter 1, 4

Software – http://continuum.io/*downloads*.Anaconda 3.x

References:

1. Programming with Java: A Primer 4th Edition by E.Balagurusamy, Tata McGrawHill.
2. Java The Complete Reference,8thEdition, HerbertSchildt, TataMcGrawHill
3. Fundamentals of Python First programs 2nd edition - Kenneth A Lambert, CengageLearning India.
4. Doing Math with Python - Amit Saha, No starch ptress,

Additional References:

5. Eric Jendrock, Jennifer Ball, DCarsonandothers,TheJava EE5Tutorial,Pearson Education, Third Edition,2003.
6. Ivan Bay Ross, Web Enabled Commercial Applications Development UsingJava2, BPBPublications, Revised Edition, 2006
7. Joe Wigglesworth and Paula McMillan, Java Programming: Advanced Topics,Thomson Course Technology (SPD)Third Edition,2004
8. The Java Tutorials of Sun Microsystems Inc. http://docs.oracle.com/javase/tutorial
9. Problem solving and Python programming- E. Balgurusamy, Tata Mc Graw Hill.

Suggested Practical:

1. Write a program that demonstrates the use of input from the user using parse Int ().
2. Write a Java applet to demonstrate graphics, Font and Color classes.
3. Write a Java program to illustrate AWT package.
4. Preparing investment report by calculating compound interest, computing approximate value of π by using the $\frac{\pi}{4} = 1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \cdots$ (Gottfried Leibniz)
5. Convert decimal to binary, octal using string, Write the encrypted text of each of thefollowing words using a Caesar cipher with a distance value of 3.

6. Hexadecimal to binary using dictionary, finding median of list of numbers.
7. Enhanced Multiplication Table Generator, Unit Converter, Fraction Calculator.
8. Factor Finder, Graphical Equation Solver
9. Summing a Series, Solving Single-Variable Inequalities

Theory: At the end of the semester, examination of three hours duration and 100 marks based on the four units shall be held for each course.

Pattern of **Theory question** paper at the end of the semester for **each course**: There shall be Five compulsory Questions of 20 marks each with internal option. Question1 based on UnitI, Question2 based on UnitII, Question3 based on UnitIII, Question 4 based on Unit IV and Question 5 based on all four Units combined.

Q1 to Q4 pattern

(a) Attempt any one out of two (08 Marks)

(b) Attempt any two out of four (12 Marks)Q5 Attempt any four out of eight (20 Marks)

Semester End Practical Examination (Total 100 marks)

Semester V: Total evaluation is of 100 marks-

(a)	Question on Unit 1 and Unit 2	-40 Marks
(b)	Question on Unit 3 and Unit 4	-40 Marks
(c)	Certified Journal	-10 Marks
(d)	Viva Voce	-10 Marks

Semester VI: Total evaluation is of 100 marks-

(a)	Question on Unit 1 and Unit 2	-40 Marks
(b)	Question on Unit 3 and Unit 4	-40 Marks
(c)	Certified Journal	-10 Marks
(d)	Viva Voce	-10 Marks

1. The questions to be asked in the practical examination shall be from the list of practical experiments mentioned in the practical topics. A few simple modifications may be expected during the examination.
2. The semester end practical examination on the machine will be of THREE hours.
3. Students should carry a certified journal with minimum of 06practicals (mentionedinthe practical topics) at the time of examination.
4. Number of students per batch for the regular practical should note xceed20.Not more than two students are allowed to do practical experiment on one computer at a time.

Workload

Theory: 4 lectures per week.

Practicals: 2 practical s each of 2 lecture periods per week per batch. Two lecture periods of the practical's shall be conducted in succession together on a single day.

Semester VI

Evaluation Scheme

Internals

<table>
<tr><th></th><th></th><th></th><th>Attendance & Leadership qualities</th><th>Total</th></tr>
<tr><td>10</td><td>10</td><td>10</td><td rowspan="2">10</td><td rowspan="2">40</td></tr>
<tr><td colspan="3">Certification of Swayam / NPTEL in concern course
Class test 20
Assignment/Project/courses/achievements 10</td></tr>
</table>

Internal Examination: Based on Unit 1 / Unit 2 / Unit 3

Duration: 1 Hour **Total**

Marks: 20

	Answer the following	**20**
Q. 1		
Q. 2		
Q. 3		
Q. 4		
Q. 5		

Theory Examination: Suggested Format of Question paper

Duration: 2 Hours Total Marks: 60

- **All questions are compulsory**

Q. 1	Answer ***any two*** of the following		**16**
	a	Based on Unit I	
	b	Based on Unit I	
	c	Based on Unit I	
	d	Based on Unit I	
Q. 2	Answer ***any two*** of the following		**16**
	a	Based on Unit II	
	b	Based on Unit II	
	c	Based on Unit II	
	d	Based on Unit II	
Q. 3	Answer ***any two*** of the following		**16**
	a	Based on Unit III	
	b	Based on Unit III	
	c	Based on Unit III	
	d	Based on Unit III	
Q. 4	Answer ***any two*** of the following		**12**
	a	Based on Unit I	
	b	Based on Unit II	
	c	Based on Unit III	

	d	Based on Unit IV	

** (4 questions of 8 marks each / 8 questions of 4 marks can be asked with 50% options)

Marks Distribution and Passing Criterion for Each Semester

Theory					**Practical**		
Course Code	Internal	Min marks for passing	Theory Examination	Min marks for passing	Course Code	Practical Examination	Min marks for passing
BNBUSMT3T1	**40**	**16**	**60**	**24**	BNBUSMT3P3	**150**	**60**
BNBUSMT3T2	**40**	**16**	**60**	**24**	-	-	-
BNBUSMT3T3	**40**	**16**	**60**	**24**	-	-	-

Theory					**Practical**		
Course Code	Internal	Min marks for passing	Theory Examination	Min marks for passing	Course Code	Practical Examination	Min marks for passing
BNBUSMT4T1	**40**	**16**	**60**	**24**	BNBUSMT4P4	**150**	**60**
BNBUSMT4T2	**40**	**16**	**60**	**24**	-	-	-
BNBUSMT4T3A / BNBUSMT4T3B	**40**	**16**	**60**	**24**			

List of paper Setters

Aided Staff

1. **Mrs. Minal T Wankhede**
2. **Mrs. Akanksha Shinde**
3. **Mrs. Umalaxmi Patne**

Unaided Staff

1. **Ms. Priyanka G Rajput**

List of Moderators

1. **Mrs. Minal T Wankhede**
2. **Mrs. Veena Shinde Deore (External)**
3. **Mrs. Santosh Tikre (External)**
4. **Mr. Prakash Sansare (External)**

List of Examiners

Aided Staff

1. **Mrs. Minal T Wankhede**
2. **Mrs. Akanksha Shinde**
3. **Mrs. Umalaxmi Patne**

Unaided Staff

2. **Ms. Priyanka G Rajput**

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