John Wilson Education Society's

Wilson College, Mumbai

(Autonomous)

Wilson College informs all concerned that the recommendations made by the Board of Studies in the subject of Mathematics at its meeting held on 15th February 2024, have been accepted by the Academic Council at its meeting held on _____ vide item no. _____ and that in accordance therewith, the proposed syllabus as per the (CBCS) for the subject of Mathematics: Third Year B.Sc. has been brought into force with effect from the academic year 2024-25, accordingly, the same is made available on the college website: www.wilsoncollege.edu.

MUMBAI - 400 007 Principal

Date:

John Wilson Education Society's

Wilson College (Autonomous)

Chowpatty, Mumbai-400007
RE-ACCREDITED 'A' grade by NAAC

Affiliated to the

UNIVERSITY OF MUMBAI

Wilson College

Syllabus for T.Y

Programme: B.Sc.

Programme Code: WUSMAT (Mathematics)

Choice Based Credit System (CBCS) with effect from Academic year 2024–2025

PROGRAMME OUTLINE 2024-2025

YEAR	SEM	COURSE CODE	UNIT	NAME OF THE UNIT/UNIT TITLE	CREDITS
TY	V	WUSMAT501		Multivariable Calculus II	3
			I	Multiple Integrals	
			II	Line Integrals	
			III	Surface Integrals	
		WUSMAT502		Group Theory	3
			I	Groups and Subgroups	
			II	Normal subgroups, Direct products and Cayley's Theorem	
			III	Cyclic groups and cyclic subgroups	
		WUSMAT503		Topology of Metric Spaces	3
			I	Metric Spaces	
			II	Sequences and Complete Metric Spaces	
			III	Compact spaces	
		WUSMAT504		Graph Theory	3
			I	Basics of Graph Theory	
			II	Trees	
			III	Eulerian and Hamiltonian graphs	
		WUSMAT5P1		Practical based on WUSMAT501 and WUSMAT502	4
		WUSMAT5P2		Practical based on WUSMAT503 and WUSMAT504	4

	VI	WUSMAT601		Basic Complex Analysis	3
			I	Introduction to Complex Analysis	
			II	Cauchy Integral Formula	
			III	Complex power series, Laurent series and isolated singularities	
		WUSMAT602		Ring Theory	3
			I	Rings	
			II	Ideals and special rings	
			III	Factorization	
		WUSMAT603		Topology of Metric Spaces and Real Analysis	3
			I	Continuous Functions on Metric Spaces	
			II	Connected Spaces	
			III	Sequence and Series of Functions	
		WUSMAT604		Graph Theory and Combinatorics	3
			I	Graph coloring and chromatic number	
			II	Planar Graphs	
			III	Combinatorics	
		WUSMAT6P1		Practical based on WUSMAT601 and WUSMAT602	4
		WUSMAT6P2		Practical based on WUSMAT603 and WUSMAT604	4

PROGRAMME SPECIFIC OUTCOME (PSOs)

At the end of the course the learner will be able to:

PSO 1: Utilize the skills of logical thinking in problem solving and inculcate the habit of self-learning.
PSO 2: Formulate and use quantitative models arising in social science,business and other contexts.
PSO 3: Analyze the mathematical results and apply them in various problems appearing in different branches of mathematics and related fields.
PSO 4: Recognize patterns and to distinguish between essential and irrelevant aspects of the problems.
PSO 5: Employ technically oriented skills to solve specific theoretical and applied problems in mathematics and other domains.
PSO 6: Translate information presented verbally into mathematical form, select and use appropriate mathematical formulae or techniques in order to process the information and draw the relevant conclusion.
PSO 7: Identify unethical behavior such as misrepresentation of data, unbiased and truthful actions in all aspects.
PSO 8: Solve mathematical problems using analytical methods.
PSO 9: Recognize the relationships between different areas of mathematics and the connections between mathematics and other disciplines.

PREAMBLE:

Keeping in view the new National Education Policy, Wilson College Mumbai under autonomy revised the syllabi as per the Choice Based Credit System (CBCS) for the Third year B.Sc. Programme in Mathematics from the academic year 2024-2025.

Mathematics has been fundamental to the development of science and technology. In recent decades, the extent of application of Mathematics to real world problems has increased by leaps and bounds. Taking into consideration the rapid changes in science and technology and new approaches in different areas of mathematics and related subjects like Physics, Statistics and Computer Sciences, the Board of Studies in Mathematics of Wilson College Mumbai has prepared the syllabus of T.Y.B.Sc. Mathematics.

The syllabi of T.Y.B.Sc. Mathematics for Semester V and Semester VI has been designed so that the students learn basic concepts of Mathematics and are exposed to rigorous methods gently and slowly. The syllabi of T.Y.B.Sc. Mathematics. would consist of two semesters and each semester would comprise four courses. Course I is 'Multivariable Calculus II and Basic Complex Analysis'. Course II is 'Group Theory and Ring Theory' which develops mathematical reasoning and logical thinking and has applications in science and technology. Course III is 'Topology of Metric Spaces and Real Analysis' and Course IV is 'Graph Theory and Combinatorics'.

PROGRAMME: T.Y.B.Sc.	SEMESTER: V
Course: Multivariable Calculus II	Course Code: WUSMAT501

Teaching Scheme					Evaluation Scheme
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CA) (Marks- 40)	Semester End Examination (Marks- 60)
3 Lectures (2 Hours & 24 Minutes)	2 Hours and 24 minutes	NA	3	40	60

Learning Objectives:

1. To enable the learner to think critically and to encourage them to develop scientific temper.
2. To enable the learner to acquire basic subject knowledge required for other professional courses.
3. To enable the learner to apply mathematical concepts to solve real world problems.
4. To inculcate skills for data collection and data analysis among the learners.
5. To introduce the learner with basic tools for programming and to enable them to develop mathematical algorithms.
6. To inculcate communication skills among the learners to express ideas using mathematical language.

Course Outcomes:

CO1: Integrate functions of several variables over curves and surfaces.
CO2: Calculate line integrals and apply the information contained in Green's Theorem and Stokes' Theorem
CO3: Perform a change of variables utilizing polar, cylindrical or spherical coordinates to calculate integrals

DETAILED SYLLABUS

Course Code	Unit	Sub-Unit	Course/ Unit Title	Credits/ Lectures: 2 Credits/ 45 Lectures
WUSMAT501	**I**		**Multiple Integrals**	
		1.1	Definition of double and triple integral of a function and bounded on a rectangle Geometric interpretation as area and volume. Fubini's Theorem over rectangles and any closed bounded sets, Iterated Integrals. Basic properties of double and triple integrals proved using the Fubini's theorem	**15 Lectures**
		1.2	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. 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.) Domain additively of the integral. Inerrability and the integral over arbitrary bounded Domains. Change of variables formula (Statement only).	
		1.3	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.	
	II		**Line Integrals**	**15 Lectures**
		2.1	Review of Scalar and Vector fields on $\mathbb{R}^n$, Vector Differential Operators, Gradient, Curl, Divergence. Paths (parametrized curves) in $\mathbb{R}^n$(emphasis on $\mathbb{R}^2$ and $\mathbb{R}^3$) Smooth and piecewise smooth paths. Closed paths. Equivalence and orientation preserving equivalence of paths	
		2.2	Definition of the line integral of a vector field over a piecewise smooth path.	

			Basic properties of line integrals including linearity, path-additively and behaviour under a change of parameters.	
		2.3	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.	
	III		**Surface Integrals**	**15 Lectures**
		3.1	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 a surface.	
		3.2	Curl and divergence of a vector field. Elementary identities involving gradient, curl and divergence.	
		3.3	Stokes Theorem (proof assuming the general form of Greens Theorem).Examples. Gauss Divergence Theorem (proof only in the case of cubical domains).	

References:

(1) Apostol, Tom M. Calculus Volume I, Wiley & Sons (Asia) Pvt. Ltd, 1991.

(2) Bartle, Robert G., and Donald R. Sherbert. Introduction to Real Analysis, 3rd Edition. Wiley, 1999.

(3) Binmore, K. G. Mathematical Analysis : A Straightforward Approach. Cambridge University Press, 2001.

(4) Courant, Richard. Introduction to Calculus and Analysis: Volume One. Interscience Publishers, 1965.

(5) Ghorpade, Sudhir R. and Limaye, Balmohan V. A Course in Calculus and Real Analysis, Springer International Ltd, 2006.

(6) Goldberg, Richard R. Methods of Real Analysis. Blaisdell Pub. Co.; Oxford And IBH, 1964.

(7) Kumar, Ajit, and S. Kumaresan. A Basic Course in Real Analysis. Chapman and Hall/CRC, 2014, https://doi.org/10.1201/b16440.

(8) Stewart, J. Calculus, Third Edition, Brooks/Cole Publishing Company, 1994.

PROGRAMME: T.Y.B.Sc.		SEMESTER: V			
Course: Group Theory		Course Code: WUSMAT502			
Teaching Scheme					Evaluation Scheme
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CA) (Marks- 40)	Semester End Examination (Marks- 60)
3 Lectures (2 Hours & 24 Minutes)	2 Hours and 24 minutes	NA	3	40	60

Learning Objectives:

1. To enable the learner to think critically and to encourage them to develop scientific temper.
2. To enable the learner to acquire basic subject knowledge required for other professional courses.
3. To enable the learner to apply mathematical concepts to solve real world problems.
4. To inculcate skills for data collection and data analysis among the learners.
5. To introduce the learner with basic tools for programming and to enable them to develop mathematical algorithms.
6. To inculcate communication skills among the learners to express ideas using mathematical language.

Course Outcomes:

CO1: Recall the definition of groups, subgroups.
CO2: Determining the centre of groups, solving it.
CO3: Recall the concept of left and right coset of groups and Lagrange's Theorem
CO4: Recall the concept of normal subgroups and quotient groups
CO5: Recall the concept of finite cyclic groups and their generators
CO6: Recall the definition of infinite cyclic groups and their properties

DETAILED SYLLABUS

Course Code	Unit	Sub-Unit	Course/ Unit Title	Credits/ Lectures: 2 Credits/ 45 Lectures
WUSMAT502	I		**Groups and Subgroups**	
		1.1	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.	15 Lectures
		1.2	Examples of groups including Z, Q, ℝ, C, Klein 4-group, symmetric and alternating groups, (=the unit circle in C), GL_n(R), SL_n(R), O_n (= the group of n × n nonsingular upper triangular matrices), B_n(= the group of n × n nonsingular upper triangular matrices), and groups of symmetries of plane figures.	
		1.3	Order of an element. Subgroup generated by a subset of the group.	
	II		**Normal subgroups, Direct products and Cayley's Theorem**	15 Lectures
		2.1	Cosets of a subgroup in a group. Lagrange's Theorem. Normal subgroups. Alternating group . Listing normal subgroups of , A_4, S_3 . Quotient (or Factor) groups. Fundamental Theorem of homomorphisms of groups.	
		2.2	External direct products of groups. Examples. Relation with internal products such as HK of subgroups H, K of a group.	
		2.3	Cayley's Theorem for finite groups.	
	III		**Cyclic groups and cyclic subgroups**	15 Lectures
		3.1	Examples of cyclic groups such as and the group of the n−th roots of unity. Properties of cyclic groups and cyclic subgroups.	
		3.2	Finite cyclic groups, infinite cyclic groups and their generators. Properties of generators.	
		3.3	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	

References:

1. I. N. Herstein, Topics in Algebra, Wiley Eastern Limied, Second edition.
2. P. B. Bhattacharya, S.K. Jain, S. Nagpaul. Abstract Algebra, Second edition, Foundation Books, New Delhi, 1995.
3. N. S. Gopalkrishnan, University Algebra, Wiley Eastern Limited.
4. M. Artin, Algebra, Prentice Hall of India, New Delhi.
5. J. B. Fraleigh, A first course in Abstract Algebra, Third edition, Narosa, New Delhi.
6. J. Gallian. Contemporary Abstract Algebra. Narosa, New Delhi
7. T. W. Hungerford. Algebra, Springer.
8. D. Dummit, R. Foote. Abstract Algebra, John Wiley & Sons, Inc.
9. I. S. Luther, I.B.S. Passi. Algebra. Vol. I and II.

PROGRAMME: T.Y.B.Sc.		SEMESTER: V			
Course: Topology of Metric Spaces		Course Code: WUSMAT503			
Teaching Scheme					Evaluation Scheme
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CA) (Marks- 40)	Semester End Examination (Marks- 60)
3 Lectures (2 Hours & 24 Minutes)	2 Hours & 24 Minutes	NA	3	40	60

Learning Objectives:

1. To enable the learner to think critically and to encourage them to develop scientific temper.
2. To enable the learner to acquire basic subject knowledge required for other professional courses.
3. To enable the learner to apply mathematical concepts to solve real world problems.
4. To inculcate skills for data collection and data analysis among the learners.
5. To introduce the learner with basic tools for programming and to enable them to develop mathematical algorithms.
6. To inculcate communication skills among the learners to express ideas using mathematical language.

Course Outcomes:

CO1: Define metric spaces, open balls, closed balls, open sets, closed sets, distance between sets.
CO2: Recognize metric spaces and equivalent metrics.
CO3: Define sequences, convergent and divergent sequences, Cauchy sequences in a metric space.
CO4: Characterize limit points and closure points in terms of sequences.
CO5: Define complete metric spaces and give examples of complete metric spaces.
CO6: Define compact metric spaces and examine their properties.
CO7: Examine union and intersection of compact metric, sequentially compactness property, Heine-Borel property and Bolzano Weierstrass property.

DETAILED SYLLABUS

Course Code	Unit	Sub-Unit	Course/ Unit Title	Credits/ Lectures: 3 Credits/ 45 Lectures
WUSMAT503	**I**		**Metric Spaces**	
		1.1	Definition and examples of metric spaces such as R, R2, Rn with Euclidean, sup and sum metrics, C, l1 and l2 spaces of sequences, C[a,b] the space of real valued continuous functions on a,b, discrete metric space, metric induced by norm, translation invariance of metric induced by norm, metric subspaces.	**15 Lectures**
		1.2	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 R, equivalent metrics.	
		1.3	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 set, closure of a set, boundary of a set.	
	II		**Sequences and Complete Metric Spaces**	**15 Lectures**
		2.1	Sequences in a metric space, convergent sequence in metric space, Cauchy sequence in a metric space, subsequence, examples of convergent sequence, Cauchy sequence in different metric space, characterization of limit points and closure points in terms of sequences, definition and examples of relative openness/closeness in subspaces.	
		2.2	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 R.	
		2.3	Cantor's Intersection Theorem and applications of Cantor's Intersection Theorem: (i) The set of real Numbers is uncountable. (ii) Density of rational Numbers. (iii) Intermediate Value Theorem	
	III		**Compact Spaces**	**15 Lectures**

		3.1	Definition of a compact metric space using open cover. Examples of compact sets in different metric spaces such as R, R^2, R^n with Euclidean metric.	
		3.2	Properties of compact sets: (i) (A compact set is closed and bounded, (Converse is not true). (ii) Every infinite bounded subset of compact metric space has a limit point. (iii) A closed subset of a compact set is compact. (iv) Union and Intersection of Compact sets.	
		3.3	Equivalent statements for compact sets in R with usual metric: (i) Sequentially compactness property. (ii) Heine-Borel property. (iii) Closed and boundedness property. (iv) Bolzano-Weierstrass property.	

References:

(1) S. Kumaresan, Topology of Metric spaces.
(2) E. T. Copson. Metric Spaces. Universal Book Stall, New Delhi, 1996.
(3) W. Rudin, Principles of Mathematical Analysis.
(4) T. Apostol. Mathematical Analysis, Second edition, Narosa, New Delhi, 1974
(5) R. R. Goldberg Methods of Real Analysis, Oxford and IBH Pub. Co., New Delhi 1970.
(6) P.K.Jain. K. Ahmed. Metric Spaces. Narosa, New Delhi, 1996.
(7) G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hi, New York, 1963

PROGRAMME: T.Y.B.Sc.		SEMESTER: V			
Course: GRAPH THEORY		Course Code: WUSMAT504			
Teaching Scheme					Evaluation Scheme
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CA) (Marks- 40)	Semester End Examination (Marks- 60)
3 Lectures (2 Hours & 24 Minutes)	2 Hours and 24 minutes	NA	3	40	60

Learning Objectives:

1: To enable the learner to understand the concept of a graph and its applications in real world problems.
2: To enable the learner to understand the applications of different types of graphs.
3: To enable the learner to convert real world problems into graph theoretical problems.
4: To enable the learner to apply various algorithms in graph theory.

Course Outcomes:

CO1: Recall the definitions of a graph; degree of a vertex; different types of graphs namely regular, directed, null, complete, complementary, subgraph, connected, bipartite etc.; walk; path; circuit; cycle; tree and spanning trees; m-ary trees; Eulerian and Hamiltonian graphs.
CO2: Determine cut edges and cut vertices in a graph, Hamiltoninan closure of a graph and line graph of a graph.
CO3: Construct the incidence and adjacency matrices for a given graph.
CO4: Apply Handshaking lemma, Havel-Hakimi theorem, recurrence relation to find the number of spanning trees in a graph; Dijkstra's algorithm; BFS and DFS algorithms; Kruskal's algorithm and Fleury's algorithm.

DETAILED SYLLABUS

Course Code	Unit	Sub-Unit	Course/ Unit Title	Credits/ Lectures: 3 Credits/ 45 Lectures
WUSMAT504	**I**		**Basics of Graph Theory**	**15 Lectures**
		1.1	Definition of general graph, Directed and undirected graph, Simple and multiple graph, Types Of graphs- Complete graph, Null graph, Complementary graphs, Regular graphs Subgraph of a graph, Vertex and Edge induced subgraphs, Spanning subgraphs. Basic terminology-Degree of a vertex, Minimum and maximum degree, walk, trail, circuit, path, cycle. Wilson College	
		1.2	Handshaking theorem and its applications, Isomorphism between the graphs and consequences of isomorphism between the graphs, Self-complementary graphs, Connected Graphs, Connected Components.	
		1.3	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.	
	II		**Trees**	**15 Lectures**
		2.1	Cut edges and cut vertices and relevant results. Characterization of cut edges and cut vertices. Definition of a Tree and its characterizations.	
		2.2	Spanning tree, Recurrence relation of spanning trees and Algorithms for spanning tree-BFS and DFS. Cayley formula for spanning trees of Kn.	
		2.3	Binary and m-ary tree, Prefix codes and Huffman coding. Weighted graphs and minimal spanning trees - Kruskal's algorithm for minimal spanning trees.	
	III		**Eulerian and Hamiltonian graphs**	**15 Lectures**
		3.1	Eulerian graph and its characterization- Fleury's Algorithm-(Chinese postman problem).	

			Hamiltonian graph, Necessary condition for Hamiltonian graphs using G- S where S is a proper subset of V (G).	
		3.2	Sufficient conditions for Hamiltonian graphs- Ore's theorem and Dirac's theorem, Hamiltonian closure of a graph, Cube graphs and properties like regular, bipartite, Connected and Hamiltonian nature of cube graphs.	
		3.3	Line graph of graph and simple results.	

Reference Books:

1. Bondy and Murty; Graph Theory with Applications.
2. Balkrishnan and Ranganathan; Graph theory and applications.
3. Douglas B. West, Introduction to Graph Theory, 2nd Ed., Pearson, 2000

Additional Reference Book:

1. Behzad and Chartrand; Graph theory.
2. Choudam S. A.; Introductory Graph theory.

Practical	Credits
SECTION-1	**4**
1. Evaluation of double and triple integrals.	
2. Change of variables in double and triple integrals and applications	
3. Line integrals of scalar and vector fields	
4. Green's theorem, conservative field and applications	
5. Evaluation of surface integrals	
6. Stokes and Gauss divergence theorem	
7. Miscellaneous Theoretical Questions based on full paper	
SECTION-2	
1. Examples of groups and groups of symmetries of equilateral triangle, square and rectangle.	
2. Examples of determining centers of different groups. Examples of subgroups of various groups and orders of elements in a group.	
3. Left and right cosets of a group and Lagrange's theorem.	
4. Normal subgroups and quotient groups. Direct products of groups.	
5. Finite cyclic groups and their generators	
6. Infinite cyclic groups and their properties.	
7. Miscellaneous Theoretical Questions based on full paper	
SECTION-3	**4**
(1)Examples of Metric Spaces, Normed Linear Spaces	
(2)Sketching of Open Balls in IR2, Open and Closed sets, Equivalent Metrics	
(3)Subspaces, Interior points, Limit Points, Dense Sets and Separability, Diameter of a set, Closure.	
(4)Limit Points, Sequences, Bounded, Convergent and Cauchy Sequences in a Metric Space	
(5)Complete Metric Spaces and Applications	

(6)Examples of Compact Sets	
(7)Miscellaneous Theory Questions based on full paper	
SECTION-4	
(1) Handshaking Lemma and Isomorphism.	
(2) Degree sequence and Dijkstra's algorithm	
(3) Trees, Cayley Formula	
(4) Applications of Trees	
(5) Eulerian Graphs.	
(6) Hamiltonian Graphs.	
(7) Miscellaneous Problems.	

Modality of Assessment

Theory Examination Pattern:

A. **Internal Assessment- 40%- 40 Marks per paper**

Sr. No.	Evaluation Type	Marks
1	**Written Objective Examination**	**20**
2	**Assignment/ Case study/ field visit report/ presentation/ project**	**20**
	Total	**40**

B. **External Examination- 60%- 60 Marks per paper**

Semester End Theory Examination:

1. Duration - These examinations shall be of **two hours** duration.
2. Theory question paper pattern:
   a. There shall be 4 questions each of 15 marks.
   b. All questions shall be compulsory with internal choice within the questions.

Paper Pattern:

Question	Options	Marks	Questions based on
1	**Part A:** Attempt any one of two theory questions each of **7 marks** **Part B:** Attempt any two of four questions each of **4 marks**	15	Unit I
2	**Part A:** Attempt any one of two theory questions each of **7 marks** **Part B:** Attempt any two of four questions each of **4 marks**	15	Unit II
3	**Part A:** Attempt any one of two theory questions each of **7 marks** **Part B:** Attempt any two of four questions each of **4 marks**	15	Unit III
4	Attempt any three of six questions each of **5 marks**	15	Unit I, II & III
	TOTAL	**60**	

Practical Examination Pattern:

A. **Internal Examination: 40%- 40 Marks**

Particulars	Paper I	Paper II	Paper III	Paper IV
Journal	05	05	05	05
Quiz	10	10	10	10
Participation	05	05	05	05
Total	**20**	**20**	**20**	**20**

B. **External Examination: 60%- 60 Marks**

Semester End Practical Examination:

Particulars	Paper I	Paper II	Paper III	Paper IV
Laboratory work	25	25	25	25
Spots/Quiz/Viva	05	05	05	05
Total	**30**	**30**	**30**	**30**

PRACTICAL BOOK/JOURNAL

The learners are required to perform in class 75% of the practical for the journal to be duly certified. The learners are required to present a duly certified journal or a certificate of satisfactorily complete work for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

Overall Examination & Marks Distribution Pattern

Semester V

Course	WUSMAT501			WUSMAT502			WUSMAT503			WUSMAT504			Grand Total
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	40	60	100	40	60	100	400
Practical	20	30	50	20	30	50	20	30	50	20	30	50	200

PROGRAMME: T.Y.B.Sc		SEMESTER: VI			
Course: Basic Complex Analysis		Course Code: WUSMAT601			
Teaching Scheme					Evaluation Scheme
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CA) (Marks- 40)	Semester End Examination (Marks- 60)
3 Lectures (2 hours and 24 minutes)	2 Hours and 24 minutes	NA	3	40	60

Learning Objectives:

PO 1. To enable the learner to think critically and to encourage them to develop scientific temper.
PO 2. To enable the learner to acquire basic subject knowledge required for other professional courses.
PO 3. To enable the learner to apply mathematical concepts to solve real world problems.
PO 4. To inculcate skills for data collection and data analysis among the learners.
PO 5. To introduce the learner with basic tools for programming and to enable them to develop mathematical algorithms.
PO 6. To inculcate communication skills among the learners to express ideas using mathematical language.

Course Outcomes:

CO1: Analyze Analytic functions and exponential functions.
CO2:Apply Cauchy's theorem for disk and the Integral formula.
CO3: Understand Local properties of Analytic functions.
CO4:Study Residue theorem and the argument principle. Differentiate the Taylor's series and Laurent series.
CO5: Determine whether given functions have antiderivatives, logarithms, and nth roots.
CO6: Use conformal mapping to solve the Dirichlet problem in a region
CO7 :Use power series and line integrals to construct differentiable functions.

DETAILED SYLLABUS

Course Code	Unit	Sub-Unit	Course/ Unit Title	Credits/ Lectures: 2 Credits/ 45 Lectures
WUSMAT601	I		**Introduction to Complex Analysis**	**15 Lectures**
		1.1	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).	
		1.2	Limit at a point, theorems on limits, convergence of sequences of complex numbers and results using properties of real sequences. Functions $f : C \to C$, real and imaginary part of functions, continuity at a point and algebra of continuous functions. Derivative of $f : C \to C$, comparison between differentiability in real and complex sense, Cauchy-Riemann equations, sufficient conditions for differentiability, analytic function, f, g analytic then $f + g$, $f - g$, fg and f/g are analytic, chain rule.	
		1.3	Theorem:- If $f(z) = 0$ everywhere in a domain D, then f(z) must be constant throughout D Harmonic functions and harmonic conjugate with example.	
	II		**Cauchy Integral Formula**	**15 Lectures**

		2.1	Explain how to evaluate the line integral f(z) dz over $\|z-z_0\| = r$ and prove the Cauchy integral formula	
		2.2	If f is analytic in $B(z_0, r)$ then for any w in $B(z_0, r)$ we have f(w).	
		2.3	Taylor's theorem for analytic function , Mobius transformations: definition and examples exponential function, its properties, trigonometric function, hyperbolic functions.	
	III		**Complex power series, Laurent series and isolated singularities**	**15 Lectures**
		3.1	Power series of complex numbers and related results following from Unit I, radius of convergences, disc of convergence, uniqueness of series representation, examples	
		3.2	Definition of Laurent series , Definition of isolated singularity, statement (without proof) of existence of Laurent series expansion in neighbourhood of an isolated singularity, type of isolated singularities viz. removable, pole and essential defined using Laurent series expansion with examples.	
		3.3	Statement of Residue theorem and calculation of residue.	

References:

(1) Robert E. Greene and Steven G. Krantz, Function theory of one complex variable
(2) T.W. Gamelin, Complex analysis

DETAILED SYLLABUS

Course Code	Unit	Sub-Unit	Course/ Unit Title	Credits/ Lectures: 2 Credits/ 45 Lectures
WUSMAT602	I		**Rings**	15 Lectures
		1.1	Definition and elementary properties of rings (where the definition should include the existence of unity), commutative rings, integral domains and fields. Examples, including Z , Q , $\mathbb{R}$, Z /nZ, C , $M_n(\mathbb{R})$, Z[i], Z[√2], Z[√−5], Z[X], $\mathbb{R}$[X], C[X], Z/n[X].	
		1.2	Units in a ring. The multiplicative group of units in a ring R [and, in particular, the multiplicative group F* of nonzero elements of a field F]. Description of the units in Z/nZ. Results such as: A finite integral domain is a field. Z/pZ, where p is a prime, as an example of a finite field.	
		1.3	Characteristics of a ring. Examples. Elementary facts such as: the characteristic of an integral domain is either 0 or a prime number. (Note: From here on all rings are assumed to be commutative with unity).	
	II		**Ideals and special rings**	15 Lectures
		2.1	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 , $\mathbb{R}[X]$ and $C[X]$.	
		2.2	Homomorphism and isomorphism of rings. Kernel and the image of a homomorphism. Fundamental Theorem of homomorphism of a ring. Construction of the quotient field of an integral domain (Emphasis on Z , Q). A field contains a subfield isomorphic to Z/pZ or Q .	
		2.3	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).	
	III		**Factorization**	**15 Lectures**
		3.1	Divisibility in a ring. Irreducible and prime elements. Examples.	
		3.2	Division algorithm in F[X] (where F is a field). Monic polynomials, greatest common divisor of f(x), g(x) ∈ F[X] (not both 0). Theorem: Given f(x) and g(x) ≠0, in F[X] then their greatest common divisor d(x) ∈ F[X] exists; moreover, d(x) = a(x)f(x) + b(x)g(x) for some a(x), b(x) ∈ F[X]. Relatively prime polynomials in F[X], irreducible polynomials in F[X]. Examples of irreducible polynomials in $(Z/pZ)[X]$ (p prime), Eisenstein Criterion(without proof).	
		3.3	Notion of unique factorization domain (UFD). Elementary properties. Example of a non-UFD is $Z[\sqrt{-5}]$ (without proof). Theorem (without proof). 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.	

References:

1. N. Herstein; Topics in Algebra; Wiley Eastern Limited, Second edition.
2. P. B. Bhattacharya, S. K. Jain, and S. R. Nagpaul; Abstract Algebra; Second edition, Foundation Books, New Delhi, 1995.
3. N. S. Gopalakrishnan; University Algebra; Wiley Eastern Limited.
4. M. Artin; Algebra; Prentice Hall of India, New Delhi.
5. J. B. Fraleigh; A First course in Abstract Algebra; Third edition, Narosa, New Delhi.
6. J. Gallian; Contemporary Abstract Algebra; Narosa, New Delhi

PROGRAMME: T.Y.B.Sc.		SEMESTER: VI			
Course: Topology of Metric Spaces and Real Analysis		Course Code: WUSMAT603			
Teaching Scheme					Evaluation Scheme
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CA) (Marks- 40)	Semester End Examination (Marks- 60)
3 Lectures (2 Hours & 24 Minutes)	2 Hours & 24 Minutes	NA	3	40	60

Learning Objectives:

1. To enable the learner to think critically and to encourage them to develop scientific temper.
2. To enable the learner to acquire basic subject knowledge required for other professional courses.
3. To enable the learner to apply mathematical concepts to solve real world problems.
4. To inculcate skills for data collection and data analysis among the learners.
5. To introduce the learner with basic tools for programming and to enable them to develop mathematical algorithms.
6. To inculcate communication skills among the learners to express ideas using mathematical language.

Course Outcomes:

CO1: Give the characterization of continuous functions using closed and open sets.
CO2: Define uniform continuity, Lipchitz continuity, contraction mapping and fixed point.
CO3: Recognize uniform continuous and Lipchitz continuous functions.
CO4: Define separated sets, connected sets and disconnected sets and give examples of each.
CO5: Characterize connected space using continuous functions.
CO6: Define path connected space and give the relation between path connectedness and connectedness.
CO7: Define sequences and series of functions and examine their convergence.
CO8: Define power series and find the radius and interval of convergence of a power series

DETAILED SYLLABUS

Course Code	Unit	Sub-Unit	Course/ Unit Title	Credits/ Lectures: 3 Credits/ 45 Lectures
WUSMAT603	**I**		**Continuous Functions on Metric Spaces**	**15 Lectures**
		1.1	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.	
		1.2	Algebra of continuous real valued functions on a metric space. Continuity of compositeFunction. Continuous image of compact set is compact	
		1.3	Uniform continuity in a metric space, examples (emphasis on R). Results such as: every continuous function from a compact metric space is uniformly continuous. Contraction mapping and fixed-point theorem applications.	
	II		**Connected Spaces**	**15 Lectures**
		2.1	Separated sets- Definition and examples. Connected and disconnected sets. Connected and disconnected metric spaces. Results such as: (i) A subset of R is connected if and only if it is an interval. (ii)A continuous image of a connected set is connected	
		2.2	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.	
		2.3	Path connectedness in R^n , definition and examples. A path connected subset of $R^n$is connected, convex sets are path connected. Connected components. An example of a connected subset of R^n which is not path connected.	
	III		**Sequence and Series of Functions**	**15 Lectures**
		3.1	Sequence of functions - point wise and uniform convergence of sequences of real- valued functions, examples. Uniform convergence	

			implies point wise convergence, example to show converse is not true, series of functions, convergence of series of functions, Weierstrass M-test (statement only). Examples.	
		3.2	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).	
		3.3	Power series in R centered at origin and at some point in R, radius of convergence, region (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.	

References:

(1) S. Kumaresan, Topology of Metric spaces.
(2) E. T. Copson. Metric Spaces. Universal Book Stall, New Delhi, 1996.
(3) W. Rudin, Principles of Mathematical Analysis.
(4) T. Apostol. Mathematical Analysis, Second edition, Narosa, New Delhi, 1974
(5) R. R. Goldberg Methods of Real Analysis, Oxford and IBH Pub. Co., New Delhi 1970.
(6) P.K.Jain. K. Ahmed. Metric Spaces. Narosa, New Delhi, 1996.
(7) G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hi, New York, 1963.

PROGRAMME: T.Y.B.Sc		SEMESTER: VI			
Course: Graph Theory and Combinatorics		Course Code: WUSMAT604			
Teaching Scheme					Evaluation Scheme
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CA) (Marks- 40)	Semester End Examination (Marks- 60)
3 Lectures (2 hours and 24 minutes)	2 Hours and 24 minutes	NA	3	40	60

Course Objectives:

1: To enable the learner to understand graph coloring and its applications.
2: To enable the learner to understand flow networks and its applications in real world problems.
3: To enable the learner to understand the planarity of graphs and its applications.
4: To enable the learner to acquire basic knowledge of combinatorial mathematics.

Course Outcomes:

CO1: Recall definitions of vertex and edge colouring of graphs, and flow and cut in a network.
CO2: State Brooks' theorem, Vizing's theorem and Hall's theorem of marriage.
CO3: Determine vertex chromatic number and chromatic index of graphs, the chromatic polynomial of a graph and the planarity of a graph.
CO4: Apply the algorithm to find the maximum flow in a network and inclusion exclusion principle.
CO5: Derive the formula for catalan number.
CO6: Solve recurrence relations with the help of generating function technique.

DETAILED SYLLABUS

Course Code	Unit	Sub-Unit	Course/ Unit Title	Credits/ Lectures: 3 Credits/ 45 Lectures
WUSMAT604	I		**Graph Coloring and Chromatic number**	15 Lectures
		1.1	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, Statement of Vizing's theorem.	
		1.2	Complete bipartite graph, cycle. Statement of Vizing Theorem. Chromatic polynomial of graphs Recurrence Relation and properties of Chromatic polynomials. Vertex and edge cuts,	
		1.3	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.	
	II		**Planar Graphs**	15 Lectures
		2.1	Definition of planar graph. Euler formula and its consequences. Non-planarity of K_5; $K_(3; 3)$. Dual of a graph. Polyhedron in $\mathbb{R}^3$ and existence of exactly five regular polyhedra (Platonic solids). Colorability of planar graphs - 5 color theorem, and 6-color theorem for planar graphs. 4-color theorem (only statement).	
		2.2	Flows in networks, cut in a network, value of a flow and the capacity of cut in a network.	
		2.3	Relation between flow and cut. Maximum flow and minimum cut in a network, Ford Fulkerson theorem and algorithm to find maximum flow in a network.	
	III		**Combinatorics**	15 Lectures
		3.1	Applications of Inclusion - Exclusion principle-Forbidden position problem, Rook polynomial.	

		3.2	Catalan number - Triangulation of a polygon, parenthesizing the product, deriving formula for catalan number.	
		3.3	Introduction to ordinary generating functions. Solving recurrence relations using generating functions technique	

Recommended Books.

1. Bondy and Murty; Graph Theory with Applications.

2. Balkrishnan and Ranganathan; Graph theory and applications.

3. Douglas B. West, Introduction to Graph Theory, 2nd Ed., Pearson, 2000 4.

Richard Brualdi; Introduction to Combinatorics.

Additional Reference Book.

1. Behzad and Chartrand; Graph theory.

2. Choudam S. A.; Introductory Graph theory; 3 Cohen, Combinatorics.

Practical	Credits
SECTION-1	**4**
1. Limit continuity and derivatives of functions of complex variables.	
2. Stereographic Projection , Analytic function, finding harmonic conjugate.	
3. Contour Integral, Cauchy Integral Formula ,Mobius transformations.	
4. Taylor's Theorem , Exponential , Trigonometric, Hyperbolic functions.	
5.Power Series , Radius of Convergence, Laurents Series.	
6.Finding isolated singularities- removable, pole and essential, Cauchy Residue theorem.	
7. Miscellaneous Theoretical Questions based on full paper	
SECTION-2	
1.Examples of rings (commutative and non-commutative), integral domains and fields	
2. Units in various rings. Determining characteristics of rings.	
3. Prime Ideals and Maximal Ideals, examples on various rings.	
4. Euclidean domains and principal ideal domains (examples and non-examples)	
5. Examples of irreducible and prime elements.	
6. Applications of division algorithm and Eisenstein's criterion.	
7. Miscellaneous Theoretical Questions based on full paper	
SECTION-3	**4**
(1)Continuity in a Metric Spaces	
(2)Uniform Continuity, Contraction maps, Fixed point theorem	
(3) Connected Sets , Connected Metric Spaces	
(4) Path Connectedness, Convex sets, Continuity and Connectedness	
(5)Pointwise and uniform convergence of sequence functions, properties	

(6)Point wise and uniform convergence of series of functions and properties	
(7)Miscellaneous Theory Questions	
SECTION-4	
(1) Coloring of Graphs	
(2) Chromatic polynomial and connectivity	
(3) Planar Graphs	
(4) Flow theory	
(5) Application of Inclusion Principle,rook polynomial,recurrence relation	
(6) Generating Function and SDR	
(7) Miscellaneous theoretical questions.	

Wilson College

Modality of Assessment

Theory Examination Pattern:

A. **Internal Assessment- 40%- 40 Marks per paper**

Sr. No.	Evaluation Type	Marks
1	**Written Objective Examination**	**20**
2	**Assignment/ Case study/ field visit report/ presentation/ project**	**20**
	Total	**40**

B. **External Examination- 60%- 60 Marks per paper**

Semester End Theory Examination:

1. Duration - These examinations shall be of **two hours** duration.
2. Theory question paper pattern:
   c. There shall be 4 questions each of 15 marks.
   d. All questions shall be compulsory with internal choice within the questions.

Paper Pattern:

Question	Options	Marks	Questions based on
1	**Part A:** Attempt any one of two theory questions each of **7 marks** **Part B:** Attempt any two of four questions each of **4 marks**	15	Unit I
2	**Part A:** Attempt any one of two theory questions each of **7 marks** **Part B:** Attempt any two of four questions each of **4 marks**	15	Unit II
3	**Part A:** Attempt any one of two theory questions each of **7 marks** **Part B:** Attempt any two of four questions each of **4 marks**	15	Unit III
4	Attempt any three of six questions each of **5 marks**	15	Unit I, II & III
	TOTAL	**60**	

Practical Examination Pattern:

A. **Internal Examination: 40%- 40 Marks**

Particulars	Paper I	Paper II	Paper III	Paper IV
Journal	05	05	05	05
Quiz	10	10	10	10
Participation	05	05	05	05
Total	**20**	**20**	**20**	**20**

B. **External Examination: 60%- 60 Marks**

Semester End Practical Examination:

Particulars	Paper I	Paper II	Paper III	Paper IV
Laboratory work	25	25	25	25
Spots/Quiz/Viva	05	05	05	05
Total	**30**	**30**	**30**	**30**

PRACTICAL BOOK/JOURNAL

The learners are required to perform in class 75% of the practical for the journal to be duly certified. The learners are required to present a duly certified journal or a certificate of satisfactorily complete work for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

Overall Examination & Marks Distribution Pattern

Semester VI

Course	WUSMAT601			WUSMAT602			WUSMAT603			WUSMAT604			Grand Total
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	40	60	100	40	60	100	400
Practical	20	30	50	20	30	50	20	30	50	20	30	50	200

Wilson College

John Wilson Education Society's

Wilson College, Mumbai

Wilson College

(Autonomous)

Wilson College informs all concerned that the recommendations made by the Board of Studies in the subject of Mathematics at its meeting held on 15th February 2024, have been accepted by the Academic Council at its meeting held on _____ vide item no. _____ and that in accordance therewith, the proposed syllabus as per the (CBCS) for the subject of Mathematics: Third Year B.Sc. has been brought into force with effect from the academic year 2024-25, accordingly, the same is made available on the college website: www.wilsoncollege.edu.

MUMBAI 400 007 Principal

Date:

John Wilson Education Society's

Wilson College (Autonomous)

Chowpatty, Mumbai-400007
RE-ACCREDITED 'A' grade by NAAC

Affiliated to the
UNIVERSITY OF MUMBAI

Syllabus for T.Y

Programme: B.Sc.

Programme Code: WUSMAT (Applied Component)

Choice Based Credit System (CBCS) with effect from Academic year 2024–2025

PROGRAMME OUTLINE 2024-2025

YEAR	SEM	COURSE CODE	UNIT	NAME OF THE UNIT/UNIT TITLE	CREDITS
TY	V	WUSMAT505		Computer Programming And System Analysis I	4
			I	Relational Database Management System	
			II	Introduction to PL/SQL	
			III	Introduction to Java Programming	
			IV	Inheritance, Exception Handling	
		WUSMAT5P3		Practical based on WUSMAT5P3	4
	VI	WUSMAT605		Computer Programming And System Analysis II	4
			I	Files And Exception on Python	
			II	Python 3.x	
			III	String, List And Dictionaries.	
			IV	Doing Math with Python	
		WUSMAT6P3		Practical based on WUSMAT6P3	4

PROGRAMME SPECIFIC OUTCOME (PSOs)

At the end of the course the learner will be able to:

PSO 1: Utilize the skills of logical thinking in problem solving and inculcate the habit of self-learning.
PSO 2: Formulate and use quantitative models arising in social science,business and other contexts.
PSO 3: Analyze the mathematical results and apply them in various problems appearing in different branches of mathematics and related fields.
PSO 4: Recognize patterns and to distinguish between essential and irrelevant aspects of the problems.
PSO 5: Employ technically oriented skills to solve specific theoretical and applied problems in mathematics and other domains.
PSO 6: Translate information presented verbally into mathematical form, select and use appropriate mathematical formulae or techniques in order to process the information and draw the relevant conclusion.
PSO 7: Identify unethical behavior such as misrepresentation of data, unbiased and truthful actions in all aspects.
PSO 8: Solve mathematical problems using analytical methods.
PSO 9: Recognize the relationships between different areas of mathematics and the connections between mathematics and other disciplines.

PREAMBLE:

Keeping in view the new National Education Policy, Wilson College Mumbai under autonomy revised the syllabi as per the Choice Based Credit System (CBCS) for the Third year B.Sc. Programme in Mathematics- Applied Component from the academic year 2024-2025.

Mathematics has been fundamental to the development of science and technology. In recent decades, the extent of application of Mathematics to real world problems has increased by leaps and bounds. Taking into consideration the rapid changes in science and technology and new approaches in different areas of mathematics and related subjects like Physics, Statistics and Computer Sciences, the Board of Studies in Mathematics of Wilson College Mumbai has prepared the syllabus of T.Y.B.Sc. Mathematics-Applied Component.

The syllabi of T.Y.B.Sc. Mathematics-Applied Component for Semester V and Semester VI has been designed so that the students learn basic concepts of Mathematics and are exposed to rigorous methods gently and slowly. The syllabi of T.Y.B.Sc. Mathematics-Applied Component would consist of two semesters and each semester would comprise one course that is ‘Computer Programming and System Analysis I and Computer Programming and System Analysis II’.

PROGRAMME: B.Sc.			SEMESTER: V		
Course: Computer Programming And System Analysis I			Course Code: WUSMAT505		
Teaching Scheme	Evaluation Scheme				
Lectures (Hours per week)	Practical (Hours per week)	Tutorial (Hours per week)	Credit	Continuous Internal Assessment (CA) (Marks- 40)	Semester End Examination (Marks- 60)
4 Lectures (3 Hours & 12 Minutes)	3 Hours & 12 Minutes	NA	4	40	60

Learning Objectives:

1. To enable the learner to think critically and to encourage them to develop scientific temper.
2. To enable the learner to acquire basic subject knowledge required for other professional courses.
3. To enable the learner to apply mathematical concepts to solve real world problems.
4. To inculcate skills for data collection and data analysis among the learners.
5. To introduce the learner with basic tools for programming and to enable them to develop mathematical algorithms.
6. To inculcate communication skills among the learners to express ideas using mathematical language.

Course Outcomes:

CO1: :Apply ethical computing concepts and practices to database design and implementation.
CO2:Students can analyze a problem, and identify and define the computing requirements appropriate to its solution.
CO3: Students can design, implement, and evaluate a computer-based system, process, component, or program to meet
desired needs.
CO4:Enhance Programming and Software Engineering skills and techniques using SQL and PL/SQL.
CO5:Use an integrated development environment to write, compile, run, and test simple object-oriented Java programs.
CO6: Identify and fix defects and common security issues in code.

DETAILED SYLLABUS

Course Code	Unit	Sub-Unit	Course/ Unit Title	Credits/ Lectures: 2 Credits/ 45 Lectures
WUSMAT505	**I**		**RELATIONAL DATABASE MANAGEMENT SYSTEM**	**15 Lectures**
		1.1	Introduction to Database Concepts: Database, Overview of database management system. Database Languages- Data Definition Languages (DDL) and Data Manipulation Languages (DML).	
		1.2	Entity Relation Model : Entity, attributes, keys, relations, Designing ER diagram, integrity Constraints over relations, conversion of ER to relations with and without constraints.	
		1.3	SQL Commands and functions a) Creating and altering tables: CREATE statement with constraints like KEY, CHECK, DEFAULT, ALTER and DROP statements. b) Handling data using SQL: selecting data using SELECT statement, FROM clause, 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, Date functions- ADD_MONTHS(), CURRENT_DATE(), LAST_DAY(), MONTHS_BETWEEN(), NEXT_DAY(). String functions- LOWER(), UPPER(), LTRIN(), RTRIM(), TRIN(), INSERT(), RIGHT(), LEFT(), LENGTH(), SUBSTR(). Numeric functions: ABS(), EXP(), LOG(), SQRT(), POWER(), SIGN(), ROUND(number). d) Joining tables: Inner, outer and cross joins, union.	

	II		**INTRODUCTION TO PL/SQL**	**15 Lectures**
		2.1	Fundamentals of PL/SQL: Defining variables and constants, PL/SQL expressions and comparisons: Logical Operators, Boolean Expressions, CASE Expressions Handling, Null Values in Comparisons and Conditional Statements	
		2.2	L/SQL Data Types: Number Types, Character Types, Boolean Type. Date time and Interval types.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,	
		2.3	Iterative Control: LOOP and EXIT Statements, WHILE-LOOP, FOR-LOOP, Sequential Control: GOTO and NULL Statements.	
	III		**INTRODUCTION TO JAVA PROGRAMMING**	**15 Lectures**
		3.1	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.	
		3.2	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 .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, parameterized constructor, calling another constructor, finalize() method, overloading constructor.	
		3.3	Arrays: one and two – dimensional array, declaring array variables, creating array objects, accessing array elements Access control: public access, friendly access, protected access, private access.	

	IV		**Inheritance, Exception Handling**	**15 Lectures**
		4.1	Inheritance: Various types so inheritance, super and subclasses, keywords- 'extends', 'super', overriding method, final and abstract class: final variables and methods, final classes, abstract methods and classes. Concepts of interface.	
		4.2	Exception Handling and Packages: Need for Exceptional Handling	
		4.3	Exception Handling techniques: try and catch, multiple catch statements, finally block, us age of throw and throw. Concept of packages. Inter class method: parseInt().	

References:

1. Data base management system, RamaKrishnan, 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 and Management", Thomson Learning.
6.C.J. Date, Longman, "Introduction database system", Pearson Education.
7.Jeffrey D. Ullman, Jennifer Wisdom, "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 McGraw Hill.
11. Java the complete Reference, 8th Edition, Herbert Schildt, Tata McGraw Hill.

Practical-I	Credits
1.Creating a single table with/without constraints and executing queries. Queries containing aggregate, string and date functions fired on a single table.	**4**
2.Updating tables, altering table structure and deleting table Creating and altering a single table 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) without instance variables and 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)construct or 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.	

Modality of Assessment

Theory Examination Pattern:

A. **Internal Assessment- 40%- 40 Marks per paper**

Sr. No.	Evaluation Type	Marks
1	Written Objective Examination	20
2	Assignment/ Case study/ field visit report/ presentation/ project	20
	Total	40

B. **External Examination- 60%- 60 Marks per paper**

Semester End Theory Examination:

1. Duration - These examinations shall be of **two hours** duration.
2. Theory question paper pattern:
   a. There shall be 4 questions each of 15 marks.
   b. All questions shall be compulsory with internal choice within the questions.

Paper Pattern:

Question	Options	Marks	Questions based on
1	**Part A:** Attempt any one of two theory questions each of **7 marks** **Part B:** Attempt any two of four questions each of **4 marks**	15	Unit I
2	**Part A:** Attempt any one of two theory questions each of **7 marks** **Part B:** Attempt any two of four questions each of **4 marks**	15	Unit II
3	**Part A:** Attempt any one of two theory questions each of **7 marks** **Part B:** Attempt any two of four questions each of **4 marks**	15	Unit III
4	**Part A:** Attempt any one of two theory questions each of **7 marks** **Part B:** Attempt any two of four questions each of **4 marks**	15	Unit IV
	TOTAL	**60**	

Practical Examination Pattern:

A. **Internal Examination: 40%- 40 Marks**

Particulars	Paper I
Journal	05
Quiz	10
Participation	05
Total	**20**

B. **External Examination: 60%- 60 Marks**

Semester End Practical Examination:

Particulars	Paper I
Laboratory work	25
Spots/Quiz/Viva	05
Total	**30**

PRACTICAL BOOK/JOURNAL

The students are required to perform 75% of the Practical for the journal to be duly certified.
The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

Overall Examination & Marks Distribution Pattern

Semester V

Course	501			Grand Total
	Internal	External	Total	
Theory	40	60	100	100
Practical	40	60	100	100

PROGRAMME: B.Sc		**SEMESTER: VI**			
Course: Computer Programming and system Analysis II		**Course Code: WUSMAT605**			
Teaching Scheme	**Evaluation Scheme**				
Lectures (Hours per week)	**Practical (Hours per week)**	**Tutorial (Hours per week)**	**Credit**	**Continuous Internal Assessment (CA) (Marks- 40)**	**Semester End Examination (Marks- 60)**
4 Lectures (3 Hours & 12 Minutes)	**3 Hours & 12 Minutes**	**NA**	**4**	**40**	**60**

Learning Objectives:

1. To enable the learner to think critically and to encourage them to develop scientific temper.
2. To enable the learner to acquire basic subject knowledge required for other professional courses.
3. To enable the learner to apply mathematical concepts to solve real world problems.
4. To inculcate skills for data collection and data analysis among the learners.
5. To introduce the learner with basic tools for programming and to enable them to develop mathematical algorithms.
6. To inculcate communication skills among the learners to express ideas using mathematical language.

Course Outcomes:

CO1: Examine the differentiability of functions and evaluate the derivative.
CO2: Apply chain rule and Leibniz rule to find higher order derivatives.
CO3: Discuss the applicability of mean value theorems and L-Hospital rule.
CO4: Determine the Taylor expansion, critical points, local maxima and minima of a function.
CO5: Review the definitions of differential equations, order, degree, linear and nonlinear differential equations and create a differential equation.
CO6: Identify exact equations, find integrating factors and solve differential equations.
CO7: Formulate mathematical models and apply in interdisciplinary fields like physics, economics, etc.

DETAILED SYLLABUS

Course Code	Unit	Sub-Unit	Course/ Unit Title	Credits/ Lectures: 2 Credits/ 45 Lectures
WUSMAT605	**I**		**Files And Exceptions in Python**	**15 Lectures**
		1.1	Objective ,Text files ,The file object attributes Directories and built -in-Exceptions with example	
		1.2	Exception with Arguments user-defined Exceptions with example	
		1.3	Introduction: The Python Programming Language, History, features, Installing Python.	
	II		**PYTHON 3.x**	**15 Lectures**
		2.1	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.	
		2.2	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( ).	
		2.3	Loops and selection statements: Definite Iteration: The for Loop, Executing statements a given number of times , Specifying the steps using range( ) , Loops that countdown, Boolean and Comparison operators and Expressions, Conditional and alternative statements- Chained and Nested Conditionals: if, if-else, if-elif-else, nested	

			if, nested if-else. Compound Boolean Expressions , Conditional Iteration: The while Loop –with True condition, the break Statement. Random Numbers. Loop Logic, errors, and testing.	
	III		**STRINGS, LIST AND DICTIONARIES.**	**15 Lectures**
		3.1	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( ).	
		3.2	Lists – Accessing and slicing, Basic Operations (Comparison, +),List membership and for 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.	
		3.3	Design with functions : Defining Simple Functions- Parameters and Arguments, the return Statement, tuple as return value. Boolean Functions. Defining a main function. Defining and tracing recursive functions. Exception handling: try- except.	
	IV		**DOING MATH WITH PYTHON**	**15 Lectures**
		4.1	Working with Numbers: Calculating the Factors of an Integer, Generating Multiplication Tables, converting units of Measurement ,Finding the roots of a Quadratic Equation	
		4.2	Algebra and Symbolic Math with SymPy: symbolic math using the SymPy library.	
		4.3	Defining Symbols and Symbolic Operations, factoring 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 .	

References:

1.Programming with Java:A Primer 4th Edition by E.Balagurusamy, Tata McGraw Hill.

2. JavaTheCompleteReference,8thEdition,HerbertSchildt,TataMcGrawHill

3. Fundamentals of Python First programs 2nd edition - Kenneth A Lambert, Cengage Learning India.

4. Doing Math with Python - Amit Saha, No starch ptress,

Practical-II	Credits
1. Write a program that demonstrates the use of input from the user using parse Int().	4
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 by using the = 1 − + − + ⋯ (Gottfried Leibniz)	
5.Convert decimal to binary, octal using string, Write the encrypted text of each of the following 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	

Modality of Assessment

Theory Examination Pattern:

A. **Internal Assessment- 40%- 40 Marks per paper**

Sr. No.	Evaluation Type	Marks
1	Written Objective Examination	20
2	Assignment/ Case study/ field visit report/ presentation/ project	20
	Total	40

B. **External Examination- 60%- 60 Marks per paper**

Semester End Theory Examination:

1. Duration - These examinations shall be of **two hours** duration.
2. Theory question paper pattern:
   c. There shall be 4 questions each of 15 marks.
   d. All questions shall be compulsory with internal choice within the questions.

Paper Pattern:

Question	Options	Marks	Questions based on
1	**Part A:** Attempt any one of two theory questions each of **7 marks** **Part B:** Attempt any two of four questions each of **4 marks**	15	Unit I
2	**Part A:** Attempt any one of two theory questions each of **7 marks** **Part B:** Attempt any two of four questions each of **4 marks**	15	Unit II
3	**Part A:** Attempt any one of two theory questions each of **7 marks** **Part B:** Attempt any two of four questions each of **4 marks**	15	Unit III
4	**Part A:** Attempt any one of two theory questions each of **7 marks** **Part B:** Attempt any two of four questions each of **4 marks**	15	Unit IV

	TOTAL	**60**

Practical Examination Pattern:

A. **Internal Examination: 40%- 40 Marks**

Particulars	**Paper I**
Journal	05
Quiz	10
Participation	05
Total	**20**

B. **External Examination: 60%- 60 Marks**

Semester End Practical Examination:

Particulars	**Paper I**
Laboratory work	25
Spots/Quiz/Viva	05
Total	**30**

PRACTICAL BOOK/JOURNAL

The students are required to perform 75% of the Practical for the journal to be duly certified.
The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

Overall Examination & Marks Distribution Pattern

Semester VI

Course	**601**			**Grand Total**
	Internal	**External**	**Total**	
Theory	**40**	**60**	**100**	**100**
Practical	**40**	**60**	**100**	**100**