Sant Gadge Baba Amravati University, Amravati

FACULTY: SCIENCE AND TECHNOLOGY

Two Year Semesters Master Degree Program NEPv2023 with Exit and Entry Option

Subject: Mathematics (Semester-I)

S.N.	Subject	Type of Course	Subject Code	Teaching and Learning Scheme							Durations of Exam Hours	Examination and Evaluation Scheme							
				Teaching Hours Per Week				Credits				Maximum Marks					Minimum Passing		
												Theory		Practical		Total Marks	Marks Internal	Marks External	Grade
				L	T	P	Total	L/T	Practical	Total		Theory Internal	Theory +MCQ External	Internal	External				
1	Research Methodology and IPR	FSC		4			4	4		4	3	30	70			100	12	28	P
2	DSC-I: Real Analysis	Th-Major		4			4	4		4	3	30	70			100	12	28	P
3	DSC-II: Advanced Abstract Algebra	Th-Major		4			4	4		4	3	30	70			100	12	28	P
4	DSC-III: Complex Analysis	Th-Major		3			3	3		3	3	30	70			100	12	28	P
5	**DSE-I (Any One)**	Th-Major																	
	1. Advanced Discrete Mathematics I 2. Differential Geometry			4			4	4		4	3	30	70			100	12	28	P
6	Introduction to LaTeX	**Practical**				6	6**		3	3	3			50	50	100	25	25	P
7	On Job training, Internship/ Apprenticeship, Field Project	**Major**		120 hours cumulatively during vacations of Semester-I and Semester-II						4*									P
							25			**22**						**600**			

L: Lecture, T: Tutorial, P: Practical

Note: ** indicate that for the subject mathematics, the strength of a batch of practical's for PG classes shall be 16 (Sixteen) students.

Sant Gadge Baba Amravati University, Amravati

FACULTY: SCIENCE AND TECHNOLOGY

Two Year Semesters Master Degree Program NEPv2023 with Exit and Entry Option

Subject: Mathematics (Semester-II)

S.N.	Subject	Type of Course	Subject Code	Teaching and Learning Scheme							Duration s of Exam Hours	Examination and Evaluation Scheme							
				Teaching hours per week				Credits				Maximum Marks					Minimum Passing		
												Theory		Practical		Total Marks	Marks Internal	Marks External	Grade
				L	T	P	Total	L/T	Practical	Total		Theory Internal	Theory +MCQ External	Internal	External				
1	DSC-IV: Advanced Linear Algebra and Field Theory	Th-Major		4			4	4		4	3	30	70			100	12	28	P
2	DSC-V: Topology	Th-Major		4			4	4		4	3	30	70			100	12	28	P
3	DSC-VI: Integral Equations	Th-Major		3			3	3		3	3	30	70			100	12	28	P
4	**DSE-II (Any One)**	**Th-Major**																	
	1.Advanced Discrete Mathematics II 2. Riemannian Geometry 3. Measure and Integration Theory			4			4	4		4	3	30	70			100	12	28	P
5	Mathematics with Scilab	**Practical**				6	6**		3	3	3			50	50	100	25	25	P
6	On Job training, Internship/ Apprenticeship, Field Project	**Major**		120 hours cumulatively during vacations of Semester-I and Semester-II						4*									P
							21			**18+4***						**500**			

L: Lecture, T: Tutorial, P: Practical
Note: ** indicate that for the subject mathematics, the strength of a batch of practical's for PG classes shall be 16 (Sixteen) students.

Sant Gadge Baba Amravati University, Amravati

M.Sc. I (MATHEMATICS) NEP-2023

Faculty: Science and Technology

Programme: M.Sc. Part-1 Mathematics

POs

At the end of the programme, students would be able to

- apply knowledge of Mathematics, in all the fields of learning including higher research and its extensions.
- innovate, invent and solve complex mathematical problems using critical understanding, analysis and synthesis.
- adjust themselves completely to the demands of the growing field of Mathematics by lifelong learning.
- affectively communicate about their field of expertise on their activities, with their peer and society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations
- crack lectureship and fellowship exams approved by UGC like CSIR – NET and SET.
- Use the Mathematical Software LaTex and Scilab applicable for research.

PSOs

Upon completion of the programme successfully, students would be able to

- develop problem-solving skills and apply them independently to problems in pure and applied mathematics.
- understand advanced mathematical knowledge and skills that prepare them to pursue further studies and research.
- understand advanced and pure mathematical concepts and research.
- create knowledge, capability in formulating and analyzing mathematical models of real life applications.
- analyze the latest advances in applied mathematics such as numerical computations and mathematical modeling in physical sciences.

Employability Potential of the Programme:

After completing M.Sc. in Mathematics, career will be more stable and successful. The private and government sectors both have thousands of job options available. The government sector also wants a good mathematician, who can manage the data and business mode. Every business requires financial activity and data management for better improvement and success. Various companies have a position like numerical operator and as a accountant. So career after **M.Sc. Mathematics** is very fruitful.

The job profile option after completing the M.Sc. Mathematics as follows:

1. Assistant Professor in Mathematics.

Many of the colleges and Universities/Institutes can offer job as a Assistant professor after clearing SLET/ CSIR-NET examination or Ph.D. degree.

2. Junior Research Fellow.

Junior research fellow exam is now conducted by NTA. Normally only top candidates acquire the JRF post after clearing the NET/GATE exam.

3. Scientific Officer.

Students can apply for a scientific office job in the industry such as **ISRO** (the Indian Space research Organization), **DRDO** (Defense Research and Development Organization), TIFR (Tata Institute of Fundamental Research) and **NAL** (National Aeronautics Limited).

4. Operational Research.

Students can also become operational researcher if they are good at mathematics. Under this profession basically, they have to solve the business profitability, improve efficiency, and complex organization problems. Also have to understand the assigned assignment in deep. And they have to use **mathematical programming, analyst techniques, optimizatio**n, and so on for enhancing the project planning and skills.

5. Statistical Research.

A career in statistical research is very interesting. It presents the company's statistical businesses at a modest and technical level. Under this profession, students will get the chance of analyzing, researching, using mathematical tools, algorithms, and theories, and become a professor.

6. **ICT**

Information and communication technology is playing a big role in this platform. ICT always offer a new role for Mathematics Post Graduate students. Such as the development of ICT, Regular Maintenance, Manufacturing and design part, general part, and so on.

7. **Data Science Modelers**.

The demand for data science specialists is huge because every company wants to convert its data into the required information. Making good information sheet help company decision-maker to take the best decision for the company.

8. **Banking – Investment Banking**.

Many famous investment banks provide financial advice to the customer. These professions help to increase the equity and debt market. A career in investment banking is a very high-profile post along with good stability. In this profession, students have to deal with the clients and the market. Some basic skills required for an investment banker. Integrity, knowledge of finance and the markets, interpersonal skills, communication, etc. **Job opportunity** comes from varies area such as finance, wells Fargo, American Express, Deutsche bank, CICNA, Barclay's bank, AIG, JP Morgan, Goldman Sachs, etc.

Syllabus Prescribed for the year 2023-24, PG Programme

Programme : M.Sc.-I (Mathematics)

Semester- I

Code of the Course/Subject	**Title of the Course/Subject**	**(Total Number of Periods/week)**
FSC	Research Methodology and IPR	04

COs:

On successful completion of this course, students would be able to

- understand the role of research methodology in Mathematics.
- understand data collection methods and basic instrumentation.
- understand literature review process and formulation of a research problem.
- create awareness at intellectual property and patents.
- learn technical writing and communication skills required for research.

Unit	**Content**
Unit I	Research: Definition of research, Types of Research, Research Process, Criteria of good research, Significance of research. **(15 Hrs.)**
Unit II	Sampling Fundamentals: Need of Sampling, Some fundamental definition, Important sampling distributions, Chi-Square test, Bibliography, Hypothesis: Definition of hypothesis, procedure for hypothesis testing, Flow diagram for hypothesis testing, Literature review, system of references in Mathematics. **(15 Hrs.)**
Unit III	IPR: Intellectual Property Rights and patent law, Techniques of writing a Patent, Filling procedure, Technology transfer, Copy right, Royalty, Trade related aspects of Intellectual property Rights, Plagiarism tools. **(15 Hrs.)**
Unit IV	Methodology of Mathematics: Nature of Mathematics, Objects of Mathematics, Methodology and Rules of Mathematics, Research of Mathematics. **(15 Hrs.)**

Text Books:

- C. R. Kothari: Research Methodology methods and Technique, , New Age International Ltd. Publishers, New Delhi, second edition.
- Ronald Brown and Timothy Porter: The Methodology of Mathematics, Published online by Cambridge University press, 2016.

Reference Books:

(1) R. Brown and T. Porter, 'Why we made a Mathematical Exhibition', in the popularization of mathematics, Ed G Howson and P Kahane, Cambridge University Press,1992.
(2) T. Dantzig, Number: The language of science, 1930, Second Edition 1954, Macmillian.
(3) Chaturvedi, J. C., Mathematical Statistics, Agra: Nok Jhonk Karyalaya,1953.
(4) Freedmann P., The Principles of Scientific Research, Second Edition, New York: Pergamon Press, 19960.

Syllabus Prescribed for the year 2023-24, PG Programme

Programme : M.Sc.-I (Mathematics)

Semester- I

Code of the Course/Subject	**Title of the Course/Subject**	**(Total Number of Periods/week)**
DSC-I / Mathematics	Real Analysis	04

COs:

On successful completion of this course, students would be able to

- restate the ideas and concept of Riemann – Stieltjes integral with some of its properties and apply the fundamental theorem of integration.
- apply the Weierstrass M-test, Abel's and Dirichlet's tests for uniform convergence of sequences.
- differentiate between uniqueness theorem for power series, Abel's limit theorem and Tauber's first theorem.
- recognize the functions of several variables, linear transformation, partial and higher order derivatives in an open subset of R.

Unit	**Content**
Unit I	Definition and existence of Riemann Stieltjes integral, properties of the integral, Integration and differentiation, the fundamental theorem of calculus, integral of vector valued function. **(15 Hrs.)**
Unit II	Sequences and uniform convergence, Cauchy criterion for uniform convergence, Weierstrass M-test, Abel' s and Dirichlet's tests for uniform convergence, uniform convergence and continuity, uniform convergence and integration, uniform and differentiation, Weierstrass approximation theorem. **(15 Hrs.)**
Unit III	Rearrangement of terms of a series, Riemann's theorem. Power series, Uniqueness theorem for power series, Abel's limit theorem, Tauber's first theorem. **(15 Hrs.)**
Unit IV	Functions of several variables, linear transformation, derivatives in an open subset of Rn, chain Rule, partial derivatives, interchange of order of differentiation, Derivatives of higher order, Taylor's theorem. **(15 Hrs.)**

Text Book:

- Walter Rudin, Real and Complex Analysis, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

Reference Books:

1) Apostol T. M., Mathematical Analysis, Narosa Publishing House, New Delhi, 1985.
2) Eurl D. Rainville: Infinite series, The Macmillan Company, New York.

3) Friedman A., Foundations of Modern Analysis, Holt Rinehart and Winston, Inc, New York, 1970.
4) Hewitt E. and Starmberg, Real and Abstract Analysis, Berlin, Springer 1969.
5) Jain P. K. and Gupta V. P., Lebesque Measure and Integration, New Age international (P) Ltd., Published, New Delhi, 1986, (Reprint2000)
6) Gabriel Klambaucer , Mathematical Analysis Marcel Dekkar , Inc.,New York, 1975.
7) Natanson I. P., Theory of Function of real variables, Vol.-I, Frederick Ungar Publishing Co.1961.
8) Parthasarathy K.R., Introduction to Probability and Measure,Macmillan Company of India, Delhi, 1977.
9) Royden H.L., Real Analysis, Macmillian Pub. Co. Inc., 4th Edition,New York, 1993.
10) R.R.Goldber g : Real Analysis, Oxford & I.B.H. Publishing Co., New Delhi - 1970.
11) Serge Lang, Analysis I & II, Addison - Wesley Publishing CompanyInc., 1969.
12) S.C.Malik and Savita Arora: Mathematical Analysis, Wiley Fastern Ltd., New Delhi.
13) S.C.Malik and Savita Arora : Mathematical Analysis, New Age International (P.) Ltd.2010, Fourth Edition.
14) Shani Narayan: A Course of Mathematical Analysis, S.Chand and Company, New Delhi.
15) White A.J., Real Analysis, an introduction.
16) Karade T. M. and Salunke J.N., Lectures on Advanced Real Analysis, Sonu Nilu Publication, 2004.
17) Robert, G. Bartle, Donald R. Sherbert: Introduction to Real Analysis Wiley India Edition 2010
18) B.Chaudhari and D.Somasundarm: Mathematical Analysis, Narosa Publishing House, New Delhi
19) N.P.Bali , Real Analysis:Golden Math Series (2011)Publish by Firewall Media
20) Walter Rudin; Principles of Mathematical Analysis, Mc Graw Hill Books Company, Third Edition 1976, international student edition.

Syllabus Prescribed for the year 2023-24, PG Programme

Programme : M.Sc.-I (Mathematics)

Semester- I

Code of the Course/Subject	**Title of the Course/Subject**	**(Total Number of Periods/week)**
DSC-II / Mathematics	Advanced Abstract Algebra	04

COs:

On successful completion of this course, students would be able to

a. recall the concepts of coset and normal subgroup and to prove elementary propositions involving these concepts.
b. recognize different types of subgroups such as normal subgroups, cyclic subgroups and understand the structure and characteristics of these subgroups.
c. demonstrate the homomorphism, Sum and direct sum of ideals, maximal and prime ideals, nilpotent and nil ideals.
d. translate the transition of important concepts of homomorphisms and isomorphisms from discrete Mathematics to advanced abstract Mathematics.

Unit	**Content**
Unit I	Normal Subgroups, quotient groups and Isomorphism (Definition only), Automorphisms, Conjugacy and G-sets, Normal series, Solvable groups, Nilpotent groups. **(15 Hrs.)**

Unit II	Permutation groups, cyclic decomposition, Alternating group An, Simplicity of An, structure theorems of groups, Direct products, Finitely generated abelian groups, invariants of a finite abelian group, Sylow theorems, Groups of order p^2, pq. **(15 Hrs.)**
Unit III	Ideals, definition of left ideal, right ideal, examples, algebra of ideals, prime ideal, maximal ideal, principle ideal, sum and direct sum of ideals, Nilpotent and Nil ideals. **(15 Hrs.)**
Unit IV	Unique factorization domain, Principle ideal domain, Euclidean domain, Polynomial rings over UFD. **(15 Hrs.)**

Text Book:

- P.B. Bhattacharya, S.K. Jain, S.R. Nagpaul, Basic Abstract Algebra, Second Edition, Cambridge University Press.

Reference Books:

1) I.N. Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975.
2) M. Artin, Algebra, Pretice-Hall of India, 1991.
3) P.M. Cohn, Algebra, Vols. I, II & III, John Wiley & Sons, 1982,1989,1991.
4) N. Jacobson, Basic Algebra, Vols. I & II, W.H. Freeman, 1980.
5) S. Lang, Algebra, 3rd edition, Addison – Wesley, 1993.
6) I.S. Luthar and I.B.S. Passi, Algebra, Vol. I-Groups, Vol. II – Rings, Narosa Publishing House.
7) D.S. Malik, J.N. Mordenson, and M.K. Sen, Fundamentals of Abstract Algebra, McGraw- Hill, International Edition, 1997.
8) K.B. Datta, Matrix and Linear Algebra, Pretice Hall of India Pvt. Ltd., New Delhi, 2000.
9) S.K. Jain, A.Gunawadena and P.B. Bhattacharya, Basic Linear Algebra with MATLAB, Key College Publishing (Springer – Verlag), 2001.
10) S. Kumarsena, Linear Algebra, a Geometric Approach, Prentice Hall of India, 2000.
11) Vivek Sahai and Vikas Bist, Algebra, Narosa Publishing House, 1999.
12) I. Stewart, Galois Theory, 2nd Edition, Chapman and Hall, 1989.
13) J.P. Escofier, Galois Theory, GTM Vol.204, Springer, 2001.
14) T.Y. Lam, Lectures on Modules and Rings. GTM Vol.189, Springer Verlag, 1999.
15) D.S. Passman, A Course in Ring Theory, Wadsworth and Brooks/ Cole Advanced Books and Softwares, Pacific Groves, California, 1991.
16) J.A. Gallian, Contemporary Abstract Algebra, Narosa Publication.
17) A.R. Vashistha, Modern Algebra, Krishna Prakashan Media (P) Ltd.
18) John B. Fraleigh, a First Course in Abstract Algebra (Seventh Edition).
19) Abstract Algebra (Third Edition) By David S. Dummit, Richard M. Foote, Wilay India Edition.
20) V.K.Khanna and Bhambri, A Course in Abstract Algebra, Vikas Publication House.Pvt. Ltd., 2010

Syllabus Prescribed for the year 2023-24, PG Programme

Programme : M.Sc.-I (Mathematics)

Semester- I

Code of the Course/Subject	**Title of the Course/Subject**	**(Total Number of Periods/week)**
DSC-III / Mathematics	Complex Analysis	03

COs:

On successful completion of this course, students would be able to

- Identify Cauchy integral formula apply to find the value of function at inside point of the region.
- Express the function in series of positive and negative power of variable in a given region.

7

- Record the concept of singularities to find integral of complex valued function on some simple connected region and multi connected region.
- Apply the residue theorem to compute several kinds of real integrals.

Unit	Content
Unit I	Complex Integration: Power Series representation of analytic functions, Cauchy's integral formula, higher order derivatives, Cauchy's inequality, Zeros of Analytic function, Liouvilles theorem, Fundamental theorem of algebra. **(11 Hrs.)**
Unit II	Taylor's theorem, Maximum Modulus theorem, Morera's theorem, Counting of zeros, open Mapping theorem, Cauchy Goursat theorem, Schwarz's lemma. **(11 Hrs.)**
Unit III	Singularities, Isolated singularities, classification of isolated singularities, Laurent's series development, Casorti Wierstrass theorem, Argument principle, Rouche's theorem. **(11 Hrs.)**
Unit IV	Residue, Cauchy's residue theorem, Evaluation of integration by using residue theorem, Branches of many valued function (Specially arg z, log z, z), Hadamard's three circle theorem, Spaces of continuous functions, spaces of analytic functions, Hurwitz theorem. **(12 Hrs.)**

Text Books:

- J.B.Conway, Functions of One Complex Variable , Springer Verlag International Students Edition, Narosa Publishing House, 1980.
- S.Ponnusamy Foundation of Complex Analysis , Narosa Publishing House, 1967.

Reference Books:

1) H. S. Kasana, Complex variables: Theory and Application, PHI Learning Pvt. Ltd., New Delhi.
2) Schaum's outline series Complex Analysis, Tata McGraw Hill Education Pvt. Ltd., New Delhi (2010).
3) J. N. Sharma, Complex Variables, Pragati Publication,Meerut.
4) A. R. Vashistha, Complex Variables, Krishna Publication.
5) Murray R. Spiegel, Seymour Lipschutz, Jon J. Schiller, Dennis Spellman., Schaum's outline series Complex Analysis, Tata McGraw Hill Education Pvt. Ltd., 3rd Edition, New Delhi 2010.
6) Walter Rudin, Real & Complex Analysis, McGraw Hill Book Co., 1966.
7) J. Ward Brown, Ruel V. Churchill, Complex variables and Application, McGraw Hill International Edition (2009).
8) H. A. Priestly, Introduction to Complex Analysis, Clarendon Press, Oxford, 1990.
9) Liang-Shin Hahn & Bernhard Epstein, Classical Complex Analysis, Jones & Berlett Publishers. International London, 1996.
10) L. V. Ahlfors, Complex Analysis, McGraw Hill, 1979.
11) S. Lang, Complex Analysis, Addison Wesley, 1977.1998.
12) D. Sarason, Complex Function Theory, Hindustan Book, Agency, Delhi, 1994.
13) Mark J. Ablowitz and A. S. Fokar, Complex variables: Introduction & Application, Cambridge University Press, South Asian Edition, 56.
14) E. Hille, Analytic Function Theory (2 Vols), Gonn & Co. 1959.
15) W. H. J. Fuchs, Topics in the Theory of Function of Complex Variable, D. Van Nostrand Co., 1967.
16) C. Carathedory, Theory of Functions (2 Vols), Chelsea Publishing Company, 1964.
17) M. Heins, Complex Function Theory, Academic Press, 1968.
18) S. Saks & A. Zygmund, Analytic Functions, Monografie, Matematyczne, 1952.
19) E. C. Titchmarsh, the Theory of Functions, Oxford University Press, London.
20) W. A. Veech, A Second Course in Complex Analysis, W. A. Benjamin, 1967.

21) Complex variables and Applications, Jams Ward Brown, Ruel V. Churchill, McGraw Hill International Edition (2009).
22) Dennis G. Zill, Patrick D. Shanhan Jones and Burtlett, A First Course in Complex Analysis with application (Second edition) Publisher (2010).
23) John Mathew and Howell, Complex Analysis for Mathematician and Engineers.

Syllabus Prescribed for the year 2023-24, PG Programme

Programme : M.Sc.-I (Mathematics)

Semester- I

Code of the Course/Subject Title of the Course/Subject (Total Number of Periods/week)

DSE-I / Mathematics Advanced Discrete Mathematics-I (Optional) 04

COs

On successful completion of this course, students would be able to

- design the graphs, paths, circuits, cycles and subgraphs.
- determine Circuit, Fundamental Circuit, cut sets, fundamental cut sets of the graph.
- illustrate chromatic number
- describe introductory computability theory its techniques.

Unit	Content
Unit I	Graph Theory: Definition of (undirected) graphs, paths, circuits, cycles and subgraphs, Induced subgraphs, Degree of a vertex, Connectivity planar graphs and their properties, Trees, Euler formula for connected planar graphs, Complete and complete bipartite graphs, Kuratowski' s theorem (Statement only) and its use. **(15 hrs.)**
Unit II	Graph Theory (Continue): Spanning trees, Circuit, Fundamental Circuit, cut sets, fundamental cut sets, and cycles, Minimal spanning trees and Kruskal's Algorithm, Matrix representations of graphs, Euler 's theorem on the existence of Eulerian paths and circuits, Directed graphs, Indegree and outdegree of a vertex, Weighted undirected graphs, Dijkstra' s algorithm, Strong connectivity and Warshall's algorithm. **(15 hrs.)**
Unit III	Chromatic Number: Chromatic Partitioning, Chromatic Polynomial, Matchings, Coverings, The Four Color Problem. **(15 hrs.)**
Unit IV	Introductory Computability Theorem: Finite state machines and their transition table diagrams, Equivalence of finite state machines, Reduced machines, Homomorphism, Finite automata acceptors, Moore and Mealy machines. **(15 hrs.)**

Text Books:

- N. Deo, Graph Theory with applications to Engineering and Computer Sciences, Prentice Hall of India.
- J.P. Tremblay and R. Manohar , Discrete Mathematical Structure with Application to Computer Science, McGraw Hill Book Co. 1997.

Reference Books:

(1) Seymour Lipschutz, Finite Mathematics (International Edition 1983). McGraw Hill Book Company .

(2) S. Wiitala, Discrete Mathematics - A Unified Approach, McGraw Hill Book Co.

(3) J.L. Gersting : Mathematical Structure for Computer Science (3rd Edition), Computer Science Press, New York.

(4) C.L.Liu, Elements of Discrete Mathematics, McGraw Hill Book Co.

Syllabus Prescribed for the year 2023-24, PG Programme

Programme : M.Sc.-I (Mathematics)

Semester- I

Code of the Course/Subject	**Title of the Course/Subject**	**(Total Number of Periods/week)**
DSE-I / Mathematics	Differential Geometry (Optional)	04

COs

On successful completion of this course, students would be able to

- discuss the local intrinsic properties of a surface, curves on a surface, surfaces of revolution.
- design arguments in the geometric description of family of curves and surfaces in order to establish basic properties of geodesics.
- apply Geodesics theorem and restate the Gaussian Curvature, Surface of constant curvature, conformal and Geodesic mappings.
- recognize the tensor calculus, tensor product of vector spaces, transformation formulae, contraction special tensors, and inner product.

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Unit	Content
Unit I	Local Intrinsic properties of a surface, Definition of surface, curves on a surface, surfaces of Revolution, Helicoids, Metric, Direction Coefficients. **(15 hrs.)**
Unit II	Families of curves, Isometric correspondence, Intrinsic properties, Geodesics, Canonical Geodesic Equation, Normal Properties, Geodesic Existence theorems, Geodesic parallels. **(15 hrs.)**
Unit III	Geodesic curvature, Gauss-Bonnet Theorem, Gaussian Curvature, Surface of constant curvature, conformal mapping, Geodesic mapping. **(15 hrs.)**
Unit IV	Review of tensor calculus, Vector spaces, the dual space, Tensor product of vector spaces, Transformation formulae, contraction special tensors, Inner product. Associated tensors Exterior Algebra. **(15 hrs.)**

Text Book:

- T . J. Wilmore, An Introduction to Differential Geometry Oxford University Press (1959).

Reference Books:

(1) W. Klingenberg (Springer), A course in Differential Geometry.
(2) Weatherburn, C. Riemannian Geometry and Tensor Calculus.
(3) T. M. Karade, G.S. Khadekar, Maya S. Bendre, Lectures on General relativity, Sonu-Nilu Publication, 2004.
(4) D. Somasundaram, Differential Geometry a first course, Narosa Publishing House,2008.

Syllabus Prescribed for the year 2023-24, PG Programme

Programme : M.Sc.-I (Mathematics)

Semester- I

Code of the Course/Subject	**Title of the Course/Subject**	**(Total Number of Periods/week)**
Practical / Mathematics	Introduction to LaTeX	06

Course Objectives: To prepare a Latex document, to make scientific article and project report, book, include figures and tables in a Latex document, make conference proceedings and presentations, the preamble of LaTeX file to define document class and layout options, Use BibTeX to maintain bibliographic information and to generate a bibliography for a particular document and beamer for beautiful presentations

On successful completion of this course, students would be able to

1. Do typesetting of complex mathematical formulae using LaTeX.
2. use various methods to either create or import graphics into a LaTeX document.
3. Do typesetting of journal articles, technical reports, thesis, books, and slide presentations.
4. Perform automatic generation of table of contents, bibliographies and indexes.

Unit	**Content**
Unit-I	**The Basics of LaTeX** : Simple Typesetting, font, type size, documents produced with LaTeX, document class, page style, numbering, length, title, abstract dividing document, sectioning command, bibliography, bibliography database – basic commands, creating of the bibliographic database, Table of contents, index, row and column setting and command (**18 Hrs.)**
Unit-II	**Typesetting in Mathematics:** Subscript, superscript, roots and mathematical symbols/commands, Mathematical equations (single, group, numbered), matrices, dots, determinants (delimiters, equation affixing symbols), new operators of mathematics, symbols and their commands (**18 Hrs.)**
Unit-III	**Typesetting for theorems:** Theorem representation in LaTeX, designer theorems – then amsthm package, several kinds of boxes (LR boxes, paragraph boxes and with a specific height, nested boxes and rule boxes) **(18 Hrs.)**
Unit-IV	**Figure and table environments:** Creating floating figures, figure placement, customizing float placements, using graphics in LaTeX, rotating and scaling objects, Table environments – constructing table style parameters and examples, cross references in LaTeX, footnotes, marginal notes and end notes.**(18 Hrs.)**

Text Book:

- LATEX Tutorials A Primer, Indian TEX Users Group, Trivandrum, India, 2003 September

Reference Books:

(1) Learning LATEX by Doing, Andre Heck, 2002.
(2) The Latex companion, M. Carter, B.vanBrunt, second edition, Addison wisely, Pearson Education

11

Syllabus Prescribed for the year 2023-24, PG Programme

Programme : M.Sc.-I (Mathematics)

Semester- II

Code of the Course/Subject	**Title of the Course/Subject**	**(Total Number of Periods/week)**
DSC-IV / Mathematics	Advanced Linear Algebra and Field Theory	04

COs:

On successful completion of this course, students would be able to

- recall the concepts of eigen values, eigen vectors and polynomials.
- explain quadratic form, linear transformation, canonical and normal form.
- describe the concepts of algebraic extension of fields.
- understand the concepts of Galois theory and its application.

Unit	Content
Unit I	Canonical forms: Eigen values and eigenvectors. The minimal polynomial, Diagonalizable and triangular operators, The Jordan form, The rational form. **(15 Hrs.)**
Unit II	Quadratic forms, Linear transformation, Congruence of matrices, Reduction of real quadratic form, Canonical or Normal form of a real quadratic form, Signature and index of a real quadratic form, Sylvester's law of inertia, Definite and semi-definite real quadratic Forms, Hermitian forms. **(15 Hrs.)**
Unit III	Algebraic extension of fields: Irreducible polynomials and Einstein criterion, Adjunction of roots, Algebraic extension, Algebraically closed fields. **(15 Hrs.)**
Unit IV	Galois theory and Applications: automorphism groups and fixed fields, Fundamental theorem of Galois theory, Fundamental theorem of algebra, Roots of unity and cyclotomic polynomials, Cyclic extension, Polynomials solvable by radicals, Symmetric functions, Ruler and compass constructions. **(15 Hrs.)**

Text Books:

- P.B. Bhattacharya, S.K. Jain, S.R. Nagpaul, Basic Abstract Algebra, Second Edition, Cambridge University Press.
- I. N. Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975.

Reference Books:

1) M. Artin, Algebra, Pretice-Hall of India, 1991.
2) P.M. Cohn, Algebra, Vols. I, II & III, John Wiley & Sons, 1982, 1989, 1991.
3) N. Jacobson, Basic Algebra, Vols. I & II, W.H. Freeman, 1980.
4) S. Lang, Algebra, 3rd edition, Addison – Wesley, 1993.
5) I.S. Luthar and I.B.S. Passi, Algebra, Vol. I-Groups, Vol. II – Rings, Narosa Publishing House.
6) D.S. Malik, J.N. Mordenson, and M.K. Sen, Fundamentals of Abstract Algebra, McGraw- Hill, International Edition, 1997.
7) K.B. Datta, Matrix and Linear Algebra, Pretice Hall of India Pvt. Ltd., New Delhi, 2000.
8) S.K. Jain, A.Gunawadena and P.B. Bhattacharya, Basic Linear Algebra with MATLAB, Key College Publishing (Springer – Verlag), 2001.
9) S. Kumarsena, Linear Algebra, a Geometric Approach, Pretice Hall of India, 2000.
10) Vivek Sahai and Vikas Bist, Algebra, Narosa Publishing House, 1999.

12

11) I. Stewart, Galois Theory, 2nd Edition, Chapman and Hall, 1989.
12) J.P. Escofier, Galois Theory, GTM Vol.204, Springer, 2001.
13) T.Y. Lam, Lectures on Modules and Rings. GTM Vol.189, Springer Verlag, 1999.
14) D.S. Passman, A Course in Ring Theory, Wadsworth and Brooks/ Cole Advanced Books and Softwares, Pacific Groves, California, 1991.
15) J.A. Gallian, Contemporary Abstract Algebra, Narosa Publication.
16) A.R. Vashistha, Modern Algebra, Krishna Prakashan Media (P) Ltd.
17) V.K. Khanna and Bhambri, a Cource in Abstract Algebra, Vikas Publication, House (P) Ltd. (2010).
18) John B. Fraleigh, a First Course in Abstract Algebra (Seventh Edition).
19) David S. Dummit, Richard M. Foote , Abstract Algebra (Third Edition) , Willey India Edition.
20) A.R. Vashistha and A. K. Vashistha, Matrices, Krishna Publication, Meerut.

Syllabus Prescribed for the year 2023-24, PG Programme

Programme : M.Sc.-I (Mathematics)

Semester- II

Code of the Course/Subject **Title of the Course/Subject** **(Total Number of Periods/week)**

DSC-V / Mathematics Topology 04

COs

On successful completion of this course, students would be able to

- demonstrate the concepts such as topological spaces, open and closed sets, interior, closure and boundary.
- categorize some important concepts like continuity, compactness, connectedness, projection mapping etc. and prove related theorems.
- relate the basic concepts of countability axiom, separation axioms and convergence in topological spaces.
- distinguish between the regular, normal and completely regular spaces.
- categorize some important concepts of metric spaces.

Unit	Content
Unit I	Topological Spaces : Definition and examples of topological spaces. Open sets and Limit points. Closed sets and closure. operators and neighbourhoods. Bases and Relative Topologies. **(15 Hrs.)**
Unit II	Connectedness, Compactness and Continuity : Connected sets and components, compact and countably compact spaces. Continuous functions. Homeomorphisms. Arcwise connectivity . **(15 Hrs.)**
Unit III	Separation and Countability Axioms : T_0, T_1 & T_2 spaces. T spaces and sequences. First and Second axiom spaces, separability, Regular and normal spaces, Completely regular spaces. **(15 Hrs.)**
Unit IV	Metric Spaces : Metric Spaces as topological spaces. Topological properties. Hilbert (L_2) space. Frechet space. Space of continuous functions. **(15 Hrs.)**

Text Book:

- William J. Pervin , Foundations of General Topology, Publisher: Academic Press.

13

Reference Books:

1) Semour Lipshutz , Theory and Problems of Set Theory and Related Topics , Publisher: Schaum Publishing Co., New York.
2) J.R. Munkres, Topology : A First Course Publishers Prentice Hall of India.
3) K.D.Joshi, Introduction to General Topology, Publisher , Wiley Eastern Ltd.
4) R.S.Aggarwal ,A Text Book on Topology, Publisher : S.Chand & Company .
5) J.N. Sharma, General and Algebric Topology, Krishna Prakashan, Meerut.

Syllabus Prescribed for the year 2023-24, PG Programme

Programme : M.Sc.-I (Mathematics)

Semester- II

Code of the Course/Subject	**Title of the Course/Subject**	**(Total Number of Periods/week)**
DSC-VI / Mathematics	Integral Equations	03

COs:

On successful completion of this course, students would be able to

- understand the type of integral equations.
- categorize Volterra integral equations of first and second kinds.
- determine the solution of Fredholm integral equations of the second kinds.
- define the concepts of iterated kernels and reciprocals kernels.

Unit	**Content**
Unit I	Definition of integral equations, Types of integral equations: Fredholm integral equations of the first and second kind, homogeneous Fredholm integral equations of the second kind, Volterra integral equations of first and second kind, Homogeneous Volterra integral equations of the second kind, special kinds of kernels, symmetric kernels, separable and degenerate kernels, Leibnitz rule, solution of integral equations, solved examples, Method of converting an initial value problem into integral equations, solved examples, method of converting a boundary value problems into a Fredholm integral equations. Solved examples. **(12 Hrs.)**
Unit II	Eigen values and Eigen functions: (a) Solution of homogeneous Fredholm integral equations of the second kind with separable kernels, solved examples based on (a). (b) Solution of Fredholm integral equation of the second kind with separable kernels, Solved examples based on (b). **(11 Hrs.)**
Unit III	Definition of iterated kernels or functions, definition of resolvent kernels or reciprocal kernel, solution of Fredholm integral equation of the second kind by successive substitutions, solution of Volterra integral equation of the second kind by successive substitutions, Neumann's series, some important theorems, determination of iterated kernels, determination of resolvent kernels for Fredholm integral equations, solution of Fredholm integral equation with the help of resolvent kernels, solution of Fredholm integral equations by method of successive approximation to find solutions up to third order. Solve examples. **(11 Hrs.)**

14

Unit IV	Solution of Volterra integral equations of second kind, determination of resolvent kernels for Volterra integral equations, solution of Volterra integral equations with the help of the resolvent kernels, solved examples, Neumann's series, Method of successive approximation for solving Volterra integral equations of second kind, Volterra integral equations of first kind , solution of Volterra integral equations of the first kind, solved examples, some fundamental properties of Eigen values and Eigen functions for symmetric kernels. **(11 Hrs.)**

Text Books:

- M. D. Raisinghania, Integral equations and boundary value problems, S. Chand Publication.
- Shanti Swaroop, Shiv Raj Singh, Integral equations.

Reference Books:

1) R.P. Kanwal, Linear Integral Equation, Theory and Techniques, Academic Press, N.Y. (1971).
2) S.G. Mikhlin, Linear Integral Equations, Hindustan Book Agency, (1960).
3) A.M. Viazwaz, A First Course in Integral Equations, World Scientific (1997).
4) L.I.G. Chambers, Integral Equation: A Short Course, International Text Book Company Ltd. (1976).
5) Larry Andrews, Bhimsen Shiramoggo, Integral Transform for Engineers, Prentice Hall of India (2003).

Syllabus Prescribed for the year 2023-24, PG Programme

Programme : M.Sc.-I (Mathematics)

Semester- II

Code of the Course/Subject **Title of the Course/Subject** **(Total Number of Periods/week)**

DSE-II / Mathematics Advanced Discrete Mathematics-II (Optional) 04

COs:

On successful completion of this course, students would be able to

- Develop the logical tools among the students.
- Interpret the concepts of Semigroups and Monoids.
- Categorize the concepts of Lattice and sublattice.
- Apply the Boolean algebra to switching circuits.

Unit	**Content**
Unit I	Formal Logic: Statements, symbolic representation and Tautologies. Quantifiers, Predicates and validity. Propositional logic. **(15 hrs.)**
Unit II	Semigroups and Monoids: Definitions and examples of semigroups and monoids (including those pertaining to concatenation operation). Homomorphism of semigroups and monoids. Congruence relation and Quotient semigroups. Subsemigroups and submonoids. Direct products. Basic Homomorphism theorem **(15 hrs.)**

15

Unit III	Lattice Theory: Lattices are partial ordered sets. Their properties. Lattices as algebraic systems. Sublattices. Direct products and Homomorphisms. Some special lattices, e.g. complete, complemented and distributive lattices. **(15 hrs.)**
Unit IV	Boolean Algebras: Boolean algebra as a lattice. Various Boolean identities. The switching algebra examples. Subalgebras. Direct products and Homomorphisms. Joint irreducible elements, Applications of Boolean algebra of switching theory. (Using AND, OR and NOR gates). **(15 hrs.)**

Text Books:

- J.R.Tremblay and R. Manohar , Discrete Mathematical Structure with Application to Computer Science, McGraw Hill Book Co., 1997
- N.Deo, Graph Theory with Applications to Engineering and Computer Sciences, Prentice Hall of India.

Reference Books:

(1) J.E. Hopcroft and J.D.Ullman, Introduction to Automata Theory, Language and Computation, Narosa Publishing House.

(2) C.L. Liu, Elements of Discrete Mathematics, McGraw Hill Books co.

(3) F.H. Harary - Graph Theory, Narosa Publishers, New Delhi (1989)

(4) K.R.Parthasarthy , Basic Graph Theory (TMH)

Syllabus Prescribed for the year 2023-24, PG Programme

Programme : M.Sc.-I (Mathematics)

Semester- II

Code of the Course/Subject	**Title of the Course/Subject**	**(Total Number of Periods/week)**
DSE-II/ Mathematics	Riemannian Geometry (Optional)	04

COs:

On successful completion of this course, students would be able to

- discuss the properties of Christoffel symbols, divergence, gradient and Laplacian.
- demonstrate the concepts of parallel vector field.
- interpret the concepts of curvature tensor.
- categorize some concepts like Ricci tensor, curvature invariant and Einstein tensor.
- summarize the concepts of Riemannian curvature , space of constant curvature, intrinsic symmetric and killing vectors.

Unit	**Content**
Unit I	Riemannian metric, metric tensor , Christoffel symbol, Christoffel symbol of first kind, second kind, properties of Christoffel symbols. Computations of Christoffel's symbols for static and non-static spherically symmetric and R-W spacetimes , transformation of Christoffel symbols, derivatives of tensor, absolute derivative. Covariant derivatives, divergence, gradient, Laplacian. **(15 Hrs.)**

16

Unit II	Parallel Vector Fields: Parallel vector field of constant magnitude, parallel displacement of covariant vector field, parallelism of a vector field of variable magnitude Geodesic, Differential equations of a geodesic, special co-ordinate system , Local Cartesians, Riemannian co-ordinates, Normal coordinates, Geodesic normal co-ordinates. **(15 Hrs.)**
Unit III	Curvature Tensor : Covariant curvature tensor of Riemann tensor , curvature tensor in Riemannian coordinates, properties of curvature tensors, on a cyclic property, number of independent components of R. **(15 Hrs.)**
Unit IV	Ricci tensor, curvature invariant, Einstein tensor, Computations of Einstein's tensor for static and nonstatic spherically symmetric and R-W space times, the Bianchi identity. Geodesic deviation : Equations of Geodesic deviation, Riemannian curvature, space of constant curvature, flat space, tensor derivatives, dual tensors, intrinsic symmetries and killing vectors. **(15 Hrs.)**

Text Book:

- T. J. Willmore, An Introduction in Differential Geometry, Dover Publication, London, 2012

Reference Books:

(1) T. M.Karade, K. S.Adhav, V.G.Mete, A.S.Nimkar, S.N.Bayaskar,M.S.Bendre, Elements of Riemannian Geometry, Sonu Nilu Einstein Foundation, International, 2022.
(2) J. L. Synge, Tensor Calculus – Schild.
(3) C.E. Weatherburn, An introduction to Riemannian geometry and tensor calculus, Cambridge university press, (1963)
(4) L.P. Eisenhard, Riemannian geometry, University press Princeton (1926)
(5) J.A. Schouten, Ricci Calculus, Springer Verlag, Berlin
(6) T.Y. Thomas, Concepts from tensor analysis and differential geometry, Academic press, New York
(7) W. Boothby, Introduction to differentiable manifold and Riemannian geometry, Academic press, 1975
(8) S. Kobayashi and K. Nomizu, Foundations of differential geometry, Vol. I and II Wiley Interscience publisher 1963 (Vol.I), 1969 (Vol. II)

Syllabus Prescribed for the year 2023-24, PG Programme

Programme : M.Sc.-I (Mathematics)

Semester- II

Code of the Course/Subject	**Title of the Course/Subject**	**(Total Number of Periods/week)**
DSE-II / Mathematics	Measure and Integration Theory (Optional)	04

COs:

On successful completion of this course, students would be able to

- analyse Lebesgue outer measure, regularity and Lebesgue measurability
- explain integration and non-negative function, the general integral, Riemann and Lebesgue integrals
- demonstrate the concepts of four derivatives, differentiation and integration
- discuss the measure and outer measure

17

Unit	Content
Unit I	Lebesgue outer measure, measurable sets, Regularity, Measurable functions, Borel and Lebesgue measurability. **(15 Hrs.)**
Unit II	Integration of Non-negative function, the general integral, integration of series, Riemann and Lebesgue integrals. **(15 Hrs.)**
Unit III	The Four derivatives, continuous non-differentiable functions, functions of bounded variation, Lebesgue differentiation theorem, differentiation and integration. **(15 Hrs.)**
Unit IV	Measures and outer measures, Extension of a measure, The Lp uniqueness of Extension, Completion of measure. **(15 Hrs.)**

Text Book:

- G. de Barra, Measure Theory and Integration. Wiley Eastern Limited, 1981.

Reference Books:

1) Bartle R.G ., The Elements of Integration, John Wiley & Sons, Inc.,New York, 1966.
2) Halmos P .R. Measure Theory, Van Nostrand Princeton, 1950.
3) Hawkins T. G., Lebesgue' s Theory of Integration, its origins and Development, Chelsea, New York, 1979.
4) Inder K. Rana, An Introduction to Measure and Integration, Narosa Publishing House, Delhi, 1997.
5) Karade T .M., Salunke J.N., Lectures on Advanced Real Analysis, Sonu Nilu Publication, Nagpur, 2004.
6) Royden H.L., Real Analysis, Macmillan Pub. Co. Inc., 4th Edition,New York, 1993.
7) P.K. Jain and V.K.Gupta, Leabegue Measure and integration, June 2010.

Syllabus Prescribed for the year 2023-24, PG Programme

Programme : M.Sc.-I (Mathematics)

Semester- II

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods/week)
Practical / Mathematics	Mathematics with Scilab	06

COs:

On successful completion of this course, students would be able to

- install Scilab Software and execute loops and conditional statements.
- able to understand the basic concepts of programming.
- perform basic mathematical operations using Scilab Software.
- analyze different types of data using plotting of functions in Scilab.
- handle matrices and their operations in Scilab; Plot and visualize 2D and 3D graphs of various functions.
- understand the main features of the Scilab program development environment to enable it's usage in the higher learning. Interpret and visualize simple mathematical functions and operations by using plots.

18

Unit	Content
Unit-I	**Introduction to Scilab** • Introduction to Scilab, Installation of Scilab • Basic elements of the language, Looping and Branching: • If, select, for, break, continue, Functions, return, • Contour plots, tiles, axes, legends. **(18 Hrs.)**
Unit-II	**Linear Algebra using Scilab** • Creating matrices, sum, product of matrices, inverse, rank determinant, • Comparing matrices, system of equations, High level linear algebra features, working with polynomials, • Matrix inversions, Solving system of equations **(18 Hrs.)**
Unit-III	**Scilab Demonstrations:** • Polynomials, discrete and continuous Random variables, • Basic functions, animation, Bezier curves and surfaces, matplot, • complex elementary functions. Scilab
Unit-IV	**Calculus Using Scilab** • Plotting 2D and 3D graphs, defining a function and output arguments. 5L+10P • Parametric plots, Polar plots • Evaluation of definite integrals, Generating prime numbers • Illustration of Rolle's and Mean value theorems. **(18 Hrs.)**

Text Book:

1. Sandeep Nagar, Introduction to scilab,: For Engineers and Scientists Apress Publisher New York USA 2017.

Reference Books:

1. Michael Baudin , Introduction to scilab, , Scilab Consortium, digiteo, Nov 2010.
2. Satish Annigeri , An introduction to scilab, , free online version.
3. Graeme Chandler, Stephen Roberts , Introduction to Scilab, free online version, 2002.
4. Gilberto E. Urroz , Introduction to Scilab, distributed by infoclearinghouse.com

Sant Gadge Baba Amravati University, Amravati

M.Sc.-I (Mathematics) Semester-I (NEP)

2023-24

Practical: Introduction to LaTeX

Group-A

1. Develop and execute a program for simple sentences.
2. Develop and execute a program for different alignments (Left, Right, Center, Justify).
3. Develop and execute a program for certificate format.
4. Develop and execute a program for application letter.
5. Develop and execute a program to produce bibliography.
6. Develop and execute a program to prepare a report card.
7. Develop and execute a program to generate index.
8. Develop and execute a program to obtain mathematical equations.
9. Develop and execute a program to obtain matrices.
10. Develop and execute a program to obtain addition of matrices.
11. Develop and execute a program to obtain multiplication of matrices.

Group-B

1. Develop and execute a program to obtain formulae in mathematics.
2. Develop and execute a program to obtain theorem, lemma or proposition.
3. Develop and execute a program to insert a picture.
4. Develop and execute a program to make a question paper.
5. Develop and execute a program to make a time table.
6. Develop and execute a program to convert one latex file into Power Point Presentation.
7. Develop and execute a program to obtain complex mathematical formulae.
8. Develop and execute a program to obtain mathematical expression using Differentiation, Integration and Trigonometry.
9. Develop and execute a program to obtain graph.
10. Develop and execute a program to create title page.
11. Develop and execute a program to write research paper.

Distribution of Practical Marks

A] Internal Practical Marks:

i) Internal Assessment	=	30
ii) Practical/Record	=	20
Total	**=**	**50**

B] External Practical Marks:

i) Program design/ Performed (Any one of each group A & B)	=	30
ii) Viva Voce	=	20
Total	**=**	**50**

Note: In external practical students have to perform one practical from group A and one practical from group B. Each practical carry 15 marks.

Sant Gadge Baba Amravati University, Amravati

M.Sc. - I (Mathematics) Semester – II (NEP)

2023-24

Practical: Mathematics with Scilab

Group A

1. Design and execute a program to find the average of three numbers.
2. Design and execute a program to find the sum, difference, multiplication and division of two numbers
3. Design and execute a program to find largest and smallest of three numbers
4. Design and execute a program to generate even numbers from 1 to n
5. Design and execute a program to generate first n even numbers
6. Design and execute a program to odd numbers between 50 to 100
7. Design and execute a program to generate the sequence 1, 4, 7, 10, 13, ------
8. Design and execute a program to display multiplication table for n numbers
9. Design and execute a program to find the sum of n natural numbers and hence between 100 to 250
10. Design and execute a program to find area and volume of the sphere

Group B

1. Design and execute a program to find the roots of the polynomials given below: x^2-9x+9=0 and x^2+x-12=0
2. Design and execute a program to solve the ODE dy/dx=cos(t) with an initial value condition y(0)=0 and plot the graph.
3. Design and execute a program to plot the graph of trigonometric functions by using Scilab
4. Design and execute a program to plot the graphs of functions: log(ax+b), ax, $(ax+b)^{1/2}$, absolute value of (ax+b)
5. Design and execute the program to find the average of n numbers
6. Design and execute a program to find factorial of positive numbers
7. Design and execute a program to solve the ODE dy/dt = y^2 -ysin(t) + cos(t) with the initial condition y(0) =0 and plot the graph
8. Design and execute a menu driven program to obtain square and cube of numbers
9. Design and execute a program for sin(ax+b) and cos(ax+b) and plot the graph.

Distribution of Practical Marks:

A) **Internal Practical Marks**

i) Internal Assessment ---------- = 30 marks

ii) Practical Record ---------- = 20

Total ---------- = 50

B) **External / University Practical Marks**

i) Design and Performed Practical
(Any One of Each Group A and B) ------- = 30 marks

ii) Viva-Voce Exam. ---------- = 20

Total ---------- = 50

Note: In external practical students have to perform one practical from group A and one practical from group B. Each practical carry 15 marks.