

ST. JOSEPH'S COLLEGE (AUTONOMOUS) BENGALURU-27



Re-accredited with 'A++' GRADE with 3.79/4 CGPA by
NAAC Recognized by UGC as College of Excellence

DEPARTMENT OF MATHEMATICS

Syllabus for Bachelor of Science (Basic/Hons.)

Under National Education Policy

For Batch 2021 (Onwards)

Name of the Degree Program: B.Sc.

Discipline Core: Mathematics

Total Credits for the Program: 176 (till 8 semesters)

Starting year of implementation: 2021-22



**ST. JOSEPH'S COLLEGE (AUTONOMOUS)
BENGALURU**

Syllabus for B.A. / B.Sc. (Honours) Mathematics

Name of the Degree Program : B.A. / B.Sc.
Discipline Course : Mathematics
Starting Year of Implementation : 2021-22

Programme Outcomes (PO)

By the end of the programme the students will be able to:

PO1	Disciplinary Knowledge: Bachelors degree in Mathematics is the culmination of in-depth knowledge of Algebra, Calculus, Geometry, Differential Equations and several other branches of pure and applied Mathematics. This also leads to a study in related areas.
PO2	Communication Skills: Ability to communicate various Mathematical concepts effectively using examples and their geometric visualization. The skills and knowledge gained in this programme will lead to the proficiency in analytical reasoning which can be used for modelling and solving of real-life problems.
PO3	Critical thinking and analytical reasoning: The students undergoing this programme acquire the ability of critical thinking and logical reasoning and the capability of recognizing and distinguishing various aspects of real-life problems.
PO4	Problem Solving: The Mathematical knowledge gained by the students through this programme gives them an ability to analyse the problems and identify or define appropriate computing techniques for their solutions. This programme enhances student's overall development.
PO5	Research related skills: Upon completing this programme the students will develop the capability of asking appropriate questions related to the Mathematical concepts in different areas of Mathematics.
PO6	Information / Digital Literacy: The completion of this programme will enable the learner to find, evaluate and effectively communicate knowledge related to certain mathematical topics using appropriate software.
PO7	Self-directed learning: The student completing this programme will develop an ability to work independently and to make an in-depth study of various notions of Mathematics.
PO8	Moral and ethical awareness / reasoning: The student, on completing this programme, will develop an ability to identify unethical behaviour such as fabrication, falsification or misinterpretation of data and adopt objectives that are unbiased and truthful in all aspects of life in general and Mathematical Studies in particular.
PO9	Lifelong learning: This programme provides self-directed and lifelong learning skills. This programme helps the learner to think independently, develop algorithms and computational skills for solving real world problems.
PO10	Ability to pursue advanced studies and research in Pure and Applied Mathematical Sciences.

ASSESSMENTS

Weightage for the Assessments (in percentage)

Type of Course	Formative Assessment (I.A.)	Summative Assessment (S.A.)
Theory	40%	60%
Practical	50%	50%
Projects	40%	60%
Experiential Learning (Internship etc.)	--	--

Contents of Courses for B.A./B.Sc. with Mathematics as Major Subject & B.A./B.Sc. (Hons) Mathematics

Model III A

Semester	Course No.		Paper Title		Marks	
					S.A.	I.A.
I	MT121	Theory	4	Mathematics–I	60	40
	MT1P1	Practical	2	Mathematics Practical-I	25	25
	MTOE-1 MTOE-2	Theory	3	(A) Business Mathematics (B) Quantitative Methods for Competitive Examinations	60	40
II	MT221	Theory	4	Mathematics–II	60	40
	MT2P1	Practical	2	Mathematics Practical-II	25	25
	MTOE-3 MTOE-4	Theory	3	(A) Mathematics for Biologists (B) Mathematics for Management Aptitude Tests	60	40
Exit Option with Certificate						

EXAMINATION AND ASSESSMENTS

THEORY

I.A. Weightage	40 %
End Semester Examination Weightage	60 %

PRACTICAL/PROJECTS

I.A. Weightage	50 %
End Semester Examination Weightage	50 %

Title	Credits	CA Marks	SE Marks	Total marks	Max Marks for ESE	Reduced Marks	Time Duration for ESE
Core Subjects	4	40	60	100	100	60	3 Hrs
Department Electives	4	40	60	100	100	60	3 Hrs
Open Electives	3	40	60	100	60	60	2 Hrs
Practical	2	25	25	50	25	25	3 Hrs

Title	Credits	Max marks	Written	MCQ	Total time
Core and Department Electives	4	100	80	20	3 Hrs
Core and Department Electives	4	100	100	-	3 Hrs
OE	3	60	60	-	2 Hrs
OE	3	60		60	1 ½ Hrs

INTERNAL ASSESSMENT FORMAT

THEORY:

1. First Activity (should be multiple activities)	10 marks
2. Mid Semester Test (Test will be for 50 marks. It will be converted to 20)	20 marks
3. Second Activity (should be multiple activities)	10 marks
Total	40 marks

PRACTICAL:

Every practical class the student should be assessed.
PIA 25 marks

Syllabus for B.A./B.Sc. with Mathematics as Major Subject & B.A./B.Sc. (Honours)
Mathematics

SEMESTER– I

MT121: Mathematics-I	
Teaching Hours: 4 Hours / Week	Credits: 4
Total Teaching Hours: 56 Hours	Max. Marks: 100 (S.A: 60 + I.A: 40)

Course Learning Outcomes: This course will enable the students to

- Find the rank of a matrix.
- Solve the system of homogeneous and non-homogeneous linear equations in 'n' variables by using concept of rank of matrix, finding eigenvalues and eigenvectors.
- Familiarize with the techniques of finding n^{th} derivatives of standard functions.
- Identify and apply the intermediate value theorems and L'hospital's rule.
- Differentiate partially along with its applications.

Algebra-I

Unit-I: Matrices

Recapitulation of Symmetric and Skew Symmetric matrices, Algebra of Matrices; Row and column reduction to Echelon form. Rank of a matrix; Finding rank of a matrix by reducing to row reduced echelon form and normal form; Solution of system of linear equations; Criteria for existence of non-trivial solutions of homogeneous system of linear equations. Solution of non-homogeneous system of linear equations. Eigenvalues and Eigenvectors of square matrices, standard properties; Cayley-Hamilton theorem and its applications. **14 Hours**

Calculus-I

Unit-II:

Limits, Continuity, Differentiability and Properties of continuous functions. n^{th} Derivatives of Standard functions e^{ax+b} , $(ax+b)^n$, $\log(ax+b)$, $\sin(ax+b)$, $\cos(ax+b)$, $e^{ax}\sin(bx+c)$, $e^{ax}\cos(bx+c)$. Leibnitz theorem and its applications. **14 Hours**

Unit-III:

Intermediate value theorem, Rolle's Theorem, Lagrange's Mean Value theorem, Cauchy's Mean value theorem and examples. Taylor's theorem, Maclaurin's series, Indeterminate forms and evaluation of limits using L'hospital's rule. **14 Hours**

Unit-IV: Partial Differentiation

Functions of two or more variables - explicit and implicit functions, partial derivatives. Homogeneous functions- Euler's theorem, total derivatives, differentiation of implicit and composite functions, Jacobians and standard properties and illustrative examples. Taylor's and Maclaurin's series for functions of two variables, Maxima-Minima of functions of two variables. **14 Hours**

Reference Books:

1. N.S. Gopala Krishnan. *University Algebra*, New Age International (P) Limited.
2. B S Vatsa, *Theory of Matrices*, New Age International Publishers.
3. A R Vasista, *Matrices*, Krishna Prakashan Media.
4. R. K. Ghosh, K. C. Maity, *An Introduction to Analysis Differential Calculus Part - I*, 13th Edition, New Central Book Agency Pvt. Ltd., 2018.
5. S. Bandyopadhyay, S. K. Maity, *Application of Calculus Theory and Problems*, 4th Edition, Academic Publishers, 2019.
6. Shanti Narayan, *Differential Calculus*, S. Chand & Company, New Delhi.
7. Debasish Sengupta, *Applications of Calculus*, Books and Allied (P) Ltd., 2019.
8. Lipman Bers, *Calculus*, Holt, Rinehart & Winston.
9. S Narayanan & T. K. Manicavachogam Pillay, *Calculus – Volume I and II*, S.Viswanathan (Printers & Publishers) Pvt Limited.
10. Frank Ayres and Elliott Mendelson, *Schaum's Outline of Calculus*, 5th ed. USA, Tata McGraw - Hill.

Blueprint

	Unit-I	Unit-II	Unit-III	Unit-IV	Number of Questions to be answered	Total
2 Marks	3	3	3	3	10/12	20
5 Marks	4/6	4/6	4/6	4/6	16/24	80

MT1P1: Mathematics Practical-I	
Practical Hours: 4 Hours/Week	Credits: 2
Total Practical Hours: 44 Hours	Marks: 50 (S.A.-25+ I.A.-25)

Course Learning Outcomes: This course will enable the students to

- Learn Free and Open-Source Software(FOSS) tools for computer programming
- Solve problems on algebra and calculus theory studied in MT121 by using FOSS
- Acquire knowledge of applications of algebra and calculus through FOSS

Practical / Lab Work to be performed in Computer Lab (FOSS)

Suggested Software:

Python. Introduction to the software and commands related to the topic.

Practical-I

1. Basics of software with simple examples.
2. Matrices–Algebra of Matrices with problems.
3. Computation of rank of a matrix by row reduced echelon form and normal form.
4. Solving the system of homogeneous and non-homogeneous linear equations.
5. Computation of inverse of a matrix using Cayley-Hamilton theorem.
6. A) Finding the n^{th} derivatives of functions without Leibnitz theorem.
B) Finding the n^{th} derivatives of functions with Leibnitz theorem.
7. Partial Differentiation of some standard functions and Jacobians.
8. A) Verification of Euler’s theorem with examples.
B) Finding the Taylor’s and Maclaurin’s expansion of the given function.
9. Indeterminate forms and evaluation of limits using L’hospital's rule.
10. Finding the maxima and minima of functions of two variables.

Note: Each problem given in the Lab Manual has to be solved manually.

Open Elective-1

MTOE-1: Business Mathematics	
Teaching Hours: 3 Hours/Week	Credits:3
Total Teaching Hours: 42 Hours	Max.Marks:100 (S.A.-60+ I.A.-40)

Course Learning Outcomes: This course will enable the students to

- Translate the real-world problems through appropriate Mathematical modelling.
- Explain the concepts and use equations, formulae and Mathematical expressions and relationships in various contexts.
- Analyse and demonstrate the mathematical skills required in Mathematically intensive areas in economics and business problems.

Unit-I: Algebra

Simple Linear Equations, Quadratic Equations, simultaneous equations in 2 variables, application problems. **14 Hours**

Unit - II: Matrices

Definition of a matrix, types of matrices and algebra of matrices. Calculation of values of determinants up to third order, Adjoint and inverse of a square matrix, solution of a system of linear equations having unique solution and involving not more than three variables. Examples on Commercial Mathematics. **14 Hours**

Unit - III: Percentage, Ratio & Proportions

Percentage-Definition, Calculation of percentage, Ratios - Types of Ratios - Duplicate, Triplicate & Sub-duplicate of a ratio. Proportions -Definition & properties - cross product property & reciprocal property, united proportions - continued proportion - compound proportions, Examples on Commercial Mathematics. **14 Hours**

Reference Books:

1. Allel R.G.A, *Basic Mathematics*, Macmillan, New Delhi.
2. Dowling, E.T., *Schaum's Series: Mathematics for Economics*, McGraw Hill, London.
3. Vohra, N.D., *Quantitative Techniques in Management*, Tata McGraw Hill, New Delhi.
4. Soni R.S., *Business Mathematics*, Pitamber Publishing House, Delhi
5. Edward T. Downling, *Schaum's Outline Series: Introduction to Mathematical Economics*, McGraw-Hill, New York.

Blueprint

	Unit-I	Unit-II	Unit-III	Number of Questions to be answered	Total
2 Marks	4	4	4	10/12	20
5 Marks	2/3	3/5	3/5	8/13	40

Open Elective -2

MTOE -2: Quantitative Methods for Competitive Examinations	
Teaching Hours : 3 Hours/Week	Credits: 3
Total Teaching Hours: 42 Hours	Max.Marks:100 (S.A.-60+I.A.-40)

Course Learning Outcomes: This course will enable the students to

- Demonstrate procedural fluency with real number arithmetic operations and use those operations to represent real-world scenarios
- Solve linear equations, graph and interpret linear models, and read and apply formulas
- Demonstrate a basic understanding of displays of univariate data graphically, including appropriate labelling
- Applications of simple formulae to various elementary concepts and provide acquaintance to shortcut methods
- Improve and learn basic mathematics skills
- Familiarise themselves with mathematics required for various competitive examinations like MAT, CAT, GMAT, GRE, UPSC, SSE, Bank Exams etc.

UNIT- I: Arithmetic

Decimals – Exponents and Roots – Fractions – Integers – Number Series – Percent – Profit & Loss – Ratio & Proportion : Rule of Mixture – Problems on Ages – Partnership – Simple interest – Compound interest – Solved problems. **14 Hours**

UNIT-II: Algebra & Data Analysis

Functions – Graphs of Functions, Operations with Algebraic Expressions, Rules of Exponents, Solving Linear Equations – Solving Linear Inequalities – Solving Quadratic Equations – Permutation & Combinations – Solved problems.

Counting Methods, Data Interpretation Examples, Distributions of Data, Random Variables and Probability Distributions – Graphical Methods for Describing Data– Solved problems. **14 Hours**

UNIT-III: Geometry

Circles – Lines and Angles – Polygons – Quadrilaterals – Three-Dimensional Figures – Triangles: Congruency of Triangles, Similarity of Triangles – Coordinate Geometry– Solved problems. **14 Hours**

Reference Books:

1. R.S. Aggarwal, *Quantitative Aptitude for Competitive Examinations (Fully Solved)*,
2. Ira K. Wolf, Sharon Weiner Green. *Barron's New GRE*, 19th Edition, Barron's Educational Series, 2011.
3. H S Hall, S R Knight, *Higher Algebra*, Arihant Publications.
4. Abhijit Guha, *Quantitative Aptitude for Competitive Examination*, McGraw Hill Education Series, 5th Edition.
5. Rakesh Yadav, *Advanced Maths for General Competitions*, KD Publication (2016)

Blueprint

	Unit-I	Unit-II	Unit-III	Number of Questions to be answered	Total
MCQ (1 Marks)	20	20	20	60/60	60

SEMESTER– II

MT221:Mathematics - II	
Teaching Hours: 4 Hours/Week	Credits: 4
Total Teaching Hours: 56 Hours	Max.Marks: 100 (S.A.-60+I.A.-40)

Course Learning Outcomes: This course will enable the students to

- Familiarise with algebraic structures.
- Link the fundamental concepts of groups and symmetries of geometrical objects.
- Understand the application of differentiation.
- Find the extreme values of functions of two variables.
- Understand the concept of differential equation and its application.

Algebra-II

Unit-I: Groups-I

Definition of a group with examples and properties, congruence, problems. Subgroups, centre of groups, order of an element of a group and its related theorems, cyclic groups. **14 Hours**

Calculus-II

Unit-II: Integral Calculus

Recapitulation of definite integrals and its properties. Reduction formulae - $\int \sin^n x dx$, $\int \cos^n x dx$, $\int \sin^m x \cos^n x dx$ with limits, problems, computation of length of an arc, Area of plane curves, surface area and volume of revolution in Cartesian and polar forms. **14 Hours**

Unit-III : Polar Co-ordinates

Polar coordinates, angle between the radius vector and tangent. Angle of intersection of two curves (polar forms), length of perpendicular from pole to the tangent, pedal equations. Derivative of an arc in Cartesian, parametric and polar forms, curvature of plane curve-radius of curvature formula in Cartesian, parametric and polar and pedal forms-centre of curvature, asymptotes, evolutes and envelops. **14 Hours**

Unit-IV: Differential Equations-I

Recapitulation of Solutions of ordinary differential equations of first order and first degree. Formation of differential equations. Solutions of: Linear equations, Bernoulli's equation, Exact equations, reducible to Exact Equations of first order and higher degree. Applications of first order differential equations. Orthogonal trajectories in Cartesian and polar forms. **14 Hours**

Reference Books:

1. J. A. Gallian, *Contemporary Abstract Algebra*, 4th Edition, Narosa Publishing, 2011.
2. Bernard & Child, *Higher Algebra*, Arihant, ISBN: 9350943199/ 9789350943199.
3. Sharma and Vasista, *Modern Algebra*, Krishna Prakashan Mandir, Meerut, U.P.
4. S. K. Mapa, *Higher Algebra Abstract & Linear*, 14th Edition, Levant Books, 2019.
5. R. K. Ghosh K. C. Maity, *An Introduction to Analysis Differential Calculus Part - I*, 13th Edition, New Central Book Agency Pvt. Ltd., 2018.
6. S. Bandyopadhyay, S. K. Maity, *Application of Calculus Theory and Problems*, 4th Edition, Academic Publishers, 2019.
7. Shanti Narayan, *Differential Calculus*, S. Chand & Company, New Delhi.
8. Shanti Narayan, P K Mittal, *Integral Calculus*, S. Chand and Co. Pvt. Ltd.,
9. Frank Ayres and Elliott Mendelson, *Schaum's Outline Series of Calculus*, 5th ed. USA: Tata McGraw-Hill., 2008.
10. S C Malik, *Mathematical Analysis*, Wiley Eastern.
11. Vijay K Khanna, S K Bhambri, *A Course in Abstract Algebra*, Vikas Publications.
12. V. Sundarapandian, *Ordinary and Partial Differential Equations with Laplace Transforms, Fourier Series and Applications*, Tata McGraw Hill Education Pvt., Ltd., 2013.
13. G. F. Simmons, *Differential Equation with Applications and Historical Notes*, 2nd Edition, McGraw-Hill Publishing Company, 1991
14. M. D. Raisinghania, *Ordinary and Partial Differential Equations*, S Chand and Co. Pvt. Ltd., 2014.

Blueprint

	Unit-I	Unit-II	Unit-III	Unit-IV	Number of Questions to be answered	Total
2 Marks	3	3	3	3	10/12	20
5 Marks	4/6	4/6	4/6	4/6	16/24	80

PRACTICAL

MT2P1:Mathematics Practical - II	
Practical Hours: 4Hours/Week	Credits: 2
Total Practical Hours:44Hours	Max.Marks:50 (S.A.-25+I.A.-25)

Course Learning Outcomes: This course will enable the students to

- Learn Free and Open-Source Software(FOSS) tools for computer programming
- Solve problems on algebra and calculus by using FOSS.
- Acquire knowledge of applications of algebra and calculus through FOSS

Practical/Lab Work to be performed in Computer Lab.

Suggested Software:

Python. Introduction to the software and commands related to the topic.

Practical -II

1. Constructing Cayley's table and testing commutativity for a given finite set.
2. A) Checking whether a given subset is a subgroup or not.
B) Finding the generator of a group.
3. Solving problems using reduction formulae.
4. Finding the angle between the radius vector and tangent.
5. A) Finding the angle between two curves.
B) Finding the arc length of a curve.
6. Tracing of standard curves in Cartesian, polar and parametric forms.
7. Computing surface area.
8. Computing volume of revolution.
9. Finding the solution of differential equation and plotting-1
10. Finding the solution of differential equation and plotting-2

Open Elective-3

MTOE -3: Mathematics for Biologists	
Teaching Hours : 3 Hours/Week	Credits: 3
Total Teaching Hours: 42 Hours	Max.Marks:100 (S.A.-60+I.A.-40)

Course Learning Outcomes: This course will equip the students with the necessary mathematical tools to perform computational aspects of Biology, Chemistry and other Natural Science subjects.

UNIT I:

LCM and GCF, Fractions, Addition, subtraction, multiplication and division of fractions, Decimals and percentages. Unitary method. Ratios and proportions. Conversion of units (SI system). Solving system of linear equations and application to balancing chemical equations using matrices. Spatial arrangement of atoms. Coordinate geometry. Understanding basic functions and plotting their graphs: straight line, exponential and logarithmic function etc. Least square method.

14 Hours

Unit II:

Basics of differentiation and integration and simple illustration of them in chemistry and biology.

14 Hours

Unit III:

Permutations and combinations and application to genetic code. Probability theory: calculating the probability of occurrence of biological events. Statistical methods. Frequency distributions. Frequency distribution graphs. Central tendency. Binomial distribution and Normal distribution with examples. Standard deviation and its significance.

14 Hours

Reference books

1. Alan J. Cann, Maths from Scratch for Biologists, Wiley and sons Ltd, 2003.
2. David C Lay, Linear Algebra and its applications, Third edition, Pearson, 2013.
3. Irwin H. Segel, Biochemical Calculations: How to Solve Mathematical Problems in General Biochemistry, 2nd Edition, Wiley (1976)
4. Peter Atkins, Julio de Paula, Physical Chemistry for the Life Sciences, W.H. Freeman & Company (2011)
5. Athel Cornish-Bowden, Basic Mathematics for Biochemists, First Edition, London New York, Chapman and Hall, 1981
6. Peter C. Foster, Easy Mathematics for Biologists, CRC Press (1999)
7. Raymond Chang, Jr. Thoman John W, Physical chemistry for the chemical sciences, University Science Books (2014)
8. Erich Steiner, The Chemistry Maths Book, Second Edition, Oxford University Press

Blueprint

	Unit-I	Unit-II	Unit-III	Number of Questions to be answered	Total
2 Marks	4	4	4	10/12	20
5 Marks	3/5	2/3	3/5	8/13	40

Open Elective-4

MTOE 4: Mathematics for Management Aptitude Tests

Teaching Hours : 3 Hours/Week	Credits: 3
Total Teaching Hours: 42 Hours	Max.Marks:100 (S.A.-60+I.A.-40)

Course Learning Outcomes: This course will enable the students to

- Make sense of problems, develop strategies to find solutions, and persevere in solving them.
- Evaluate the trigonometric functions and determining exact values for some special angles.
- Demonstrate knowledge of several trigonometric identities and use them to verify other identities.
- Use appropriate mathematical and statistical language in oral, written, and graphical forms.
- Solve aptitude papers covering Quantitative Ability, Logical Reasoning and Verbal Ability and Compete in various competitive exams.

UNIT-I: Arithmetic

Time & work – Time, Speed & distance – Work & Wages – Pipes & cisterns –Problems on Trains
– Boats & streams – Race and Skills – Solved Problems. **14 Hours**

Unit-II: Trigonometry

Measurement of Angles - Radian & Degree - Ratios - Identities - Ratios of combined Angles -
Angle of Elevation - Angle of Depression – Solved Problems. **14 Hours**

UNIT-III: Reasoning

Verbal: Series Completion - Coding & Decoding - Direction Sense Test - Logical Venn Diagrams -
Number Ranking and Time sequence Test - Mathematical Operations
Non Verbal: Series - Analytical Reasoning - Figure Matrix. **14 Hours**

Reference Books:

1. Abhijit Guha, *Quantitative Aptitude for Competitive Examination*, McGraw Hill Education Series, 5th Edition.
2. Rakesh Yadav, *Advanced Maths for General Competitions*, KD Publication. (2016)
3. R.S. Aggarwal, *Quantitative Aptitude for Competitive Examinations (Fully Solved)*, S. Chand & Company Ltd.
4. R. S. Aggarwal, *A Modern Approach to Verbal and Non-Verbal Reasoning*, S. Chand & Company Ltd.
5. Rajesh Verma, *Fast Track Objective Arithmetic*, Arihant Publication.

Blueprint

	Unit-I	Unit-II	Unit-III	Number of Questions to be answered	Total
MCQ (1 Marks)	20	20	20	60/60	60