

NATIONAL EDUCATION POLICY 2020 INITIATIVES

A REPORT ON MODEL CURRICULUM CONTENTS FOR

B.A./B.Sc. (Hons) Mathematics,
B.A./B.Sc. with Mathematics as a Major/Minor Subject
&
M.A./M.Sc. Mathematics (One Year)

KARNATAKA STATE HIGHER EDUCATION COUNCIL
30, Prasanna Kumar Block, Bengaluru Central University Campus,
Y Ramachandra Road, Gandhinagara,
Bengaluru, Karnataka - 560009

2021

Preamble

The subject wise expert committee to draft model curriculum contents in Mathematics constituted by the Department of Higher Education, Government of Karnataka, Bangalore vide GO No. ED 260 UNE 2019 (PART-1) DATED 13.08.2021 is pleased to submit its partial report on the syllabus for the First Year (First & Second Semesters) B.A./B.Sc.(Basic/Honors) Mathematics and detailed Course Structure for B.A./B.Sc.(Honors) Mathematics and M.Sc. (One Year) Mathematics.

The committee discussed various models suggested by the Karnataka State Higher Education Council in its joint meetings with the Chairpersons of Board of Studies of all state universities in Karnataka and resolved to adopt Model IIA (*Model Program Structure for the Bachelor of Arts (Basic/Hons.)/ Bachelor of Science (Basic/Hons.)*) for the subjects with practical's with Mathematics as Major/Minor.

To achieve the core objectives of the National Education Policy 2020 it is unanimously resolved to introduce computer based practical's for the Discipline Core (DSC) courses by using Free and Open Source Software's (FOSS) tools for implementation of theory based on DSC courses as it is also suggested by the LOCF committee that the papers may be taught using various Computer Algebra System (CAS) software's such as Mathematica, MATLAB, Maxima and R to strengthen the conceptual understanding and widen up the horizon of students' self-experience. In view of these observations the subject expert committee suggested the software's Python /R / Msxima/ Scilab/ Maple/MatLab/Mathematica for hands on experience of implementation of mathematical concepts in computer based lab.

The expert committee suggests the implementation this curriculum structure in all the Departments of Mathematics in Universities/Colleges in Karnataka.

The subject expert committee designed the Course Learning Outcome (CO) to help the learners to understand the main objectives of studying the courses by

keeping in mind of the Programme outcomes (PO) of the graduate degree with honors in Mathematics or a graduate degree with Mathematics as a major subject.

As the Mathematics subject is a vast with several branches of specializations, it is difficult for every student to learn each branch of Mathematics, even though each paper has its own importance. Hence the subject expert committee suggests number of elective papers (for both Discipline electives and Open Electives) along with Discipline Core Courses. The BoS in Mathematics of universities may include additional electives based on the expertise of their staff and needs of the students'. A student can select elective paper as per her/his needs and interest.

The subject expert committee in Mathematics suggests that the concerned Department/Autonomous Colleges/Universities to encourage their faculty members to include necessary topics in addition to courses suggested by the expert committee.

Composition of Subject Expert Committee in Mathematic

- | | |
|--|-----------------|
| 1. Dr. N. B. Naduvinamani
Professor, Department of Mathematics
Gulbarga University, Kalaburagi | Chairperson |
| 2. Dr. Soner Nandappa D.
Professor, Department of Mathematics
University of Mysore, Mysore. | Member |
| 3. Dr. P.M.Patil
Professor, Department of Mathematics
Karnatak University, Dharwad. | Member |
| 4. Dr. H. G. Nagaraja
Professor, Department of Mathematics
Bangalore University, Bangalore. | Member |
| 5. Dr. Narasinhmurthy S. K.
Professor, Department of Mathematics
Kuvempu University, Shimoga | Member |
| 6. Dr. Patil Mallikarjun B.
Professor, Department of Mathematics
Tumkur University, Tumakuru. | Member |
| 7. Dr. U. S. Mahabaleshwar
Professor, Department of Mathematics
Davangere University, Davangere. | Member |
| 8. Dr. K.V. Prasad
Professor, Department of Mathematics
VSK University, Bellary. | Member |
| 9. Dr. (Smt.) V. S. Shigehalli
Professor, Department of Mathematics
Rani Channamma University, Belagavi. | Member |
| 10. Sri. Sanjay Kumar Pattankar
Associate Professor, Nrupatunga University,
Bangalore. | Member |
| 11. Dr. Christopher R. Bhaskar
Associate Professor, Kittle College, Dharwad. | Member |
| 12. Dr. Rajesh Kanna M. R.
Associate Professor, Sri D. Devaraj Urs GFGC, Hunasur. | Member |
| 13. Smt. Geeta S. Walikar
Associate Professor, GFGC, Kumta. | Member |
| 14. Dr. Venkatesh S. Kulkarni
Associate Professor, NV Degree College,
Kalaburagi. | Member |
| 15. Dr. Tejaswini Bi. Yakkundimath
Special Officer, KSHEC, Bangalore | Member Convener |

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 program the students will be able to :

PO 1	Disciplinary Knowledge : Bachelor 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 study the related areas such as computer science and other allied subjects
PO 2	Communication Skills: Ability to communicate various mathematical concepts effectively using examples and their geometrical visualization. The skills and knowledge gained in this program will lead to the proficiency in analytical reasoning which can be used for modeling and solving of real life problems.
PO 3	Critical thinking and analytical reasoning: The students undergoing this programme acquire ability of critical thinking and logical reasoning and capability of recognizing and distinguishing the various aspects of real life problems.
PO 4	Problem Solving : The Mathematical knowledge gained by the students through this programme develop an ability to analyze the problems, identify and define appropriate computing requirements for its solutions. This programme enhances students overall development and also equip them with mathematical modelling ability, problem solving skills.
PO 5	Research related skills: The completing this programme develop the capability of inquiring about appropriate questions relating to the Mathematical concepts in different areas of Mathematics.
PO 6	Information/digital Literacy: The completion of this programme will enable the learner to use appropriate softwares to solve system of algebraic equation and differential equations.
PO 7	Self – directed learning: The student completing this program will develop an ability of working independently and to make an in-depth study of various notions of Mathematics.
PO 8	Moral and ethical awareness/reasoning: : The student completing this program will develop an ability to identify unethical behavior such as fabrication, falsification or misinterpretation of data and adopting objectives, unbiased and truthful actions in all aspects of life in general and Mathematical studies in particular.
PO 9	Lifelong learning: This programme provides self directed learning and lifelong learning skills. This programme helps the learner to think independently and develop algorithms and computational skills for solving real word problems.
PO 10	Ability to peruse advanced studies and research in pure and applied Mathematical sciences.

Assessment

Weightage for the Assessments (in percentage)

Type of Course	Formative Assessment/ I.A.	Summative Assessment (S.A.)
Theory	30%	70 %
Practical	30%	70 %
Projects	30 %	70 %
Experiential Learning (Internship etc.)	--	--

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

Semester	Course No.	Theory/ Practical	Credits	Paper Title	Marks	
					S.A.	I.A.
I	MATDSC1.1	Theory	4	Algebra - I and Calculus - I	70	30
	MATDSCP1.1	Practical	2	Theory based Practical's on Algebra - I and Calculus - I	35	15
	MATOET1.1	Theory	3	(A) Mathematics – I (B) Business Mathematics – I	70	30
II	MATDSC2.1	Theory	4	Algebra - II and Calculus - II	70	30
	MATDSCP2.1	Practical	2	Theory based Practical's on Algebra - II and Calculus - II	35	15
	MATOET2.1	Theory	3	(A) Mathematics – II (B) Business Mathematics-II	70	30
Exit Option with Certificate						
III	MATDSC3.1	Theory	4	Ordinary Differential Equations and Real Analysis-I	70	30
	MATDSCP3.1	Practical	2	Theory based Practical's on Ordinary Differential Equations and Real Analysis-I	35	15
	MATOET3.1	Theory	3	(A) Ordinary Differential Equations (B) Quantitative Mathematics	70	30
IV	MATDSC4.1	Theory	4	Partial Differential Equations and Integral Transforms	70	30
	MATDSCP4.1	Practical	2	Theory based Practical's on Partial Differential Equations and Integral Transforms	35	15
	MATOET4.1	Theory	3	(A) Partial Differential Equations (B) Mathematical Finance	70	30
Exit Option with Diploma						
V	MATDSC5.1	Theory	3	Real Analysis and Complex Analysis	70	30
	MATDSCP5.1	Practical	2	Theory based Practical's on Real Analysis and Complex Analysis	35	15
	MATDSC5.2	Theory	3	Ring Theory	70	30
	MATDSCP5.2	Practical	2	Theory based Practical's on Ring Theory	35	15
	MATDSET5.1	Theory	3	(A) Vector Calculus (B) Mechanics (C) Mathematical Logic	70	30
VI	MATDSC6.1	Theory	3	Linear Algebra	70	30
	MATDSCP6.1	Practical	2	Theory based Practical's on Linear Algebra	35	15

	MATDSCT6.2	Theory	3	Numerical Analysis	70	30
	MATDSCP6.2	Practical	2	Theory based Practical's on Numerical Analysis	35	15
	MATDSET6.1	Theory	3	(A) Analytical Geometry in 3D (B) Number Theory (C) Special Functions (D) History of Bhâratîya Gaṇita	70	30
Exit Option with Bachelor of Arts, B.A./ Bachelor of Science, B.Sc. Degree						
VII	MATDSCT7.1	Theory	3	Discrete Mathematics	70	30
	MATDSCP7.1	Practical	2	Theory based Practical's on Discrete Mathematics	35	15
	MATDSCT7.2	Theory	3	Advanced Ordinary Differential Equations	70	30
	MATDSCP7.2	Practical	2	Theory based Practical's on Advanced Ordinary Differential Equations	35	15
	MATDSCT7.3	Theory	4	Advanced Analysis	70	30
	MATDSET 7.1	Theory	3	(A) Graph Theory (B) Entire and Meromorphic Functions (C) General Topology (D) Bhâratîya Trikoṇmiti Śâstra	70	30
	MATDSET 7.2	Theory	3	Research Methodology in Mathematics	70	30
VIII	MATDSCT8.1	Theory	4	Advanced Complex Analysis	70	30
	MATDSCT8.2	Theory	4	Advanced Partial Differential Equations	70	30
	MATDSCT8.3	Theory	3	Fuzzy Sets and Fuzzy Systems	70	30
	MATDSET 8.1	Theory	3	(A) Operations Research (B) Lattice theory and Boolean Algebra (C) Mathematical Modelling (D) <i>Aṅkapâśa</i> (Combinatorics)	70	30
	MATDSET 8.2	Research Project	6	Research Project*	140	60
			(3 + 3)	OR Any Two of the following electives (A) Finite Element Methods (B) Cryptography (C) Information Theory and Coding (D) Graph Theory and Networking	OR 70 70	OR 30 30
Award of Bachelor of Arts Honours, B.A. (Hons)/ Bachelor of Science Honours, B.Sc.(Hons) Degree in Mathematics						

One Year M.A./M.Sc. degree in Mathematics (Two Semesters)						
Semester	Course Number	Theory/ Practical	Credits	Title of the Course	S.A.	I.A.
I	PGMATDSCT1.1	Theory	3	C++ Programming for Mathematics	70	30
	PGMATDSCP1.1	Practical	2	Computer Practical's on C++ Programming for Mathematics	35	15
	PGMATDSCT1.2	Theory	3	Computational Numerical Methods	70	30
	PGMATDSCP1.2	Practical	2	Computer Practical's on CNM	35	15
	PGMATDSCT1.3	Theory	4	Functional Analysis	70	30
	PGMATDSET1.1	Theory	3	(A) Fluid Mechanics – I (B) Computational Fluid Mechanics (C) Contact Geometry (D) Fuzzy Topology (E) Ramanujan Theta Function and Continued Fractions	70	30
	PGMATDSET1.2	Theory	3	(A) Advanced Graph Theory (B) Partition Theory (C) Algebraic Number Theory (D) Riemannian Geometry	70	30
II	PGMATDSCT2.1	Theory	4	Measure Theory	70	30
	PGMATDSCT2.2	Theory	4	Differential Geometry	70	30
	PGMATDSCT2.3	Theory	3	Mathematical Methods	70	30
	PGMATDSET2.1	Theory	3	(A) Fluid Mechanics – II (B) Magnetohydrodynamics (C) Finsler Geometry and Relativity (D) Mathematical Modelling	70	30
	PGMATDSET2.2	Project	6	Research Project	140	60

- In lieu of the research Project, two additional elective papers/ Internship may be offered

Abbreviation for MATDSCT1.1 /MATDSCP1.1

MAT – Mathematics ; DSC – Discipline Core; T – Theory/ P – Practical; 1 – First Semester; .1 – Course 1

PGMATDSCT1.1 : PG- Post Graduate ; MAT- Mathematics; DSC- Discipline Core; T- Theory 1 – First Semester; .1 – Course 1

CURRICULUM STRUCTURE FOR UNDERGRADUATE DEGREE PROGRAM

Name of the Degree Program : B.A. / B.Sc. (Honors)

Discipline/Subject : Mathematics

Starting Year of Implementation: 2021-22

PROGRAM ARTICULATION MATRIX

Semester	Course No.	Programme Outcomes that the Course Addresses	Pre-Requisite Course(s)	Pedagogy*	Assessment**
I	MATDSCT1.1	PO 1, PO 2, PO 3	----	MOOC	CLASS TESTS
II	MATDSCT2.1	PO 1, PO 2, PO 3, PO 8	MATDSCT1.1	PROBLEM SOLVING	SEMINAR QUIZ ASSIGNMENT
III	MATDSCT3.1	PO 1, PO 4, PO 7, PO 8	-----	SEMINAR	
IV	MATDSCT4.1	PO 1, PO 4, PO 7, PO 8	MATDSCT3.1	PROJECT BASED LEARNING	
V	MATDSCT5.1	PO 1, PO 2, PO 3, PO 5	----	ASSIGNMENTS	
V	MATDSCT5.2	PO 3, PO 4, PO 7, PO 10	MATDSCT2.1	GROUP DISCUSSION	TERM EXAM END
VI	MATDSCT6.1	PO 6, PO 7, PO 10.	MATDSCT5.2		
VI	MATDSCT6.2	PO 5, PO 8, PO 9, PO 10.	MATDSCT1.1 & MATDSCT2.1		
VII	MATDSCT7.1	PO 3, PO 4, PO 5, PO 7, PO 9.	MATDSCT1.1 & MATDSCT2.1		
VII	MATDSCT7.2	PO 2, PO 4, PO 5, PO 10	MATDSCT3.1		VIVA-VOCE
VII	MATDSCT7.3	PO 2, PO 4, PO 5, PO 10	MATDSCT3.1		
VIII	MATDSCT8.1	PO 2, PO 4, PO 5, PO 10	MATDSCT5.1		
VIII	MATDSCT8.2	PO 2, PO 4, PO 5, PO 10	MATDSCT4.1		
VIII	MATDSCT8.3	PO 2, PO 4, PO 5, PO 10	MATDSCT7.3		

** Pedagogy for student engagement is predominantly Lecture. However, other pedagogies enhancing better student engagement to be recommended for each course. This list includes active learning/ course projects / Problem based or Project based Learning / Case Studies / Self Study like Seminar, Term Paper or MOOC.

*** Every Course needs to include assessment for higher order thinking skills (Applying/ / Evaluating / Creating). However, this column may contain alternate assessment methods that help formative assessment (i.e. assessment for Learning).

B.A./B.Sc. with Mathematics as a Minor in the 3rd Year

Semester	Course No.	Theory/ Practical	Credits	Paper Title	Marks	
					S.A.	I.A.
V	MATDSCMT5.1	Theory	3	Complex Analysis	70	30
	MATDSCMP5.1	Practical	2	Theory based Practical's on Complex Analysis	35	15
VI	MATDSCMT6.1	Theory	3	Numerical Analysis	70	30
	MATDSCMP6.1	Practical	2	Theory based Practical's on Numerical Analysis	35	15

Abbreviation for MATDSCMT5.1 / MATDSCMP5.1

MAT – Mathematics; DSC – Discipline Core; M – Minor; T – Theory /P – Practical;
5 – Fifth Semester; .1 – Course 1

**Credit Distribution for B.A./B.Sc.(Honors) with Mathematics as
Major in the 3rd Year
(For Model IIA)**

Subject	Semester	Major/ Minor in the 3 rd Year	Credits					
			Discipline Specific Core (DSC)	Open Elective (OE)	Discipline Specific Elective (DSE)	AECC & Languag es	Skill Enhancement Courses (SEC)	Total Credi ts
Mathematics	I - IV	Major	4 Courses (4+2)x 4=24	4 Courses 3 x 4 = 12	---	(4+4=8) Courses 8x(3+1)= 32	2 Courses 2x(1+1)= 4	72
Other Subject		Minor	24	--	--	--	--	24
96								
Mathematics	V & VI	Major	4 Courses 4x(3+2)=20	-----	2 Courses 2 x 3 = 06	---	2 Courses 2 x 2 = 4	30
Other Subject		Minor	10	--	--	--	--	10
(96+40)=136								
Mathematics	VII & VIII	Major	2 Courses 2x(3+2)=10 3 Courses 3 x 4 = 12 1 Course 1 x 3 = 3 Total=25	-----	2 Courses 2 x 3 = 6 Res.Meth 1 x 3 = 3 2 Courses 2 x 3 = 6 Total= 15	----	-----	40
Total No. of Courses			14	04	07	08	04	
136+40=176								

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

SEMESTER – I

MATDSCT 1.1: Algebra - I and Calculus - I	
Teaching Hours : 4 Hours/Week	Credits: 4
Total Teaching Hours: 56 Hours	Max. Marks: 100 (S.A.-70 + I.A. – 30)

Course Learning Outcomes: This course will enable the students to

- Learn to solve system of linear equations.
- Solve the system of homogeneous and non homogeneous linear of m equations in n variables by using concept of rank of matrix, finding eigen values and eigen vectors.
- Sketch curves in Cartesian, polar and pedal equations.
- Students will be familiar with the techniques of integration and differentiation of function with real variables.
- Identify and apply the intermediate value theorems and L'Hospital rule.

Unit-I: Matrix: Recapitulation of Symmetric and Skew Symmetric matrices, Cayley-Hamilton theorem, inverse of matrices by Cayley-Hamilton theorem (Without Proof). Algebra of Matrices; Row and column reduction to Echelon form. Rank of a matrix; Inverse of a matrix by elementary operations; 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. Eigen values and Eigen vectors of square matrices, real symmetric matrices and their properties, reduction of such matrices to diagonal form, **14 Hours**

Unit-II: 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- center of curvature, asymptotes, evolutes and envelopes. **14 Hours**

Unit-III: Differential Calculus-I: Limits, Continuity, Differentiability and properties. Properties of continuous functions. 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 rule. **14 Hours**

Unit-IV: Successive Differentiation: 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. Tracing of curves (standard curves) **14 Hours**

Reference Books:

1. University Algebra - N.S. Gopala Krishnan, New Age International (P) Limited
2. Theory of Matrices - B S Vatsa, New Age International Publishers.
3. Matrices - A R Vasista, Krishna Prakashana Mandir.
4. Differential Calculus - Shanti Narayan, S. Chand & Company, New Delhi.
5. Applications of Calculus, Debasish Sengupta, Books and Allied (P) Ltd., 2019.
6. Calculus – Lipman Bers, Holt, Rinehart & Winston.
7. Calculus - S Narayanan & T. K. Manicavachogam Pillay, S. Viswanathan Pvt. Ltd., vol. I & II.
8. Schaum's Outline of Calculus - Frank Ayres and Elliott Mendelson, 5th ed. USA: Mc. Graw.

MATDSCP 1.1: Practical's on Algebra - I and Calculus – I	
Practical Hours : 4 Hours/Week	Credits: 2
Total Practical Hours: 56 Hours	Max. Marks: 50 (S.A.-35 + I.A. – 15)

Course Learning Outcomes: This course will enable the students to

- Learn *Free and Open Source Software (FOSS)* tools for computer programming
- Solve problem on algebra and calculus theory studied in **MATDSCP 1.1** by using FOSS software's.
- Acquire knowledge of applications of algebra and calculus through FOSS

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

Suggested Software's: Maxima/Scilab/Maple/MatLab/Mathematica/Python/R.

Introduction to the software and commands related to the topic.

1. Computation of addition and subtraction of matrices,
2. Computation of Multiplication of matrices.
3. Computation of Trace and Transpose of Matrix
4. Computation of Rank of matrix and Row reduced Echelon form.
5. Computation of Inverse of a Matrix using Cayley-Hamilton theorem.
6. Solving the system of homogeneous and non-homogeneous linear algebraic equations.
7. Finding the nth Derivative of e^{ax} , trigonometric and hyperbolic functions
8. Finding the nth Derivative of algebraic and logarithmic functions.
9. Finding the nth Derivative of $e^{ax} \sin(bx + c)$, $e^{ax} \cos(bx + c)$.
10. Finding the Taylor's and Maclaurin's expansions of the given functions.
11. Finding the angle between the radius vector and tangent.
12. Finding the curvatures of the given curves.
13. Tracing of standard curves

Open Elective Course
(For students of Science stream who have not chosen Mathematics as one of Core subjects)

MATOET 1.1: Mathematics - I	
Teaching Hours : 3 Hours/Week	Credits: 3
Total Teaching Hours: 42 Hours	Max. Marks: 100 (S.A.-70 + I.A. – 30)

Course Learning Outcomes: This course will enable the students to

- Learn to solve system of linear equations.
- Solve the system of homogeneous and non homogeneous m linear equations by using the concept of rank of matrix, finding eigen values and eigen vectors.
- Students will be familiar with the techniques of differentiation of function with real variables.
- Identify and apply the intermediate value theorems and L'Hospital rule.
- Learn to trace some standard curves.

Unit-I: Matrices: Recapitulation of Symmetric and Skew Symmetric matrices, Cayley-Hamilton theorem, inverse of matrices by Cayley-Hamilton theorem (Without Proof). Algebra of Matrices; Row and column reduction, Echelon form. Rank of a matrix; Inverse of a matrix by elementary operations; 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. Eigen values and Eigen vectors of square matrices, real symmetric matrices and their properties, reduction of such matrices to diagonal form, **14 Hours**

Unit-II: Differential Calculus: Limits, Continuity, Differentiability and properties. Intermediate value theorem, Rolle's Theorem, Lagrange's Mean Value theorem, Cauchy's Mean value theorem and examples. Taylor's theorem, Maclaurian's series, Indeterminate forms and examples. **14 Hours**

Unit-III: Successive Differentiation: nth 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. Tracing of curves (standard curves) **14 Hours**

Reference Books:

1. University Algebra - N.S. Gopala Krishnan, New Age International (P) Limited
2. Theory of Matrices - B S Vatsa, New Age International Publishers.
3. Matrices – A. R. Vasista, Krishna Prakashana Mandir.
4. Applications of Calculus, Debasish Sengupta, Books and Allied (P) Ltd., 2019.
5. Differential Calculus - Shanti Narayan, S. Chand & Company, New Delhi.
6. Calculus – Lipman Bers, Holt, Rinehart & Winston.
7. Calculus – S. Narayanan & T. K. Manicavachogam Pillay, S. Viswanathan Pvt. Ltd., vol. I & II.
8. Schaum's Outline of Calculus - Frank Ayres and Elliott Mendelson, 5th ed. USA: Mc. Graw.

Open Elective
(For Students of other than Science Stream)

MATOE 1.1(B): Business Mathematics-I	
Teaching Hours : 3 Hours/Week	Credits: 3
Totat Teaching Hours: 42 Hours	Max. Marks: 100 (S.A.- 70 + I.A. – 30)

Course Learning Outcomes: This course will enable the students to

- Translate the real word problems through appropriate mathematical modellling.
- Explain the concepts and use equations, formulae and mathematical expression and relationship in a variety of context.
- Finding the extreme values of functions.
- Analyze and demonstrate the mathematical skill require in mathematically intensive areas in economics and business.

Unit-I: Algebra – Set theory and simple applications of Venn Diagram, relations, functions, indices, logarithms, permutations and combinations. Examples on commercial mathematics.

14 Hours

Unit - II: Matrices: Definition of a matrix; types of matrices; algebra of matrices. Properties of determinants; calculations of values of determinants upto third order; Adjoint of a matrix, elementary row and column operations; 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: Differential Calculus: Constant and variables, functions, Limits & continuity. Differentiability and Differentiation, partial differentiation, rates as a measure, maxima, minima, Partial Derivatives up to second order; Homogeneity of functions and Euler's Theorem; Total Differentials; Differentiation of implicit function with the help of total differentials, Maxima and Minima; cases of one variable involving second or higher order derivatives; Cases of two variables involving not more than one constraint.

14 Hours

Reference Books:

1. Basic Mathematics, Allel R.G.A, Macmillan, New Delhi.
2. Mathematics for Economics, Dowling, E.T. , Schaum's Series, McGraw Hill, London.
3. Quantitative Techniques in Management, Vohra, N.D., Tata McGraw Hill, New Delhi.
4. Business Mathematics, Soni R.S., Pitamber Publishing House, Delhi

SEMESTER – II

MATDSCT 2.1: Algebra - II and Calculus - II	
Teaching Hours : 4 Hours/Week	Credits: 4
Total Teaching Hours: 56 Hours	Max. Marks: 100 (S.A.-70 + I.A. – 30)

Course Learning Outcomes: This course will enable the students to

- Recognize the mathematical objects called Groups.
- Link the fundamental concepts of groups and symmetries of geometrical objects.
- Explain the significance of the notions of Cosets, normal subgroups and factor groups.
- Understand the concept of differentiation and fundamental theorems in differentiation and various rules.
- Find the extreme values of functions of two variables.

Unit-I: Real Number System: Recapitulation of number system. Countable and uncountable sets, standard theorems. Real line, bounded sets, supremum and infimum of a set, completeness properties of R , Archimedean property of R . Intervals, neighborhood of a point, open sets, closed sets, limit points and Bolzano-Weierstrass theorem (Without proof)

14 hours

Unit-II: Groups: Definition of a group with examples and properties, congruence, problems. Subgroups, center of groups, order of an element of a group and its related theorems, cyclic groups, Coset decomposition, Factor groups, Lagrange's theorem and its consequences. Fermat's theorem and Euler's ϕ function.

14 hours

Unit-III: Partial Derivatives: 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

Unit-IV: Integral Calculus: Recapitulation of definite integrals and its properties. *Line integral:* Definition of line integral and basic properties, examples on evaluation of line integrals. *Double integral:* Definition of Double integrals and its conversion to iterated integrals. Evaluation of double integrals by changing the order of integration and change of variables. Computation of plane surface areas, volume underneath a surface of revolution using double integral. *Triple integral:* Definition of triple integrals and evaluation-change of variables, volume as triple integral. Differentiation under the integral sign by Leibnitz rule.

14 hours

Reference Books:

1. Topics in Algebra, I N Herstein, Wiley Eastern Ltd., New Delhi.
2. Higher algebra, Bernard & Child, Arihant, ISBN: 9350943199/ 9789350943199.
3. Modern Algebra, Sharma and Vasista, Krishna Prakashan Mandir, Meerut, U.P.
4. Differential Calculus, Shanti Narayan, S. Chand & Company, New Delhi.
5. Integral Calculus, Shanti Narayan and P K Mittal, S. Chand and Co. Pvt. Ltd.,
6. Schaum's Outline Series, Frank Ayres and Elliott Mendelson, 5th ed. USA: Mc. Graw Hill., 2008.
7. Mathematical Analysis, S C Malik, Wiley Eastern.
8. A Course in Abstract Algebra, Vijay K Khanna and S K Bhambri, Vikas Publications.
9. Text Book of B.Sc. Mathematics, G K Ranganath, S Chand & Company.

PRACTICAL

MATDSCP 2.1: On Algebra -II and Calculus - II	
Practical Hours : 4 Hours/Week	Credits: 2
Total Practical Hours: 56 Hours	Max. Marks: 50 (S.A.-35 + I.A. – 15)

Course Learning Outcomes: This course will enable the students to

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

Practical/Lab Work to be performed in Computer Lab

Suggested Software's: Maxima/Scilab/Maple/MatLab/Mathematica/Python/R.

1. Program for verification of binary operations.
2. Program to construct Cayley's table and test abelian for given finite set.
3. Program to find all possible cosets of the given finite group.
4. Program to find generators and corresponding possible subgroups of a cyclic group.
5. Programs to verification of Lagrange's theorem with suitable examples.
6. Program to verify the Euler's ϕ function for a given finite group.
7. Program to
8. Program to verify the Euler's theorem and its extension.
9. Programs to construct series using Maclaurin's expansion for functions of two variables.
10. Program to evaluate the line integrals with constant and variable limits.
11. Program to evaluate the Double integrals with constant and variable limits.
12. Program to evaluate the Triple integrals with constant and variable limits.

Open Elective

(For students of Science stream who have not chosen Mathematics as one of the Core subjects)

MATOET 2.1(A): Mathematics – II	
Teaching Hours : 3 Hours/Week	Credits: 3
Total Teaching Hours: 42 Hours	Max. Marks: 100 (S.A.- 70 + I.A. – 30)

Course Learning Outcomes: This course will enable the students to

- Recognize the mathematical objects called Groups.
- Link the fundamental concepts of groups and symmetries of geometrical objects.
- Explain the significance of the notions of Cosets, normal subgroups and factor groups.
- Understand the concept of differentiation and fundamental theorems in differentiation and various rules.
- Find the extreme values of functions of two variables.
- To understand the concepts of multiple integrals and their applications.

Unit-I: Groups: Definition of a group with examples and properties, congruence, problems. Subgroups, center of groups, order of an element of a group and its related theorems, cyclic groups, Coset decomposition, Factor groups, Lagrange's theorem and its consequences. Fermat's theorem and Euler's ϕ function. **14 hours**

Unit-II: Partial Derivatives: 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**

Unit-III: Integral Calculus: Recapitulation of definite integrals and its properties. *Line integral:* Definition of line integral and basic properties, examples on evaluation of line integrals. *Double integral:* Definition of Double integrals and its conversion to iterated integrals. Evaluation of double integrals by changing the order of integration and change of variables. Computation of plane surface areas, volume underneath a surface of revolution using double integral. *Triple integral:* Definition of triple integrals and evaluation-change of variables, volume as triple integral. Differentiation under the integral sign by Leibnitz rule. **14 hours**

Reference Books:

1. Topics in Algebra, I N Herstein, 2nd Edition, Wiley Eastern Ltd., New Delhi.
2. Higher algebra, Bernard & Child, Arihant Pub.
3. Modern Algebra, Sharma and Vasishta, Krishna Prakashan Mandir, Meerut, U.P.

4. A Course in Abstract Algebra, Vijay K Khanna and S K Bhambri, Vikas Publications.
5. Differential Calculus, Shanti Narayan, S. Chand & Company, New Delhi.
6. Integral Calculus, Shanti Narayan and P K Mittal, S. Chand and Co. Pvt. Ltd.,
7. Schaum's Outline Series, Frank Ayres and Elliott Mendelson, 5th ed. USA: McGraw Hill., 2008.
8. Mathematical Analysis, S C Malik, Wiley Eastern.
9. Text Book of B.Sc. Mathematics, G K Ranganath, S Chand & Company.

Open Elective

(For Students of other than science stream)

MATOET 2.1(B): Business Mathematics-II	
Teaching Hours : 3 Hours/Week	Credits: 3
Total Teaching Hours: 42 Hours	Max. Marks: 100 (S.A.- 70 + I.A. – 30)

Course Learning Outcomes: This course will enable the students to

- Integrate concept in international business concept with functioning of global trade.
- Evaluate the legal, social and economic environment of business.
- Apply decision-support tools to business decision making.
- Will be able to apply knowledge of business concepts and functions in an integrated manner.

Unit - I: Commercial Arithmetic: Interest: Concept of Present value and Future value, Simple interest, Compound interest, Nominal and Effective rate of interest, Examples and Problems Annuity: Ordinary Annuity, Sinking Fund, Annuity due, Present Value and Future Value of Annuity, Equated Monthly Installments (EMI) by Interest of Reducing Balance and Flat Interest methods, Examples and Problems. **14 Hours**

Unit - II: Measures of central Tendency and Dispersion: Frequency distribution: Raw data, attributes and variables, Classification of data, frequency distribution, cumulative frequency distribution, Histogram and give curves. Requisites of ideal measures of central tendency, Arithmetic Mean, Median and Mode for ungrouped and grouped data. Combined mean, Merits and demerits of measures of central tendency, Geometric mean: definition, merits and demerits, Harmonic mean: definition, merits and demerits, Choice of A.M., G.M. and H.M. Concept of dispersion, Measures of dispersion: Range, Variance, Standard deviation (SD) for grouped and ungrouped data, combined SD, Measures of relative dispersion: Coefficient of range, coefficient of variation. Examples and problems. **14 Hours**

Unit - III: Correlation and regression: Concept and types of correlation, Scatter diagram, Interpretation with respect to magnitude and direction of relationship. Karl Pearson's coefficient of correlation for ungrouped data. Spearman's rank correlation coefficient. (with tie and without tie) Concept of regression, Lines of regression for ungrouped data, predictions using lines of regression. Regression coefficients and their properties (without proof). Examples and problems. **14 Hours**

Reference Books:

1. Practical Business Mathematics, S. A. Bari New Literature Publishing Company New Delhi
2. Mathematics for Commerce, K. Selvakumar Notion Press Chennai
3. Business Mathematics with Applications, Dinesh Khattar & S. R. Arora S. Chand Publishing New Delhi
4. Business Mathematics and Statistics, N.G. Das & Dr. J.K. Das McGraw Hill New Delhi
5. Fundamentals of Business Mathematics, M. K. Bhowal, Asian Books Pvt. Ltd New Delhi
6. Mathematics for Economics and Finance: Methods and Modelling, Martin Anthony and Norman, Biggs Cambridge University Press Cambridge
7. Financial Mathematics and its Applications, Ahmad Nazri Wahidudin Ventus Publishing APS Denmark
8. Fundamentals of Mathematical Statistics, Gupta S. C. and Kapoor V. K., Sultan Chand and Sons, New Delhi.
9. Statistical Methods, Gupta S. P.: Sultan Chand and Sons, New Delhi.
10. Applied Statistics, Mukhopadhyaya Parimal New Central Book Agency Pvt. Ltd. Calcutta.
11. Fundamentals of Statistics, Goon A. M., Gupta, M. K. and Dasgupta, B. World Press Calcutta.
12. Fundamentals of Applied Statistics, Gupta S. C. and Kapoor V. K., Sultan Chand and Sons, New Delhi.