NATIONAL EDUCATION POLICY 2020

PROPOSED CURRICULUM FOR

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

TUMKUR UNIVERSITY

VISHVAVIDYANILAYA KARYALAYA,

B. H. ROAD, TUMAKURU – 572103

2022

Composition of Board of Studies in Under Graduate Mathematics, Tumkur University

1. **Prof. Patil Mallikarjun B., Chairman,**

   DoSR Mathematics, Tumkur University, Tumakuru

2. **Sri Harish A., Member,**

   Government First Grade College of Arts, Science and Commerce, Sira

3. **Smt. Sowmya T.S., Member,**

   Government First Grade College, Tiptur

4. **Dr. Vasantha Kumari T.N., Member,**

   Government First Grade College, Tumakuru

5. **Nagendrappa G., Member,**

   Government First Grade College, Koratagere

6. **Dr. Siddaramu R., Member,**

   Smt & Sri Y.E.R. Govt. First Grade College, Pavagada

7. **Dr. Jayaprakasha P C ., Member**
   Government First Grade College for Women's, Tumakuru.

8. **Dr. Narahari N ., Member**

   University College of Science, Tumkur University, Tumakuru.

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

Course : Mathematics

Starting Year of Implementation : 2021-22

Programme Outcomes (PO): By the end of the program the students will be able to:

PO1	**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
PO2	**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 modelling and solving of real life problems.
PO3	**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.
PO4	**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.
PO5	**Research related skills:** Completing this programme develops the capability of inquiring about appropriate questions relating to the Mathematical concepts in different areas of Mathematics.
PO6	**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.
PO7	**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.
PO8	**Moral and ethical awareness/reasoning:** The student completing this program will develop an ability to identify unethical behaviour 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.
PO9	**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.
PO10	Ability to pursue 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	40%	60%
Practical	50%	50%
Projects	50%	50%
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	MATDSCT1.1	Theory	4	Algebra – I and Calculus – I	60	40
	MATDSCP1.1	Practical	2	Theory based Practical's on Algebra – I and Calculus – I	25	25
	MATOET1.1	Theory	2	Mathematics – I	40	20
	MATOEP1.1	Practical	1	Theory based Practical's on Mathematics – I	20	20
	MATOET1.2	Theory	3	Biostatistics	60	40
	MATOET1.3	Theory	3	Quantitative Aptitude	60	40
	MATSECT1.1	Theory	1	Fundamentals of Mathematics – I	15	10
	MATSECP1.1	Practical	1	Theory based Practical's on Fundamentals of Mathematics – I	15	10
	MATSECT1.2	Theory	2	Fundamentals of Logic	30	20
II	MATDSCT2.1	Theory	4	Algebra – II and Calculus – II	60	40
	MATDSCP2.1	Practical	2	Theory based Practical's on Algebra – II and Calculus – II	25	25
	MATOET2.1	Theory	2	Mathematics – II	40	20
	MATOEP2.1	Practical	1	Theory based Practical's on Mathematics – II	20	20
	MATOET2.2	Theory	3	Biomathematics	60	40
	MATOET2.3	Theory	3	Business Mathematics – I	60	40
Exit Option with Certificate						

III	MATDSCT3.1	Theory	4	Ordinary Differential Equations and Real Analysis – I	60	40
	MATDSCP3.1	Practical	2	Theory based Practical's on Ordinary Differential Equations and Real Analysis – I	25	25
	MATOET3.1	Theory	2	Mathematics – III	40	20
	MATOEP3.1	Practical	1	Theory based Practical's on Mathematics – III	20	20
	MATOET3.2	Theory	3	Business Mathematics – II	60	40
	MATOET3.3	Theory	3	Vedic Mathematics	60	40
	MATSECT3.1	Theory	1	Fundamentals of Mathematics – II	15	10
	MATSECP3.1	Practical	1	Theory based Practical's on Fundamentals of Mathematics – II	15	10
	MATSECT3.2	Theory	2	Boolean Algebra	30	20
IV	MATDSCT4.1	Theory	4	Partial Differential Equations and Integral Transforms	60	40
	MATDSCP4.1	Practical	2	Theory based Practical's on Partial Differential Equations and Integral Transforms	25	25
	MATOET4.1	Theory	2	Mathematics – IV	40	20
	MATOEP4.1	Practical	1	Theory based Practical's on Mathematics – IV	20	20
	MATOET4.2	Theory	3	Mathematical Finance	60	40
	MATOET4.3	Theory	3	Mathematics for Social Science	60	40
Exit Option with Diploma						

V	MATDSCT5.1	Theory	3	Real Analysis and Complex Analysis	60	40
	MATDSCP5.1	Practical	2	Theory based Practical's on Real Analysis and Complex Analysis	25	25
	MATDSCT5.2	Theory	3	Ring Theory	60	40
	MATDSCP5.2	Practical	2	Theory based Practical's on Ring Theory	25	25
	MATDSET5.1	Theory	3	(A)Vector Calculus (B) Mechanics (C)Mathematical Logic	60	40
VI	MATDSCT6.1	Theory	3	Linear Algebra	60	40
	MATDSCP6.1	Practical	2	Theory based Practical's on Linear Algebra	25	25
	MATDSCT6.2	Theory	3	Numerical Analysis	60	40
	MATDSCP6.2	Practical	2	Theory based Practical's on Numerical Analysis	25	25
	MATDSET6.1	Theory	3	(A) Analytical Geometry in 3D (B) Number Theory (C) Special Functions (D) History of Bhârtîya Gaṇita	60	40
Exit Option with Bachelor of Arts, B.A./Bachelor of Science, B.Sc. Degree						
VII	MATDSCT7.1	Theory	3	Discrete Mathematics	60	40
	MATDSCP7.1	Practical	2	Theory based Practical's on Discrete Mathematics	25	25
	MATDSCT7.2	Theory	3	Advanced Ordinary Differential Equations	60	40
	MATDSCP7.2	Practical	2	Theory based Practical's on Advanced Ordinary Differential Equations	25	25
	MATDSCT7.3	Theory	4	Advanced Analysis	60	40
	MATDSET7.1	Theory	3	(A)Graph Theory (B)Entire and Meromorphic Functions (C)General Topology (D)Bhâratîya TrikoṇmitiŚâstra	60	40
	MATDSET7.2	Theory	3	Research Methodology in Mathematics	60	40
VIII	MATDSCT8.1	Theory	4	Advanced Complex Analysis	60	40
	MATDSCT8.2	Theory	4	Advanced Partial Differential Equations	60	40
	MATDSCT8.3	Theory	3	Fuzzy Sets and Fuzzy Systems	60	40

	MATDSET8.1	**Theory**	**3**	**(A)Operations Research** **(B)Lattice theory and Boolean Algebra** **(C)Mathematical Modelling** **(D)Aṅkapâśa (Combinatorics)**	**60**	**40**
	MATDSET8.2	**Research Project**	**6 (3 + 3)**	**Research Project*** **OR** **Any Two of the following electives** **(A) Finite Element Methods** **(B) Cryptography** **(C) Information Theory and Coding** **(D) Graph Theory and Networking**	**100** **OR** **60** **60**	**100** **OR** **40** **40**
Award of Bachelor of Arts Honours, B.A.(Hons)/ Bachelor of Science Honours, B.Sc.(Hons) Degree in Mathematics						

CURRICULUM STRUCTURE FOR UNDERGRADUATE DEGREE PROGRAM

Name of the Degree Program :B.A./B.Sc.(Honours)
Discipline/Subject :Mathematics
Starting Year of Implementation: 2021-22

PROGRAMARTICULATIONMATRIX

Semester	Course No.	Programme Outcomes that the Course Addresses	Pre-Requisite Course(s)	Pedagogy*	Assessment**
I	MATDSCT1.1	PO1,PO2,PO3	----	MOOC PROBLEM SOLVING SEMINAR PROJECT BASED LEARNING ASSIGNMENTS GROUP DISCUSSION	CLASS TESTS SEMINAR QUIZ ASSIGNMENT TERM END EXAM VIVA-VOCE
II	MATDSCT2.1	PO1,PO2,PO3, PO8	MATDSCT1.1		
III	MATDSCT3.1	PO1,PO4,PO7, PO8	-----		
IV	MATDSCT4.1	PO1,PO4,PO7, PO8	MATDSCT3.1		
V	MATDSCT5.1	PO1,PO2,PO3, PO5	----		
V	MATDSCT5.2	PO3,PO4,PO7, PO10	MATDSCT2.1		
VI	MATDSCT6.1	PO 6, PO 7, PO 10.	MATDSCT5.2		
VI	MATDSCT6.2	PO5,PO8,PO9, PO10.	MATDSCT1.1 & MATDSCT2.1		
VII	MATDSCT7.1	PO3,PO4,PO5, PO7,PO9.	MATDSCT1.1 & MATDSCT2.1		
VII	MATDSCT7.2	PO2,PO4,PO5, PO10	MATDSCT3.1		
VII	MATDSCT7.3	PO2,PO4,PO5, PO10	MATDSCT3.1		
VIII	MATDSCT8.1	PO2,PO4,PO5, PO10	MATDSCT5.1		
VIII	MATDSCT8.2	PO2,PO4,PO5, PO10	MATDSCT4.1		
VIII	MATDSCT8.3	PO2,PO4,PO5, PO10	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	Semester	Paper Title	Marks	
					S. A.	I. A.
V	MATDSCMT5.1	Theory	3	Complex Analysis	60	40
	MATDSCMP5.1	Practical	2	Theory based Practical's on Complex Analysis	25	25
VI	MATDSCMT6.1	Theory	3	Numerical Analysis	60	40
	MATDSCMP6.1	Practical	2	Theory based Practical's on Numerical Analysis	25	25

Abbreviation for MATDSCMT5.1/ MATDSCMP5.1
MAT– Mathematics; **DSC**– Discipline Core; **M**– Minor; **T**–Theory/**P**–Practical; **5**–Fifth Semester; **.1**–Course1

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 3rd year	Credits					
			Discipline Specific Core (DSC)	Open Elective (OE)	Discipline Specific Elective (DSE)	AECC & Languages	Skill Enhancement Courses (SEC)	Total Credits
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 = 6	---	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.-60 + I.A. – 40)**

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's rule.

Unit-I: Matrix: 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. Cayley-Hamilton theorem, inverse of matrices by Cayley-Hamilton theorem (Without Proof). **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 envelops. **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: 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. 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 Hill.

MATDSCP 1.1: Theory based Practical's on Algebra– I and Calculus – I	
Teaching Hours : 4 Hours/Week	**Credits: 2**
Total Teaching Hours: 56 Hours	**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 theory studied in **MATDSCT 1.1** by using Maxima software.
- Acquire knowledge of applications of algebra and calculus through Maxima.

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

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

Open Elective Course
(with Practical's)

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

MATOET1.1: Mathematics – I	
Teaching Hours : 2 Hours/Week	Credits: 2
Total Teaching Hours: 28 Hours	Max. Marks: 60 (S.A.-40 + I.A.-20)

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.
- 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.
- Learn to trace some standard curves.

Unit-I: Matrix: 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, Cayley-Hamilton theorem, inverse of matrices by Cayley-Hamilton theorem (Without Proof). **14 Hours**

Unit-II: Differential Calculus: Limits, Continuity, Differentiability and properties. Intermediate value theorem, Rolle's Theorem, Lagrange's Mean Value theorem, Taylor's theorem, Maclaurin's series, Indeterminate forms and examples. nth Derivatives of $e^{ax+b}, (ax+b)^n, \sin(ax+b), \cos(ax+b),$ **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 Hill.

MATOEP 1.1: Theory based Practical's on Mathematics – I	
Teaching Hours : 2 Hours/Week	Credits: 1
Total Teaching Hours: 28 Hours	Max. Marks: 40 (S.A.-20 + I.A.-20)

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 **MATOEP 1.1** by using Maxima software.
- Acquire knowledge of applications of algebra and calculus through Maxima.

Practical/Lab Work to be performed in Computer Lab

1. Introduction to the software and commands related to the topic.
2. Computation of addition and subtraction of matrices.
3. Computation of Multiplication of matrices.
4. Computation of Trace, Determinant and Transpose of matrices.
5. Computation of Rank of matrix and Row reduced Echelon form.
6. Computation of Inverse of a matrix.
7. Verification of Cayley-Hamilton theorem.
8. Finding the nth derivative of e^{ax+b}, trigonometric and hyperbolic functions.
9. Finding the Taylor's and Maclaurin's expansions of the given functions.
10. Computation of limits using L'Hospital rule.

Open Elective Course

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

MATOET 1.2: Biostatistics	
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 word problems, in the field of biological sciences, through appropriate mathematical modelling.
- Learn the fundamentals of statistics, data classification and analysis.
- Get an insight into the theory of probability.

Unit-I: Data classification and analysis - Collection, Classification and Tabulation of data, Bar diagrams and Pie diagrams, Histogram, Frequency curve and frequency polygon, Ogives. Mean, Median, Mode, Standard deviation. **14 hours**

Unit-II: Correlation and regression analysis - Relation between two variables, Scatter diagram, Definition of correlations, Curve fitting, Principle of least squares. **14 hours**

Unit-III: Probability theory - Random experiments, Sample space, Probability theory, Conditional probability. Baye's theorem, Probability distributions, Discrete and continuous probability distributions **14 hours**

Reference Books:

1. Fundamentals of Statistics, S. C. Gupta, Himalaya Publishing House, 2018.
2. Statistics, D. Freedman, R. Pisani and R. Purves, Viva Books.
3. Probability and Statistics, J. Schiller, M. R. Spiegel and R. A. Srinivasan, Schaum's Outline Series, 2020.

Open Elective Course

(For students from other streams)

MATOET1.3: Quantitative Aptitude	
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:

- Understand number system and fundamental operations.
- Understand the concept of linear, quadratic and simultaneous equations and their applications in real problems.
- Understand and solve the problems based on Age.
- Solve Speed and Distance related problems.

Unit-I: Number System

Numbers, Operations on Numbers, Tests on Divisibility, HCF and LCM of numbers. Decimal Fractions, Simplification, Square roots and Cube roots – Problems thereon. Surds and Indices. Illustrations thereon. **14 hours**

Unit-II: Theory of Equations

Linear equations, quadratic equations, simultaneous equations in two variables, simple application problems – problems on Age. Problems on conditional Age calculations, Present and Past age calculations. **14 hours**

Unit - III: **Quantitative Aptitude-**Percentage, Average, Average Speed-problems. Time and distance, problems based on trains, problems on-work and time, work and wages, clock and calendar. **14 hours**

ReferenceBooks:

1. Quantitative Aptitude, R.S Aggarwal, S. Chand and Company Limited, New Delhi.
2. Quantitative Aptitude, Abhijit Guha, 5th Edition, Mc.Grawhillpublications.2014.
3. Quantitative Aptitude and Reasoning, R.V Praveen, PHI publishers.
4. Objective Arithmetic, R.S Aggarwal, S. Chand & Company Ltd.
5. Business Mathematics-II, Qazi Zameeruddin, Vijay K Khanna, S. K. Bhambri,
6. Business Mathematics, S. K Sharma and Gurmeet Kaur, Sultan Chand & Sons.

7. A Text Book of Business Mathematics for B.Com and BBA Course, Hazarika Padmalochan, S. Chand Publication.
8. Business Mathematics and Statistics, J.K. Thukral, CBCS
9. Business Mathematics and Statistics, N. G. Das and J. K. Das, Mc Graw Hill Education, 2017.

Skill Enhancement Course (SEC)
(with Practical's)
(For students from other streams)

MATSECT1.1: Fundamentals of Mathematics – I	
Teaching Hours : 1 Hour/Week	**Credits: 1**
Total Teaching Hours: 14 Hours	**Max. Marks: 25 (S.A.-15 + I.A.-10)**

Set Theory: Introduction, Sets and their representations, The Empty set, Finite and Infinite Sets, Equal Sets, Subsets, Power Set, Universal Set, Venn Diagrams, Operations on sets, Complement of a Set, Problems on Union and Intersection of Two Sets, **Trigonometry:** Introduction to trigonometry, Basic trigonometric ratios, Standard Trigonometric Identities, Trigonometric ratios of Allied Angles and Compound angles.

Reference Books:

1. Discrete and combinatorial Mathematics, Ralph P Grimaldi, B V Ramana, Fifth Edition, Pearson
2. Plane Trigonometry Part-I, S L Loney, Arihant Publications
3. The Elements of Set Theory, K K Verma, Deepak Kumar, Aitbs Publishers
4. Set theory and related topics, Seymour Lipschutz , Schaum's Outlines.
5. Trigonometry, Robert Moyer, Frank Ayres , Schaum's Outlines.

MATSECP 1.1: Theory based Practical's on Fundamentals of Mathematics – I	
Teaching Hours : 2 Hours/Week	**Credits: 1**
Total Teaching Hours: 28 Hours	**Max. Marks: 25 (S.A.-15 + I.A.-10)**

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 **MATSECP 1.1** by using Maxima software.
- Acquire knowledge of applications of algebra and calculus through Maxima.

Practical's/ Lab Work to be performed in Computer Lab (Maxima)

1. Introduction to the software and commands related to the topic.
2. Basic operations in Maxima involving numbers.
3. Basic operations in Maxima involving functions.
4. Program to verify whether the given elements form a set or not.
5. Program to check whether the given set is finite set or infinite set, subset and power sets.
6. Program on basic operations on sets – Union, Intersection and Complement of a set.
7. Program to find the trigonometric ratios.
8. Program to verify standard trigonometric identities.
9. Program to find allied angles.
10. Program to find compound angles.
11. Finding the nth Derivative of e^{ax+b}, trigonometric and hyperbolic functions
12. Finding the Taylor's and Maclaurin's expansions of the given functions.

Skill Enhancement Course (SEC)

(For students from Science stream)

MATSECT 1.2: Fundamentals of Logic	
Teaching Hours : 2 Hours/Week	**Credits: 2**
Total Teaching Hours: 28 Hours	**Max. Marks: 50 (S.A.-30+ I.A.-20)**

Unit I:Basics of logic: Propositions and truth values, algebra of propositions, conditional proposition connectives and their truth tables. Converse, inverse and contrapositive of a proposition. **14 hours**

Unit II: Rules of inference: Logical Equivalence, The laws of Logic. Logical Implication: Rules of Inference. Tautology and Contradiction. Methods of proof. **14 hours**

Reference Books:

1. Discrete and Combinatorial Mathematics, Ralph P. Grimaldi, B.V. Ramana, Fifth Edition, Pearson
2. Discrete Mathematical structures, sixth edition, Kolman, Busby, Ross, PHI.
3. Discrete Mathematics and Graph Theory, Purna Chandra Biswal, Third edition, PHI.
4. A Text Book of Discrete Mathematics, Swapan Kumar Sarkar, S. Chand.

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. - 60 + I.A. – 40)

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 value 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 variable-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 function of two variables, Maxima –Minima of function of two variables. **14 hours**

Unit-IV: Integral Calculus: Reduction formulae for $\int \sin^n x\,dx \int \cos^n x\ dx$ (with proof) and the products $\int sin^m x\ \ cos^n x\ dx$(without proof). Line integral: Definition of line integral and basic properties, examples on evaluation of line integral. Definition of Double integral and its conversion to iterated integrals. Evaluation of double integrals by changing the order of integration and change of variable. Computation of plane surface areas, volume underneath a surface of revolution using double 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. Calculus, 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 Publication.
9. Text Book of B.Sc, Mathematics, G.K. Ranganath, S.Chand & Company.

MATDSCP 2.1: Theory based Practical's on Algebra – II and Calculus – II	
Teaching Hours : 4 Hours/Week	**Credits: 2**
Total Teaching Hours: 56 Hours	**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 Maxima software.
- Acquire knowledge of applications of algebra and calculus through Maxima.

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

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 obtain partial derivatives of functions of two and three variables.
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 Course
(with Practical's)

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

MATOET 2.1: Mathematics – II	
Teaching Hours : 2 Hours/Week	Credits: 2
Total Teaching Hours: 28 Hours	Max. Marks: 60 (S.A. - 40+ I.A. - 20)

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: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. **14hours**

Unit-II: Integral Calculus: Line integral: Definition of line integral and basic properties, examples on evaluation of line integrals. Definition of Double integrals and its conversion to iterated integrals. Evaluation of double integrals by changing the order of integration. Computation of plane surface areas. Definition of triple integrals and evaluation-change of variables. **14hours**

Reference Books:

1. Differential Calculus, Shanti Narayan,S. Chand & Company, NewDelhi.
2. Integral Calculus, ShantiNarayan and P K Mittal, S. Chand and Co. Pvt .Ltd.,
3. Calculus, Schaum's Outline Series, Frank Ayres and Elliott Mendelson, 5th ed. USA: Mc.GrawHill., 2008.
4. Mathematical Analysis, S C Malik,WileyEastern.
5. A Course in Abstract Algebra, Vijay K Khanna and S K Bhambri, Vikas publications.
6. Text Book of B.Sc. Mathematics, G K Ranganath, S Chand & Company.

MATOEP 2.1: Theory based Practical's on Mathematics – II	
Teaching Hours : 2 Hours/Week	Credits: 1
Total Teaching Hours: 28 Hours	Max. Marks: 40 (S.A. - 20+ I.A. - 20)

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 Maxima software.
- Acquire knowledge of applications of algebra and calculus through Maxima.

Practical/Lab work to be performed in Computer Lab (Maxima)

1. Program to obtain partial derivatives of functions of two and three variables.
2. Program to verify the Euler's theorem and its extension.
3. Program to find Jacobians of functions two and three variables.
4. Program to construct series using Maclaurin's expansion for function of two variables.
5. Program to evaluate the line integrals with constant and variable limits.
6. Program to evaluate the Double integrals with constant limits.
7. Program to evaluate the Double integrals with variable limits.
8. Program to evaluate the Triple integrals with constant limits.
9. Program to evaluate the Triple integrals with variable limits.
10. Program to evaluate area and volume.

Open Elective Course

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

MATOET 2.2: Biomathematics	
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 word problems, in the field of biological sciences, through appropriate mathematical modelling.
- Learn the applications of difference and differential equations.
- Learn the various techniques of mathematical modelling.

Unit-I: Basics of calculus - Graphs and functions, Derivative of a function, Integral of a function, Techniques of differentiation and integration. **14 hours**

Unit-II: Differential equations - First order ordinary differential equations – Variables separable method, Homogeneous and linear differential equations, Exact and reducible to exact Differential equations, Second order homogeneous ordinary differential equations with constant coefficients. **14 hours**

Unit -III: Mathematical modelling - Introduction to mathematical modelling, Discrete population models, Homogeneous recurrence relations, Fibonacci sequence, Continuous population models, Initial value problems, Equilibrium points, Single species population model, Prey-predator model. **14 hours**

Reference Books:

1. Mathematics for Biological Scientists, M.Aitken, B.Broadhursts, S. Haldky, Garland Science, 2009.
2. Calculus for Life Sciences, R. De Sapio, W. H. Freeman and Co., 1976.
3. Ordinary and Partial Differential Equations, M D Raisinghania, S. Chand, Delhi, 2020.

Open Elective Course

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

MATOET 2.3: Business Mathematics – I	
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:

- Integrate concepts 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 Instalments(EMI) by Interest of Reducing Balance and Flat Interest methods, Examples and Problems. **14 hours**

Unit-II: Ratios and Proportions-*Ratios:* Meaning, Expression of a Ratio as a fraction, Inverse ratio, Duplicate, Triplicate, Compound ratios, Variations, Problems on ratios, *Proportions:* Meaning, Types of Proportions, Direct Proportion, Inverse Proportions, Continued Proportions, Problems on Proportions. **14 hours**

Unit-III: Sequences and logarithms - Basic definition of sequence and series, Examples, Arithmetic progression and Geometric progression, Problems on Arithmetic progression and Geometric progression, Geometric Mean, Logarithm: Definitions, Basic rules, Some problems on logarithm. **14 hours**

Reference Books:

1. Basic Mathematics, Allel R.G.A, Macmillan, New Delhi.
2. Mathematics for Economics, Dowling, E.T., Schaum's Series, Mc Graw 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 – III

MATDSCT3.1: Ordinary Differential Equations and Real Analysis – 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:

- Solve first-order non-linear differential equations and linear differential equations.
- To model problems in nature using Ordinary Differential Equations.
- Formulate differential equations for various mathematical models.
- Apply these techniques to solve and analyze various mathematical models.
- Understand the fundamental properties of the real numbers that lead to define sequence and series, the formal development of real analysis.
- Learn the concept of Convergence and Divergence of a sequence.
- Able to handle and understand limits and their use in sequences, series, differentiation and integration.
- Apply the ratio, root, alternating series, and limit comparison tests for convergence and absolute convergence of an infinite series.

Unit I: Exact Differential equations, Necessary and sufficient condition for the equations to be exact, Reducible to the exact differential equations. Differential equations of the first order and higher degree: Equations solvable for p, x, y. Clairaut's equation and singular solution. Orthogonal trajectories of Cartesian and polar curves. **14 hours**

Unit II: Linear differential equations of the n^{th} order with constant coefficients. Particular Integrals when the RHS is of the form e^{ax}, $\sin(ax+b)$, $\cos(ax+b)$, x^n, e^{ax} V and x V (with proofs), where V is a function of x. Cauchy – Euler equations, Legendre differential equations, Method of variation of parameters. Simultaneous differential equations with two and more than two variables. Condition for integrability of total differential equations $Pdx+Qdy+Rdz=0$. **14 hours**

Unit III: Sequences: Sequences of real numbers, Bounded sequences. Limit of a sequence. convergent, divergent, and oscillatory sequences. Monotonic sequences. Algebra of convergent sequences. Limit points of a sequence. Bolzano Weierstrass theorem for sequence. Limit superior and limit inferior of sequences. Cauchy's first and second theorem on limits of a sequence. **14 hours**

Unit IV: Infinite Series: Definition of convergent, divergent and oscillatory series. Series of non-negative terms, Cauchy's general principle of convergence. Geometric series, P-series(Harmonic series). Comparison tests for positive term series. D'Alembert's ratio test, Raabe's test. Cauchy's Root test and Cauchy's integral test. Alternating series. Leibnitz's theorem. Absolute convergence and conditional convergence of a series. Summation of series: Binomial, exponential and logarithmic. **14 hours**

Reference Books:

1. Ordinary Differential Equations & Partial Differential Equations, M. D. Raisinghania, S. Chand & Company, New Delhi.
2. A course of Ordinary and Partial Differential Equation, J. Sinha Roy and S Padhy, Kalyani Publishers, New Delhi.
3. Introductory Course in Differential Equations, D. Murray, Orient Longman (India)
4. Ordinary Differential Equations, W. T. Reid, John Wiley, New Delhi.
5. Differential Equations, M. L. Khanna, Jai Prakash Nath & Co.Meerut.
6. Differential Equations, S. L. Ross, 3rd Ed., John Wiley and Sons, 1984.
7. Introduction to Real Analysis, R. G. Bartle and D. R. Sherbert, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2015.
8. An Introduction to Analysis, Gerald G. Bilodeau, Paul R. Thie, G. E. Keough, 2nd Ed., Jones & Bartlett, 2010.
9. Elementary Analysis: The Theory of Calculus(2nd edition), K. A. Ross, Springer, 2013
10. A First Course in Real Analysis, S. K. Berberian, Springer Verlag, New York, 1994.
11. Mathematical Analysis, T. Apostol, Narosa Publishing House.
12. Real Analysis, M. L. Khanna and L. S. Varhiney, Jai Prakash Nath & Co. Meerut.
13. Advanced Engineering Mathematics, Kreyzig, John Wiley, New Delhi.

MATDSCP3.1: Theory based Practical's on Ordinary Differential Equations and Real Analysis –I	
Teaching Hours : 4 Hours/Week	**Credits: 2**
Total Teaching Hours: 56 Hours	**Max. Marks: 50** **(S.A. - 25 + I.A. - 25)**

Course Learning Outcomes: This course will enable the students to gain hands on experience of

- Free and Open Source software (FOSS) tools or computer programming.
- Solving exact differential equations.
- Plotting orthogonal trajectories.
- Finding complementary function and particular integral of linear and homogeneous differential equations.
- Acquire knowledge of applications of real analysis and differential equations.
- Verification of convergence/divergence of different types of series.

Practical's/Lab Work to be performed in Computer Lab (Maxima)

1. Fundamentals of Ordinary differential equations and Real analysis using Maxima
2. Verification of exactness of a differential equation.
3. Solution of differential equations that are solvable for x, y, p.
4. To find the singular solution by using Clairaut's form.
5. Finding the Complementary Function and Particular Integral of linear and homogeneous differential equations with constant coefficients and plotting the solutions.
6. Finding the Particular Integral of differential equations up to second order and plot the solutions.
7. Solutions to the Total and Simultaneous differential equations and plotting the solutions.
8. Test the convergence of sequences.
9. Verification of exponential, logarithmic and binomial series.
10. Verification of geometric series, p- series, Cauchy's Integral test, root test and D'Alembert's Test
11. Examples on a series of positive terms.
12. Examples on alternating series using Leibnitz's theorem.
13. Finding the convergence of series using Cauchy's criterion for partial sums.

Open Elective Course
(with Practical's)

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

MATOET 3.1: Mathematics – III	
Teaching Hours : 2 Hours/Week	**Credits: 2**
Total Teaching Hours: 28 Hours	**Max. Marks: 60** **(S.A. - 40+ I.A. - 20)**

Course Learning Outcomes: This course will enable the students to:

- Understand the concept of the differential equations and their classification
- Know the meaning of the solution of a differential equation.
- To solve first-order ordinary differential equations.
- To solve exact differential equations and convert to separable and homogenous equations to exact differential equations by integrating factors.
- To solve Bernoulli differential equations.
- To find the solution to higher-order linear differential equations.

Unit I: Exact Differential equations, Necessary and sufficient condition for the equations to be exact, Reducible to the exact differential equations. Differential equations of the first order and higher degree: Equations solvable for p, x, y. Clairaut's equation and singular solution. **14 hours**

Unit II: Linear differential equations of the nth order with constant coefficients. Particular Integrals when the RHS is of the form e^{ax}, $\sin(ax+b)$, $\cos(ax+b)$, x^n, $e^{ax}V$ and xV(with proofs),where V is a function of x. **14 hours**

Reference Books:

1. Ordinary Differential Equations & Partial Differential Equations, M. D. Raisinghania, S. Chand & Company, New Delhi.
2. A Course of Ordinary and Partial Differential Equation, J. Sinha Roy and S. Padhy, Kalyani Publishers, New Delhi.
3. Introductory Course in Differential Equations, D Murray, Orient Longman (India)
4. Ordinary Differential Equations, W T Reid, John Wiley, New Delhi.
5. Differential Equations, M. L. Khanna, Jai Prakash Nath & Co., Meerut.
6. Differential Equations, Shepley L. Ross, 3rdEd., John Wiley and Sons,1984.

MATOEP 3.1: Theory based Practical's on Mathematics – III	
Teaching Hours : 2 Hours/Week	**Credits: 1**
Total Teaching Hours: 28 Hours	**Max. Marks: 40** **(S.A. - 20 + I.A. - 20)**

Course Learning Outcomes: This course will enable the students to gain hands on experience of

- Free and Open Source software (FOSS) tools or computer programming.
- Solving exact differential equations
- Plotting orthogonal trajectories
- Finding complementary function and particular integral of linear and homogeneous differential equations.
- Acquire knowledge of applications of real analysis and differential equations.
- Verification of convergence/divergence of different types of series.

Practical's/Lab Work to be performed in Computer Lab (Maxima)

1. Fundamentals of Ordinary differential equations and Real analysis using Maxima.
2. Verification of exactness of a differential equation.
3. Solutions of differential equations in exact form.
4. Solutions of differential equations reducible to exact form.
5. Solutions of differential equations that are solvable for x, y, p.
6. To find the singular solution by using Clairaut's form.
7. Finding the Complementary Function of linear and homogeneous differential equations with constant coefficients and plotting the solutions.
8. Finding the Particular Integral of differential equations up to second order and when RHS is of the form e^{ax}, x^n.
9. Finding the Particular Integral of differential equations up to second order and when RHS is of the form sin(ax+b), cos(ax+b).
10. Finding the Particular Integral of differential equations up to second order and when RHS is of the form $e^{ax}V$, xV.

Open Elective Course
(For Students of other than Science Stream)

MATOET3.2 : Business Mathematics – II	
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 word problems through appropriate mathematical modelling.
- 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: Matrices- Definition of a matrix; types of matrices; algebra of matrices. Properties of determinants; calculations of values of determinants up to 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. **14 hours**

Unit-II: Algebra– Set theory and simple applications of Venn Diagram, relations, functions, indices, logarithms, permutations and combinations. **14 hours**

Unit - III: Fundamentals of Commercial Mathematics- Ratio and Proportion, Properties of Proportions , Percentage, Computations involving percentage, Applications of percentage, Simple and Compound interest, Statistical representation of data – Frequency distribution, Histogram, Frequency Polygon, PieChart, Bar Chart, Mean, Median and Mode, Deviation. **14 hours**

Reference Books:

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

Open Elective Course
(For Students of other than Science Stream)

MATOET3.3 : Vedic Mathematics	
Teaching Hours : 3 Hours/Week	**Credits: 3**
Total Teaching Hours: 42 Hours	**Max. Marks:100** **(S.A. - 60+ I.A. - 40)**

Course Outcomes: This course will enable the students to:

- Understand the vedic methods of arithmetic.
- Understand the vedic methods of division with two/three digit divisor.
- Understand the vedic methods of power and root power of two digit numbers.

Unit-I: Multiplication:

1. Ekadhikenpurven method(multiplication of two numbers of two digits).
2. Eknunenpurven method(multiplication of two numbers of three digits).
3. Urdhvatiragbhyam method(multiplication of two numbers of three digits).
4. Nikhilam Navtashchramam Dashtaha(multiplication of two numbers of three digits).
5. Combined Operations. **14 Hours**

Unit-II: Division and Divisibility

Part A: Division

1. Nikhilam Navtashchramam Dashtaha (two digits divisor)
2. Paravartya Yojyet method(three digits divisor)

Part B: Divisibility

3. Ekadhikenpurven method(two digits divisor)
4. Eknunenpurven method(two digits divisor) **14 Hours**

Unit-III: Power and Root Power: Square(two digit numbers), Cube(two digit numbers). **Root:** Square root(four digit number), Cube root(six digit numbers), Solution of linear simultaneous equations. **14 Hours**

Reference Books:

1. Vedic Mathematics, Motilal Banarsi Das, New Delhi.
2. Vedic Ganita: Vihangama Drishti-1, Siksha Sanskriti Uthana Nyasa, New Delhi.
3. Vedic Ganita Praneta, Siksha Sanskriti Uthana Nyasa, New Delhi.
4. Vedic Mathematics: Past, Present and Future, Siksha Sanskriti Uthana Nyasa, New Delhi.
5. Leelavati, Chokhambba VidyaBhavan, Varanasi.
6. Bharatiya Mathematicians, Sharda Sanskrit Sansthan, Varanasi.

Skill Enhancement Course (SEC)
(with Practical's)
(For students from other streams)

MATSECT 3.1: Fundamentals of Mathematics – II	
Teaching Hours : 1 Hour/Week	Credits: 1
Total Teaching Hours: 14 Hours	Max. Marks: 25 (S.A.-15+ I.A.-10)

Theory of Equations: Introduction and definition of Equation, Degrees of the equation, Types of Equations, Linear Equations in one variable, Simultaneous Linear Equations in two variables and different methods, Quadratic Equations and its solution, Nature of the roots of Quadratic equations, Cubic Equations-Examples and solution, synthetic division.
Matrices: Introduction, Matrix, Types of Matrices, Operations on matrices, Transpose of a Matrix, Symmetric and Skew Symmetric Matrices, Elementary Operation (Transformation) of a Matrix, Invertible Matrices. **14 Hours**

Reference Books:

1. Discrete and combinatorial Mathematics, Fifth Edition, Ralph P Grimaldi, B V Ramana, Pearson
2. Discrete Mathematical Structures, Sixth edition, Kolman, Busby, Ross, PHI
3. Discrete Mathematics and Graph Theory, Third edition, Purna Chandra Biswal, PHI
4. Plane trigonometry Part-I S L Loney Arihant Publications
5. The Elements of Set Theory, K K Verma, Deepak Kumar, Aitbs Publishers

MATSECP 3.1: Theory based Practical's on Fundamentals of Mathematics – II	
Teaching Hours : 2 Hours/Week	Credits: 1
Total Teaching Hours: 28 Hours	Max. Marks: 25 (S.A.-15+ I.A.-10)

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 **MATSECP 3.1** by using Maxima software.
- Acquire knowledge of applications of algebra and calculus through Maxima.

Practical's/Lab Work to be performed in Computer Lab (Maxima)

1. Introduction to Maxima.
2. Program to solve a system of linear equations.
3. Program to find the roots of the quadratic and cubic equations.
4. Program to find the nature of the roots of quadratic and cubic equations.
5. Program to create matrices.

6. Program on basic operations on matrices.
7. Program to create identity matrix, zero matrix, triangular matrix, diagonal matrix and random matrices.
8. Program to find row reduced echelon form of matrix A.
9. Program to find the rank of A.
10. Program to find the inverse of a matrix A.

Skill Enhancement Course (SEC)

(For students from Science stream)

MATSECT 3.2: Boolean Algebra	
Teaching Hours : 2 Hours/Week	Credits: 2
Total Teaching Hours: 28 Hours	Max. Marks: 50 (S.A.-30+ I.A.-20)

Basics of Boolean Algebra: Boolean Algebra, Unique Features, Basic operations, Boolean function, De-Morgan's Theorem, Logic gates 14 hours

Simplification of Boolean Expressions: Logic gate, sum of products and product of sums form, normal form. Expression of a Boolean function as a canonical form. Simplification of Expression by an algebraic method. Boolean Expression from Logic and switching Network. 14 hours

Reference Books:

1. Discrete and Combinatorial Mathematics, Fifth Edition, Ralph P. Grimaldi, B.V. Ramana, Pearson
2. Discrete Mathematical structures, Sixth edition, Kolman, Busby, Ross, PHI.
3. Discrete Mathematics and Graph Theory, Third edition, Purna Chandra Biswal, PHI.
4. A Text Book of Discrete Mathematics, Swapan Kumar Sarkar, S. Chand.

SEMESTER – IV

MATDSCT 4.1: Partial Differential Equations and Integral Transforms	
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

- Solve the Partial Differential Equations of the first order and second order.
- Formulate, classify and transform partial differential equations into canonical form.
- Solve linear and non-linear partial differential equations using various methods and apply these methods to solving some physical problems.
- Able to take more courses on wave equation, heat equation and Laplacian equation.
- Solve PDE by Laplace Transforms and Fourier Transforms.

Partial Differential Equations:

Unit-I: Basic concepts-Formation of a partial differential equation by elimination of arbitrary constants and functions. Solutions of partial differential equation- Solution by direct integration. Lagrange's linear equation of the form $Pp + Qq = R$, standard types of first order non-linear partial differential equations, the integrals of the non-linear equation by Charpit's method. **14 Hours**

Unit-II: Homogeneous linear partial differential equations with constant co-efficients. partial differential equation of the second order. Classification of second order partial differential equations, canonical forms. classification of second order linear equations as hyperbolic, parabolic and elliptic. Solution of the Heat equation, Laplace equation and wave equation (using separation of variables). **14 Hours**

Integral Transforms:

Unit-III: Laplace Transforms: Definitions, basic properties. Laplace transform of some standard functions. Laplace transform of periodic functions. Laplace transform of derivative and integral of a function. Heaviside function. Dirac-Delta function. Convolution theorem. Inverse Laplace transforms and its properties. Solution of differential equations by using Laplace transforms. **14 Hours**

Unit-IV: Fourier Series and Transforms: Periodic functions. Fourier co-efficient. Fourier series of functions with period 2π and $2l$. Fourier series of even and odd functions. Half range cosine and sine series. Fourier Transforms- Finite cosine and sine transform. Transforms of derivatives. Applications of Fourier transforms. **14 Hours**

Reference Books:

1. Introductory Course in Differential Equations, D.A Murray, Orient and Longman.
2. Elementary Treatise on differential equations and their applications, H.T.H. Piaggio, CBS publishers & Distributors. Delhi, 1985.
3. Differential equations, G.F Simmons, Tata Mc Graw Hill.
4. Differential Equations. 3^{rd} Ed., S. L. Ross, John Wiley and Sons. India, 2004.
5. Ordinary Differential Equations and Partial Differential Equations, M. D. Raisinghania, S. Chand & Company, New Delhi.
6. Introduction to partial differential equations, Third edition, K. Sankara Rao, PHI, 2015.
7. Elements of partial differential equations, I. N Sneddon, McGraw Hill International Editions, 1986.
8. Laplace transforms, R. Murray and L. Spiegel, Schaum's Outlines.
9. Laplace Transforms, Goel and Gupta.
10. Integral Transforms Methods in Science & Engineering, Sudhir Kumar, CBS Engineering Series. 2017.
11. Fourier Transforms, Murray R. Spiegel, Schaum's Outlines.
12. A short course in Differential equations, 6^{th} edition, Earl David Rainville and Philip Edward Bedient, Prentice Hall College Div.
13. Mathematical Physics, Sathya Prakash, S. Chand and Sons, New Delhi.

MATDSCP 4.1: Theory based Practical's on Partial Differential Equations and Integral Transforms	
Practical Hours : 4 Hours/Week	**Credits: 2**
Total Teaching Hours: 56 Hours	**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 Partial Differential Equations and Integral Forms.
- To find Laplace transform of various functions.
- To find the Fourier Transform of periodic functions
- To solve differential equations by using Integral transforms.

Practical's/Lab Work to be performed in Computer Lab (Maxima)

1. Solutions of linear Partial Differential Equations of type 1 to type 4 and Lagrange's methods.
2. Solutions of Partial Differential Equations using Charpit's method.
3. Solutions of second order Homogeneous Partial Differential Equations with constand coefficients.
4. Solutions to the Partial Differential Equations using separation of variable method (Heat/Wave/Laplace).

5. Finding the Laplace transforms of some standard and periodic functions.
6. Finding the inverse Laplace Transform of simple functions.
7. Verification of convolution theorem.
8. To solve ordinary linear differential equation using Laplace Transform
9. To solve integral equation using Laplace Transform.
10. To find full range Fourier series of some simple functions with period 2π and $2l$
11. To find Half range sine and cosine series of some simple functions and plotting them.
12. To find cosine Fourier transforms.
13. To find sine Fourier transforms.

Open Elective Course
(with Practical's)

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

MATOET4.1: Mathematics-IV	
Teaching Hours : 2 Hours/Week	**Credits: 2**
Total Teaching Hours: 28 Hours	**Max. Marks: 60 (S.A.-40 + I.A.-20)**

Course Learning Outcomes: This course will enable the students to

- Explain the concept of the differential equation.
- Classify the differential equations concerning their order and linearity.
- Explain the meaning of the solution of a differential equation.
- Solve first-order ordinary differential equations.
- Solve exact differential equations and convert separable and homogenous equations to exact differential equations by integrating factors.
- Solve Bernoulli differential equations.
- Will be able to find the solution to higher-order linear differential equations.

Unit I: Basic concepts–Formation of a Partial differential equations by elimination of arbitrary constants and functions–Solution of partial differential equations–Solution by Direct integration, Lagrange's linear equations of the form Pp+Qq=R. **14hours**

Unit II: Standard types of first order non-linear partial differential equations, The integrals of the non-linear equation by Charpit's method. Partial differential equations of second order. Classification of second-order partial differential equations, canonical forms. Solutions of the Heat & Laplace equation using separation of variables. **14 hours**

Reference Books:

1. Introductory course in Differential Equations, D. A. Murray, Orient and Longman
2. Elementary Treatise on Differential Equations and their applications, H. T. H. Piaggio, C. B. S. Publisher & Distributors, Delhi, 1985.
3. Differential Equations, G. F. Simmons, Tata Mc Graw Hill 14
4. Differential Equations, 3rd Ed., S. L. Ross, John Wiley and Sons, India, 2004.
5. Schaum's outline of Laplace Transform, M. R. Speigel.

6. Ordinary Differential equations & Partial differential equations, M. D. Raisinghania, S. Chand & Company, New Delhi.
7. Introduction to Partial Differential Equations, Third Edition, K. Sankara Rao, PHI, 2015.
8. Elements of partial differential equations, I. N Sneddon, McGraw Hill International Edition, 1986.

MATOEP 4.1: Theory based Practical's on Mathematics-IV	
Teaching Hours : 2 Hours/Week	**Credits: 1**
Total Teaching Hours: 28 Hours	**Max. Marks: 40 (S.A.-20 + I.A.-20)**

Course Learning Outcomes: This course will enable the students to gain hands on experience of

- Free and Open Source software (FOSS) tools or computer programming.
- Solving exact differential equations
- Plotting orthogonal trajectories
- Finding complementary function and particular integral of linear and homogeneous differential equations.
- Acquire knowledge of applications of real analysis and differential equations.
- Verification of convergence/divergence of different types of series

Practical's/Lab Work to be performed in Computer Lab (Maxima)

1. Solutions of Linear Partial differential equations of type 1.
2. Solutions of Linear Partial differential equations of type 2.
3. Solutions of Linear Partial differential equations of type 3.
4. Solutions of Linear Partial differential equations of type 4.
5. Solutions of Lagrange Linear Partial differential equations
6. Solutions of partial differential equation using Charpit's method.
7. Program on classification of second order partial differential equations.
8. Solutions of second order Homogeneous Partial Differential Equations with constant coefficients.
9. Solutions to the Partial Differential Equations using separation of variable method
10. Solutions to the Partial Differential Equations using separation of variable method (Heat/Wave/Laplace).

Open Elective Course

(For students of other than science stream)

MATOET4.2: Mathematical Finance	
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

- Understand how compute profit and loss, discount and Banker's discount.
- Understand the concept of Linear equations and inequalities and their use in the solving the Linear Programming Problems.
- Formulation of Transportation Problem and its application in routing problem.

Unit-I: Commercial Arithmetic

Bill of exchange, Bill of discounting procedure. Basic formula related to profit, loss, discount and brokerage, Successive discount, True discount, Banker's discount. **14 Hours**

Unit-II: Linear Programming

Linear equations and inequalities- Rectangular coordinates, straight line, parallel and intersecting lines and linear inequalities, Introduction to linear programming, Mathematical formulation of LPP, Solution of a LPP by graphical method, special cases in graphical method. **14 Hours**

Unit-III: Transportation problem

Introduction, Formulation of Transportation problem, Initial basic feasible solution, Steps in solving a transportation problem, optimality check, special cases in Transportation problem. The Traveling salesman Problem (Routing Problem). **14 Hours**

Reference Books:

1. Objective Arithmetic, R S Aggarwal, S. Chand & Company Ltd.
2. Mathematics for Business and Social Sciences an Application approach, Mizrahi and Sullivan.
3. Business Mathematics- II Edition, Qazi Zameeruddin, Vijay K Khanna, S K Bhambri, Vikas Publishing House.
4. Operation Research, Fourth edition, S. Kalavathy, Vikas publication house Pvt. Ltd.
5. Operations Research 2nd edition, Sreenivasa Reddy M, Sanguine Technical publishers, Bangalore.

Open Elective Course

(For students of other than science stream)

MATOECT4.3: Mathematics for Social Sciences	
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

- Understand the mathematical concept of sets and counting problems.
- Understand the concept of limits and continuity of functions and its applications in business and social sciences.

Unit-I: Sets, Relations and Types of Relations, Functions and Types of Functions, counting, permutations, combinations, counting problems, binomial theorem and problems thereon.

14 Hours

Unit-II: Limit and continuity, Derivative- interpretation, derivative formulas, general derivatives for differentiation, composite functions, higher order derivatives and problems thereon. **14 Hours**

Unit-III: Applications of the derivative – Relative maxima and Relative minima, Absolute maximum and Absolute minimum, Applied problems, Concavity, Asymptotes, Marginal analysis, Models- Maximizing tax revenue, Optimal trade-in time, and minimizing inventory cost. **14 Hours**

Reference books:

1. Mathematics for Business and Social Sciences and Applied Approach – Third Edition, Abe Mizrahi and Michael Sullivan, Wiley.
2. Mathematics for Economists, Carl P. Simon and Lawrence Blume, Viva Books Private Limited, New Delhi, 2015.
3. Maths for Social Sciences, , L. Peccati, M. D'Amico and M. Cigola, Springer.

Question Paper Pattern for DSCT (I Semester to IV Semester)
4 Credits (S.A. - 60 + I.A. - 40)

Duration: 03 hours **Max. Marks: 60**

PART- A	
Answer any 4 questions	**4 X 2 = 8**
Question Numbers – 1 to 6	
PART- B	
Answer any 4 questions	**4 X 3 = 12**
Question Numbers –7 to 12	
PART- C	
Answer any 4 questions	**4 X 5 = 20**
Question Numbers – 13 to 18 (From Unit 1 and Unit 2)	
PART–D	
Answer any 4 questions	**4 X 5 = 20**
Question Numbers – 19 to 24 (From Unit 3 and Unit 4)	

Note: The question paper shall strictly adhere to the following blueprint:

Blueprint

Unit	Number of two marks questions	Number of three marks questions	Number of five marks questions	Total number of questions
Unit 1	01	02	03	06
Unit 2	02	01	03	06
Unit 3	01	02	03	06
Unit 4	02	01	03	06

Practical Examination Pattern for DSCT (I Semester to IV Semester)
2 Credits (S.A. - 25 + I.A. - 25)

Duration: 03 hours **Max. Marks: 25**

Marks Allotment	
Program writing*	05
Problem solving*	05
Program execution*	05
Viva-voce**	05
Record	05
Total	**25 marks**

Note:

***(i)A total of 3 programs should be given to each student. He/she has to write the program, solve the corresponding problems and then execute the program based on which the evaluation would be carried out.**

****(ii) Viva-voce examination should be conducted based on the syllabus for the corresponding semester.**

Question Paper Pattern for Open Elective Theory (MATOET) (I Semester to IV Semester)
(For open elective papers with practical's)
2 Credits (S.A. - 40 + I.A. - 20)

Duration: 02 hours **Max. Marks: 40**

PART- A	
Answer any 3 questions	**3 X 2 = 06**
Question Number	**Unit**
1 & 2	Unit- 01
3 & 4	Unit- 02
PART- B	
Answer any 3 questions	**3 X 3 = 09**
5 & 6	Unit- 01
7 & 8	Unit- 02
PART- C	
Answer any 5 questions	**5 X 5 = 25**
9, 10 & 11	Unit- 01
12, 13 & 14	Unit- 02

Practical Examination Pattern for Open Elective Practical's(MATOEP)
(I Semester to IV Semester)
(For open elective papers with practical's)
1 Credit (S.A. - 20+ I.A. - 20)

Duration: 02 hours **Max. Marks: 20**

Marks Allotment	
Program writing*	04
Problem solving*	04
Program execution*	04
Viva-voce**	04
Record	04
Total	**20 marks**

NOTE:

*(i)A total of 1 program should be given to each student. He/she has to write the program, solve the corresponding problem and then execute the program based on which the evaluation would be carried out.

**(ii) Viva-voce examination should be conducted based on the syllabus for the corresponding semester.

Question Paper Pattern for Open Elective Theory (MATOET) (I Semester to IV Semester)

(For open elective papers without practical's)

3 Credits (S.A. - 60 + I.A. - 40)

Duration: 03 hours Max. Marks: 60

PART- A	
Answer any 6 questions	6 X 2 = 12
Question Number	Unit
1, 2 & 3	Unit- 01
4, 5 & 6	Unit- 02
7, 8 & 9	Unit- 03
PART- B	
Answer any 6 questions	6 X 3 = 18
10, 11 & 12	Unit- 01
13, 14 & 15	Unit- 02
16, 17 & 18	Unit -03
PART- C	
Answer any 6 questions	6 X 5 = 30
19, 20&21	Unit- 01
22, 23 & 24	Unit- 02
25, 26 & 27	Unit -03

Question Paper Pattern for Skill Enhancement Theory (MATSECT)
(I Semester to IV Semester) (For Skill Enhancement Theory papers with practical's)
2 Credits (S.A. - 30 + I.A. - 20)

Duration: 01 hour Max. Marks: 30

PART- A	
Answer any 3 questions	3 X 2 = 6
Question Number	Unit
1& 2	Theory
3 & 4	Practical's
PART- B	
Answer any 3 questions	3 X 3 = 9
5 & 6	Theory
7 & 8	Practical's
PART- C	
Answer any 3 questions	3 X 5 = 15
9 & 10	Theory
11 & 12	Practical's

Note*: Questions related to the practical component should be asked in the theory examination question paper. No separate practical examination shall be conducted.

Question Paper Pattern for Skill Enhancement Theory (MATSECT)
(I Semester to IV Semester) (For Skill Enhancement Theory papers without practical's)
2 Credits (S.A. - 30 + I.A. - 20)

Duration: 01 hour PART- A	Max. Marks: 30
Answer any 3 questions	3 X 2 = 6
Question Number	Unit
1& 2	Unit I
3 & 4	Unit II
PART- B	
Answer any 3 questions	3 X 3 = 9
5 & 6	Unit I
7 & 8	Unit II
PART- C	
Answer any 3 questions	3 X 5 = 15
9 & 10	Unit I
11 & 12	Unit II