SRI DHARMASTHALA MANJUNATHESHWARA COLLEGE (AUTONOMOUS)

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DEPARTMENT OF MATHEMATICS

Syllabus of
Bachelor's Degree in Mathematics

CHOICE BASED CREDIT SYSTEM
SEMESTER SCHEME
UNDER NEW EDUCATION POLICY 2020
2021-22 ONWARDS
(EFFECTIVE FROM ACADEMIC YEAR 2023-24)

BOS meeting held on 12-02-2024
Academic Council meeting, held on 23-03-2024

PREAMBLE

The NEP-2020 envisages a student centric educational system with an opportunity to learn multiple courses and programmes. It also provides a comparable and globally competitive educational system. It transforms the existing Higher Educational System into creative, innovative and research oriented system. In addition to the traditional and time-tested system of continuing with the 3-year educational programme, the NEP provides an opportunity to the young minds to move up the ladder of knowledge stream by entering into the Honors and Research qualifications. The under-graduate four-year programme create a better avenue for higher-degree study at Master's / Ph.D. level and also demonstrate to prospective employers a higher capacity for independent learning and research, along with enhanced problem-solving, critical thinking, independent learning and communication.

The present syllabus in Mathematics under NEP-2020 is drafted keeping in view of the wide applications of Mathematics in science, engineering, social science, business and a most of other areas too. The study of the syllabi will enable the students to equipped with the state of the art of the subject and will empower them to get employed in technical and engineering fields as well as in business, education and healthcare sectors.

The current syllabus is at par with Mangalore University syllabus which offers ample choice of elective papers along with compulsory papers. A student can select elective papers as per her/his needs and interests. To strengthen the conceptual understanding of the topic and to widen the horizon of knowledge a Learn *Free and Open Source Software (FOSS)* tools for computer programming such as SCILAB and MAXIMA are also incorporated. This syllabus is meant to be introduced from the academic year 2021-22.

PROGRAMME OBJECTIVES

- To give greater exposure to the syllabus through open electives
- To improve the perspective of students on mathematics as per modern requirement
- To develop a spirit of inquiry and scientific temper in the student
- To initiate students to enjoy mathematics, pose and solve meaningful problems, to use abstraction to perceive relationships and structure and to understand the basic structure of mathematics
- To make learning process student-friendly
- To foster experimental, problem-oriented and discovery learning of mathematics
- To orient students towards relating mathematics applications
- To improve retention of mathematical concepts in the student

- To enable the teacher to demonstrate, explain and reinforce abstract mathematical ideas by using concrete objects, models, charts, graphs, pictures, posters with the help of FOSS tools on a computer
- To provide scope for greater involvement of both the mind and the hand
- To help the student build interest and confidence in learning the subject

PROGRAMME SPECIFIC OUT COME

PSO1: After the completion of three years B.Sc, students with the intension of higher studies, are expected to expose to topics like differential calculus, integral calculus, modern algebra, complex numbers and number theory.

PSO2: They develop problem solving skills.

PSO3: Students who are joining software companies develop a very good reasoning power.

PSO4: They develop life skills and also the confidence of facing real life problems.

PSO5: Course Pattern and Scheme of Examinations).

PSO6: The practical's introduced in the curriculum help the students to understand the concepts in a concrete way.

Programme Outcomes (PO):

By the end of the program it is expected that the students will be benefited by the following:

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 software 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.

Curriculum Structure

(Core and Electives)Semesters -I to VIII

SEM	DSCode	Core Papers
Sem-1	**MACT101**	Number Theory-I, Algebra-I and Calculus-I
	MACP101	Practicals on Number Theory-I, Algebra-I and Calculus-I
Sem-2	**MACT151**	Number Theory-II, Algebra - II and Calculus – II
	MACP151	Practicals on Number Theory-II, Algebra - II and Calculus – II
Sem-3	**MACT201**	Ordinary Differential Equations and Algebra – III
	MACP201	Practicals on Ordinary Differential Equations and Algebra – III
Sem-4	**MACT251**	Partial Differential Equations and Integral Transforms
	MACP251	Practicals on Partial Differential Equations and Integral Transforms
Sem-5	**MACT 301**	Real Analysis-II and Complex Analysis
	MACP 301	Practicals on Real Analysis-II and Complex Analysis
	MACT 302	Algebra and Graph Theory
	MACP 302	Practicals on Algebra and Graph Theory
Sem-6	**MACT 351**	Linear Algebra
	MACP 351	Practicals on Linear Algebra
	MACT 352	Numerical Analysis
	MACP 352	Practicals on Numerical Analysis

Open Electives for 1st to 4th Semesters:

Semester	Title of the courses	
	Science stream	**Non- Science stream**
First Semester	Mathematics I	1.Business Mathematics –I 2.Mathematics for Business and Economics-I
Second Semester	Mathematics II	1.Business Mathematics-II 2.Quantitative Techniques
Third Semester	Ordinary Differential Equations	1.Quantitative Mathematics 2. Vedic Mathematics
Fourth Semester	Partial Differential Equations	1.Quantitative Mathematics 2.Mathematical Finance 3.Mathematics for Social Sciences

Discipline Specific Electives for 7th and 8th Semesters:

	VII Semester Electives **Pool B-I (Select any two)**		**VIII Semester Electives** **Pool B-II (Select any two)**
A.	Graph Theory	A.	Operations Research
B.	Advanced Number Theory	B.	Lattice theory
C.	Mathematical Statistics	C.	Mathematical Modeling
D.	Advanced Numerical Analysis	D.	Discrete Mathematics
E.	Research Methodology in Mathematics*	E.	Research Project* OR Any Two of the following electives (A) Theory of Modules (B) Theory of Partitions (C) Cryptography (D) Finite Element Methods

***Compulsory paper**

COURSE PATTERN AND SCHEME:

Core/ Elective	Paper Code	Title of the Paper	Instruction Hours	Duration of the Examination (Hrs)	Max. Marks			Credit
					Exam	IA	Total	
I Semester B.Sc.								
DSC1	Theory MACT101	Number Theory-I, Algebra-I and Calculus-I	4	2	60	40	100	4
	Practical MACP101	Theory based Practicals on Number Theory-I, Algebra-I and Calculus-I	4	4	25	25	50	2
OE1	MAOE101	Business Mathematics – I(NSS)	3	2	60	40	100	3
	MAOE102	Mathematics I -SS						
	MAOE103	Mathematics for Business and Economics-I(NSS)						
Total number of Credits in I Semester: 09 (SS-Science Students, NSS-Non Science Students)								
II Semester B.Sc.								
DSC2	Theory MACT151	Number Theory-II, Algebra - II and Calculus - II	4	2	60	40	100	4
	Practical MACP151	Theory based Practicals on Number Theory-II, Algebra - II and Calculus - II	4	4	25	25	50	2
OE2	MAOE151	Business Mathematics-II	3	2	60	40	100	3
	MAOE152	Mathematics II – (SS)						
	MAOE153	Quantitative Techniques– (NSS)						
Total number of Credits in II Semester: 09 (SS-Science Students, NSS-Non Science Students)								
III Semester B.Sc.								
DSC3	Theory MACT201	Ordinary Differential Equations and Algebra – III	4	2	60	40	100	4
	Practical MACP201	Theory based Practical's on Ordinary Differential Equations and Algebra - III	4	4	25	25	50	2
OE3	Theory MAOE201	Quantitative Mathematics (NSS)	3	2	60	40	100	3

	MAOE202	Vedic Mathematics - (NSS)						
	MAOE203	Ordinary Differential Equations-(SS)						
Total number of Credits in III Semester: 09 (SS-Science Students, NSS-Non Science Students)								

IV Semester B.Sc.								
DSC4	Theory MACT251	Partial Differential Equations and Integral Transforms	4	2	60	40	100	4
	Practical MACP251	Theory based Practical's on Partial Differential Equations and Integral Transforms	4	4	25	25	50	2
OE4	Theory MAOE 251	Quantitative Mathematics (NSS)	3	2	60	40	100	3
	MAOE 252	Mathematical Finance(NSS)						
	MAOE 253	Mathematics for Social Sciences – (NSS)						
	MAOE 254	Partial Differential Equations – (SS)						
Total number of Credits in IV Semester: 09 (SS-Science Students, NSS-Non Science Students)								
V Semester B.Sc.								
DSC5	Theory MACT301	Real Analysis-II and Complex Analysis	4	2	60	40	100	4
	Practical MACP301	Theory Based practicals on Real Analysis-II and Complex Analysis	4	4	25	25	50	2
	Theory MACT302	Algebra and Graph Theory	4	2	60	40	100	4
	Practical MACP302	Theory Based practicals Algebra and Graph Theory	4	4	25	25	50	2
Total number of Credits in V Semester: 12								

VI Semester B.Sc.								
DSC6	Theory MACT351	Linear Algebra	4	2	60	40	100	4
	Practical MACP351	Theory based Practicals on Linear Algebra	4	4	25	25	50	2
	Theory MACT352	Numerical Analysis	4	2	60	40	100	4
	Practical MACP352	Theory based Practicals on Numerical Analysis	4	4	25	25	50	2
Total number of Credits in VI Semester: 12								

Outline for Internal assessment (Theory)

Activity	1	2	**Total marks**
Internals		10	20
Assignments/Projects		10	20
Total		20	40

Allotment of Marks for Practicals for I-IV Semesters

Internal Assessment

Number of experiments	08
Model practical examination after completing the minimum	20
Lab performance based on Continuous assessment	05

Total Marks.25

Practical Examination

Practical Examination Paper of 4 hours duration paper (Max. Marks 25)

Writing 4 programs code and execution :20
Class Record : 05
Total Marks -Practical Exam : **25 (Minimum marks for pass =9/25)**

Class records shall be valued at the time of Practical Exam by the External Examiner in consultation with Internal Examiner.

Total Marks = Internal Assessment marks +Practical Exam

= Max.25 + Max. 25 = 50

General Instructions for Practical Examination:

1. Question once given to the candidate during the practical examination should not be changed under any circumstances.
2. Practical record shall be valued by the external examiner in consultation with the internal examiner.
3. Practical examination answer scripts should be valued jointly by the external and internal examiners.
4. The candidates shall produce a certified practical record book while appearing for the practical examination.
5. Scientific calculators without programming facility are only allowed.
6. Each candidate has to use his/her own calculator at the time of practical examination.

Syllabus for B.Sc. with Mathematics as Major Subject &

B.Sc. (Hons.) Mathematics

SEMESTER – 1

MACT 101: Number Theory-I, 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)**

Learning Objectives:

- Learning Number Theory helps improving one's ability of mathematical thinking
- A study of basic structure and properties of Integers such as divisibility, congruence's
- To find the GCD of integers by Euclid's method, to solve linear equations by using Diophantine equations.
- How to solve system of equations by matrix method; Knowledge about caley- Hamilton theorem
- L' Hospitals rule for solving indeterminate forms of function, Taylor's series expansions of various functions
- The basic knowledge to sketch the curves in Cartesian and Parametric coordinates
- To develop the skills of solving problems through Practical

Course Learning Outcomes: This course will enable the students to

CO 1: Understand the elementary concepts of Number Theory.

CO 2: Learn to solve system of linear equations.

CO 3 Solve the system of homogeneous and non-homogeneous linear of *m* equations in *n* variables by using concept of rank of matrix.

CO 4 Sketch curves in Cartesian, polar and co-ordinates.

CO 5 Identify and apply intermediate value theorem, the mean value theorems and L'Hospital rule.

Unit-I: Number Theory: Division Algorithm, The Greatest Common Divisor (g.c.d), Euclidean Algorithm, Diophantine Equations, Fundamental Theorem of Arithmetic. The Theory of Congruences, Basic Properties of Congruences, Binary and Decimal Representation of Integers. Linear Congruences and Chinese Remainder Theorem. **14Hours**

Unit-II: 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 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. **14 Hours**

Unit-III: Polar Co-ordinates: Polar coordinates, angle between the radius vector and tangent. Angle of intersection of two curves (polar forms), length of perpendicular from pole to the tangent, pedal equations. Derivative of an arc in Cartesian, parametric and polar forms, curvature of plane curve-radius of curvature formula in Cartesian, parametric and polar and pedal forms- center of curvature, asymptotes, Tracing of curves (standard curves). **14Hours**

Unit-IV: Differential Calculus: 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. Leibnitz theorem and its applications. **14Hours**

Reference Books:

[1] David M. Burton., Elementary Number Theory, 7th Ed., McGraw Hill, 2011.

[2] Gareth A. Jones and J. Marry Jones, Elementary Number Theory, Springer, 1998.

[3] N. S Gopalakrishnan, University Algebra, 3rd Ed., New Age International Publications, 2015.

[4] B. S. Vatssa, Theory of Matrices, New Age International Publishers, New Delhi, 2005.

[5] A. R. Vashista, Matrices, Krishna Prakashana Mandir, 2003.

[6] Shanti Narayan and P.K. Mittal, Text book of Matrices, 5th Ed., S Chand and Co. Pvt. Ltd., New Delhi, 2013.

[7] Shanthi Narayan and P.K. Mittal, Differential Calculus, Reprint. S Chand and Co. Pvt. Ltd., New Delhi, 2014.

[8] Debasish Sengupta, Applications of Calculus, Books and Allied (P) Ltd., 2019.

[9] George B. Thomas and Ross L. Finney, Calculus and Analytic Geometry, Addison-Wesley, 1992.

[10] Louis Leithold, Calculus with Analytic Geometry, 5th Ed., Harper and Row International, 1986.

[11] Maurice D. Weir, George B. Thomas, Jr., Joel Hass and Frank R. Giordano, Thomas' Calculus, 11th Ed., Pearson, 2008.

[12] S. Narayanan and T. K. Manicavachogam Pillay, Calculus, Vol. I & II, S. Viswanathan Pvt. Ltd., 1996.

Self Study Topics:

Unit-II: Recapitulation of Symmetric and Skew Symmetric matrices, Cayley-Hamilton theorem, inverse of matrices by Cayley-Hamilton theorem (Without Proof). Algebra of Matrices.

Unit-IV: Intermediate value theorem, Rolle's Theorem, Lagrange's Mean Value.

Activity: Seminar on Algebra of Matrices, TED vedios on finding the Inverse of the matices, Curve tracing, Quiz on the syllabus.

SEMESTER – 1

MACP 101: Practicals on Number Theory-I, Algebra-I and Calculus-I	
Practical Hours : 4 Hours/Week	**Credits: 2**
Total Practical Hours: 56 Hours	**Max. Marks: 50** **(S.A.-25 + I.A. – 25)**

Course Learning Outcomes: This course will enable the students to

CO 1 Learn *Free and Open Source Software (FOSS)* tools for computer programming

CO 2 Solve problem on Number theory, Algebra and Calculus studied in **MATDSCT 101** by using FOSS software's.

CO 3 Acquire knowledge of applications of algebra and calculus through FOSS

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

Suggested Softwares: Maxima/Scilab/Maple/MatLab/Mathematica/Phython/R.

1. Introduction to the software and commands related to the topic.
2. Program for Euclidean Algorithm.
3. Program for Divisibility tests.
4. Programs for Binary and Decimal Representation of Integers.
5. Program to solve simultaneous congruences involving Chinese Remainder Theorem
6. Computation of addition and subtraction of matrices.
7. Computation of Multiplication of matrices.
8. Computation of Trace and Transpose of Matrix
9. Computation of Rank of matrix and Row reduced Echelon form.
10. Computation of Inverse of a Matrix using Cayley-Hamilton theorem.
11. Solving the system of homogeneous and non-homogeneous linear algebraic equations.
12. Tracing of standard curves (Cartesian form)
13. Tracing of standard curves (Polar form)
14. Taylor's and Maclaurin's expansions of the given functions.

Open Elective

(For Students of other than Science Stream)

MAOE 101 : Business Mathematics-I	
Teaching Hours : 3 Hours/Week	**Credits: 3**
Totat Teaching Hours: 42 Hours	**Max. Marks: 100** **(S.A.- 60 + I.A. – 40)**

Learning Objective:

- To study economic problems with the formal tools of mathematics like Matrices and its properties
- Analyze And Interpret numerical data, of economic model into matrix form students and able to Solve systems of linear equations by various methods
- To solve the problems optimization such as those of profit maximization, cost minimization, output and revenue maximization.
- The partial derivative is extensively used in economics and managerial decision making

Learning Outcomes: This course will enable the students to

CO 1 Translate the real word problems through appropriate mathematical modelling.

CO 2 Explain the concepts and use equations, formulae and mathematical expression and relationship in a variety of context

CO 3 Finding the extreme values of functions

CO 4 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. examples on commercial mathematics. **14Hours**

Unit-II: Straight line: Straight line in economics, Break-Even point, System of straight lines, Effect of a Tax or Subsidy. Parabola: Parabola in in economics, the non-linear model. Rectangular hyperbola: Rectangular hyperbola in economics. Circle: Circle in economics. Inequalities and absolute values:

Properties of inequalities, linear inequality in one variable, Absolute values. Applications in economics.

14 Hours

Unit-III: Derivatives of functions: Economic applications, Demand function, Price demand, income demand, Cross demand, Law of supply, Revenue functions, Short-run production function, Short-run cost function, Relation between marginal product and marginal cost. The maxima and minima of functions: Applications of maxima and minima of functions in economics and business.

14 Hours

Reference Books:

[1] E.T. Dowling, , Mathematics for Economics, Schaum's Outline, 3rd Ed., McGraw Hill, London, 2011.

[2] R. S. Soni, Business Mathematics with Applications in Business and Economics, Pitambar Publishing, India 1996.

[3] Mathematics for Business and Economics by R. C. Bharadwaj

Self Study Topics:

Unit I: Definition of a matrix; types of matrices; algebra of matrices. Properties of determinants.

Unit II: Recapitulation of straight lines, Tax or Subsidy.

Activity: Seminar on Algebra of Matrices, TED vedios on finding the Inverse of the matices, Quiz on the syllabus.

Open Elective Course

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

MAOE 102: Mathematics – I	
Teaching Hours : 3 Hours/Week	**Credits: 3**
Total Teaching Hours: 42 Hours	**Max. Marks: 100** **(S.A.- 60 + I.A. – 40)**

Learning Objectives:

- Learning Number Theory helps improving one's ability of mathematical thinking
- A study of basic structure and properties of Integers such as divisibility, congruence's
- To find the GCD of integers by Euclid's method, to solve linear equations by using Diophantine equations.
- How to solve system of equations by matrix method; Knowledge about caley- Hamilton Theorem
- L' Hospitals rule for solving indeterminant forms of function, Taylor's series expansions of various functions

Course Learning Outcomes: This course will enable the students to

CO 1 Understand the elementary concepts of Number Theory.

CO 2 Learn to solve system of linear equations.

CO 3 Solve the system of homogeneous and non-homogeneous linear of m equations in n variables by using concept of rank of matrix.

CO 4 Identify and apply intermediate value theorem, the mean value theorems and L'Hospital rule.

Unit-I: Number Theory: Division Algorithm, The Greatest Common Divisor (g.c.d), Euclidean Algorithm, Diophantine Equations, Fundamental Theorem of Arithmetic. The Theory of Congruences, Basic Properties of Congruences, Binary and Decimal Representation of Integers. Linear Congruences and The Chinese Remainder Theorem. **14Hours**

Unit-II: 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 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. **14 Hours**

Unit-III: Differential Calculus: 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. Leibnitz theorem and its applications. **14 Hours**

Reference Books:

[1] N. S Gopalakrishnan, University Algebra, 3rd Ed., New Age International Publications, 2015.

[2] B. S. Vatssa, Theory of Matrices, New Age International Publishers, New Delhi, 2005.

[3] A. R. Vashista, Matrices, Krishna Prakashana Mandir, 2003.

[4] Shanti Narayan and P.K. Mittal, Text book of Matrices, 5th Ed., S Chand and Co. Pvt. Ltd., New Delhi, 2013.

[5] Shanthi Narayan and P.K. Mittal, Differential Calculus, Reprint. S Chand and Co. Pvt. Ltd., New Delhi, 2014.

[6] Debasish Sengupta, Applications of Calculus, Books and Allied (P) Ltd., 2019.

[7] George B. Thomas and Ross L. Finney, Calculus and Analytic Geometry, Addison-Wesley, 1992.

[8] Louis Leithold, Calculus with Analytic Geometry, 5th Ed., Harper and Row International, 1986.

[9] Maurice D. Weir, George B. Thomas, Jr., Joel Hass and Frank R. Giordano, Thomas' Calculus, 11th Ed., Pearson, 2008.

[10] S. Narayanan and T. K. Manicavachogam Pillay, Calculus, Vol. I & II, S. Viswanathan Pvt. Ltd., 1996.

MAOE 103 : Mathematics for Business and Economics-I	
Teaching Hours : 3 Hours/Week	**Credits: 3**
Totat Teaching Hours: 42 Hours	**Max. Marks: 100** **(S.A.- 60 + I.A. – 40)**

Course Objective:

Students will be able to know about

- To study economic problems with the formal tools of mathematics like Matrices and its properties
- Mathematical models that can be used to know about financial structures
- Take appropriate decisions about Capital investment and understand the concept of bonds and Annuities.
- Mathematical formulation of some real life problems and their solutions using graphical methods.
- To construct mathematical model by using LPP in solving economic interpretation problems

Learning Outcomes:

Upon successful completion of this course, students will able to

CO 1 Analyze and Interpret numerical data, of economic model into matrix form students and able to Solve systems of linear equations by Gaussian Jordan Method , Cramer's rule,Matrix inversion method.

CO 2 Find compound interest, effective rate of interest by using mathematical model

CO 3 Find annuity and various types of annuity problems

CO 4 Sketching a graphical representation of 2 dimensional LPP model given in general, standard or canonical forms

CO 5 Formulation of given simplified description of a suitable real world problem as a linear programming model and to solve optimization problems by using simplex algorithm.

Unit I: Mathematics finance: Compound Interest, rates of growth/decay, nominal and effective rates of interest, Applications of present values**:** Capital investment decisions, bonds, bond price. Annuities: Types of Annuities, Amount of Annuities, Sinking funds, Present value of an Annuity-Problem. **14 hrs**

Unit II: Applications of Linear Programming model in Economics: General form of a LPP, Formulation of the problem, Graphical method of solution, Simplex method for maximization of LPP. Minimization of LPP: Standard forms, Economic Interpretation of the dual form –related problems.

14 hrs

Unit III: (Recapitulations) Matrices, Algebra of matrices, Transpose of a matrix, determinants and non singularity, Inverse of a matrix.Rank of a matrix, matrix representation of a system of linear equations, , solution of equations by Crammers rule, Matrix Inversion Method, Gauss Jordan Method.Economic applications; Two- Commodity Market equilibrium, National Income Model.

14hrs

Reference Books:

1. Mathematics for Economics and Business by Prof. R S Bharadwaj.
2. Linear Programming and it's Applications by James K Strayer.
3. https://www.youtube.com/watch?v=RU-osjAs6hE - How To Calculate The Present Value of an Annuity

https://www.youtube.com/watch?v=RO5477EKlXE - Simplex Algorithm Explanation.

Self Study Topics:

Unit-I Compound Interest,types of Annuities, Amount of Annuities, Sinking funds, Present value of an Annuity-Problem.

Unit-III (Recapitulations) Matrices, Algebra of matrices, Transpose of a matrix

Activity: Seminar on Algebra of Matrices, TED vedios on finding the Inverse of the matices, Curve tracing, Quiz on the syllabus.

SEMESTER – II

MACT 151: Number Theory-II, 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)**

Learning Objectives:

- Learning Number Theory helps improving one's ability of mathematical thinking
- Student will able to understand Fermat's theorem, Wilson's theorem, Euler Phi- function, Finite continued product.
- Group theory will enable the students how to find the solutions to polynomial equations and has its full significance, as a mathematical formulation of symmetry, been understood.
- Students will able to know properties of groups such as subgroups, cyclicness.
- Compute partial derivatives of functions of several variables, total derivatives, mixed derivatives, Jacobeans, Maxima & Minima of functions
- Use iterated integrals to evaluate integrals over planar regions, and to calculate volume. Build on elementary integration techniques to evaluate multiple integrals efficiently.
- Set up and evaluate double integrals in polar coordinates. Set up and evaluate integrals to compute surface area.
- Set up and evaluate triple integrals in Cartesian coordinates. Set up and evaluate triple integrals in cylindrical and spherical coordinates

Course Learning Outcomes: This course will enable the students to

CO 1 Understand the Euler's Phi-function and finite continued fractions.

CO 2 Recognize the mathematical objects called Groups.

CO 3 Identify cyclic and non-cyclic groups

CO 4 Link the fundamental concepts of groups and symmetries of geometrical objects.

CO 5 Explain the significance of the notions of Cosets, normal subgroups and factor groups.

CO 6 Understand the concept of partial derivatives of functions of several variables.

CO 7 Find the Taylor's and Maclaurin's series of functions of two variables.

CO 8 Find the extreme values of functions of two variables.

CO 9 Understand the concept of line integrals, multiple integrals and their applications.

Unit-I: Number Theory: Fermat's Theorem, Wilson's Theorem, and Quadratic Congruences. Euler's Phi function, definition and properties, Euler's theorem and corollaries, finite continued fractions. **14hrs**

Unit-II: Groups: Binary Operations, Associativity, Commutativity, Examples for Binary Operations, Definition of a Group, Examples, Right inverse, Left inverse, Some properties, Abelian and Non-abelian groups, Laws of exponents, Subgroups, Intersection of subgroups, Centralizer of an element, Normalizer of a subgroup, Product of subgroups, Order of products of subgroups, Cyclic groups, Properties, Number of generators. **14 hrs**

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. **14hrs**

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. **14hrs**

Reference Books:

[1] David M. Burton., Elementary Number Theory, 7th Ed., McGraw Hill, 2011.

[2] Gareth A. Jones and J. Marry Jones, Elementary Number Theory, Springer, 1998.

[3] N. S Gopalakrishnan, University Algebra, 3rd Ed., New Age International Publications, 2015.

[4] I. N. Herstein, Topics in Algebra, 2nd Ed., Wiley Publishers, 1975.

[5] A. R. Vasishtha and A. K. Vasishtha, Modern Algebra, Krishna Prakashan Mandir, Meerut, U.P., 2008.

[6] Bernald and Child, Higher Algebra, Arihant Publication India Limited, India, 2016.

[7] Vijay K Khanna and S K Bhambri, A Course in Abstract Algebra, 5th Ed., Vikas Publishing House, India, 2016.

[8] Shanthi Narayan and P. K. Mittal, Differential Calculus, Reprint, S. Chand and Co. Pvt. Ltd., New Delhi, 2014.

[9] Shanti Narayan and P. K. Mittal, Integral Calculus. S. Chand Ltd., India, 2005.

[10] George B. Thomas and Ross L. Finney, Calculus and Analytic Geometry, Addison-Wesley, 1992.

[11] Maurice D. Weir, George B. Thomas, Jr., Joel Hass and Frank R. Giordano, Thomas' Calculus, 11th Ed., Pearson, 2008.

[12] S. Arora and S .C. Malik, Mathematical analysis, Wiley, India, 1992.

Self Study Topics:

Unit-II: Groups: Binary Operations, Associativity, Commutativity, Examples for Binary Operations

Unit-IV: Integral Calculus: Recapitulation of definite integrals and its properties

Activitity : Seminar on Finite continued product, TED vedios on finding the line Integrals, Double In tegrals, Triple integrals , Quiz on the syllabus.

MACP 151: Practicals on Number Theory-II, Algebra-II and Calculus-II	
Practical Hours : 4 Hours/Week	**Credits: 2**
Total Practical Hours: 56 Hours	**Max. Marks: 50** **(S.A.-25 + I.A. – 25)**

Course Learning Outcomes: This course will enable the students to

CO 1 Learn *Free and Open Source Software (FOSS)* tools for computer programming

CO 2 Solve problems on Number Theory, Algebra and Calculus by using FOSS softwares.

CO 3 Acquire knowledge of applications of algebra and calculus through FOSS

Practical/Lab Work to be performed in Computer Lab

Suggested Softwares: Maxima/Scilab/Maple/MatLab/Mathematica/Phython/R.

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

Open Elective

(For Students of other than science stream)

MAOE 151: 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 Objectives:

- To provide college students with reinforcement of mathematical computations.
- Challenge the student to understand how to process and interpret information to arrive at logical conclusions to common business math applications.
- Develop proficiency in the application to solve business math problems.
- Understand the important role math plays in all facets of the business world
- Student will able to understand Interst Rate calculations, Annuity,Shares and profit, cost and expenditures
- To calculate age problems,Percentage, ratio , parternships, calander problems etc.
- This paper will give the confidence in facing various competitive examinations.

Course Learning Outcomes: This course will enable the students to

CO 1 Integrate concept in international business concept with functioning of global trade.

CO 2 Evaluate the legal, social and economic environment of business.

CO 3 To learn deferent techniques of simplification

CO 4 To enable to student answer competitive examinations

CO 5 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 hrs**

Unit-II: Techniques of Solving Problems involving number system and decimal Fractions, to calculate share and profit, and Simplifications of equations involving cost and expenditures, Average, Problems on numbers, Problems on ages. **14hrs**

Unit-III: Percentage, Ratio and proportion, partnerships, Concepts of Time and distance, Related problems, technique for problems related to Time and Work, Situations in Boats and Streams, velocity related problems, Simple problems on trains and other moving objects, different types of problems in Calendar, number of days, dates etc., Positions of hour hand and minute hand in Clocks, related problems. **14hrs**

Reference Books:

[1] R. S. Agarwal, Quantitative Aptitude, S. Chand & company Pvt. Ltd., 2014.

[2] S. A. Bari, Practical Business Mathematics, New Literature Publishing Company, Bombay, 1971.

[3] K. Selvakumar, Mathematics for Commerce, Notion Press, Chennai, 2014.

[4] Dinesh Khattar and S. R. Arora, Business Mathematics with Applications, S. Chand Publishing, New Delhi, 2001.

[5] N. G. Das and J. K. Das, Business Mathematics and Statistics, McGraw Hill, New Delhi, 2011.

[6] M. K. Bhowal, Fundamentals of Business Mathematics, Asian Books Pvt. Ltd., New Delhi, 2009

[7] Martin Anthony and Norman Biggs, Mathematics for Economics and Finance: Methods and Modelling, Cambridge University Press, Cambridge, 1996.

[8] Ahmad Nazri and Wahidudin, Financial Mathematics and its Applications, Ventus Publishing, APS, Denmark, 2011.

[9] S. C. Gupta and V. K Kapoor, Fundamentals of Mathematical Statistics, 12th Ed., Sultan Chand and Sons, New Delhi, 2020.

[10] S. P. Gupta, Statistical Methods, Sultan Chand and Sons, New Delhi, 2000.

[11] Parimal Mukhopadhya, Applied Statistics, New Central Book Agency Pvt. Ltd., Calcutta, 1999.

[12] A. M. Gun, M. K. Gupta, and B. Dasgupta, Fundamentals of Statistics, World Press Calcutta, 2008.

[13] S. C. Gupta and V. K Kapoor, Fundamentals of Applied Statistics, Sultan Chand and Sons, New Delhi, 2007

Self Study Toipcs

Unit-I: Interest**,** Concept of Present value and Future value, Simple interest, Compound interest

Unit-II: Techniques of Solving Problems involving number system and decimal Fractions

Unit-III: Percentage, Ratio and proportion, partnerships, Concepts of Time and distance

Self Study Topics: Short Cut methods on time and work, trains problems, Boats and streams etc. and quizzes on topics, Videos on the shortcut methods.

Open Elective

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

MAOE 152: Mathematics – II	
Teaching Hours : 3 Hours/Week	**Credits: 3**
Total Teaching Hours: 42 Hours	**Max. Marks: 100** **(S.A.- 60 + I.A. – 40)**

Learning Objectives:

- Learning Number Theory helps improving one's ability of mathematical thinking
- Student will able to understand Fermat's theorem, Wilson's theorem, Euler Phi- function, Finite continued product.
- Group theory will enable the students how to find the solutions to polynomial equations and has its full significance, as a mathematical formulation of symmetry, been understood.
- Students will able to know properties of groups such as subgroups, cyclicness.
- Compute partial derivatives of functions of several variables, totoal derivatives, mixed derivatives, Jacobinans, Maxima & Minima of functions
- Use iterated integrals to evaluate integrals over planar regions, and to calculate volume.Build on elementary integration techniques to evaluate multiple integrals efficiently.
- Set up and evaluate double integrals in polar coordinates.Set up and evaluate integrals to compute surface area.
- Set up and evaluate triple integrals in Cartesian coordinates.Set up and evaluate triple integrals in cylindrical and spherical coordinates.

Course Learning Outcomes: This course will enable the students to

CO 1 Identify cyclic and non-cyclic groups

CO 2 Recognize the mathematical objects called Groups.

CO 3 Link the fundamental concepts of groups and symmetries of geometrical objects.

CO 4 Explain the significance of the notions of Cosets, normal subgroups and factor groups.

CO 5 Find the extreme values of functions of two variables.

CO 6 Understand the concept of line integrals, multiple integrals and their applications.

Unit-I: Groups: Binary Operations, Associativity, Commutativity, Examples for Binary Operations, Definition of a Group, Examples, Right inverse, Left inverse, Some properties, Abelian and Non-abelian groups, Laws of exponents, Subgroups, Intersection of subgroups, Centralizer of an element,

Normalizer of a subgroup, Product of subgroups, Order of products of subgroups, Cyclic groups, Properties, Number of generators. **14 hrs**

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. **14hrs**

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 hrs**

Reference Books:

[1] N. S Gopalakrishnan, University Algebra, 3rd Ed., New Age International Publications, 2015.

[2] I. N. Herstein, Topics in Algebra, 2nd Ed., Wiley Publishers, 1975.

[3] A. R. Vasishtha and A. K. Vasishtha, Modern Algebra, Krishna Prakashan Mandir, Meerut, U.P., 2008.

[4] Bernald and Child, Higher Algebra, Arihant Publication India Limited, India, 2016.

[5] Vijay K Khanna and S K Bhambri, A Course in Abstract Algebra, 5th Ed., Vikas Publishing House, India, 2016.

[6] Shanthi Narayan and P. K. Mittal, Differential Calculus, Reprint, S Chand and Co. Pvt. Ltd., New Delhi, 2014.

[7] Shanti Narayan and P. K. Mittal, Integral Calculus. S. Chand Ltd., India, 2005.

[8] George B. Thomas and Ross L. Finney, Calculus and Analytic Geometry, Addison-Wesley, 1992.

[9] Maurice D. Weir, George B. Thomas, Jr., Joel Hass and Frank R. Giordano, Thomas' Calculus, 11th Ed., Pearson, 2008.

[10] S. Arora and S .C. Malik, Mathematical analysis, Wiley, India, 1992.

Self Study Topics:

Unit-II: Maxima-Minima of functions of one variable

Unit-III: Recapitulation of definite integrals and its properties

Activity: Seminars on Binary operations, Evaluation of Integration formals and its properties.

MAOE 153: Quantitative Techniques	
Teaching Hours : 3 Hours/Week	**Credits: 3**
Total Teaching Hours: 42 Hours	**Max. Marks: 100** **(S.A.- 60 + I.A. – 40)**

Learning Objective:

- This course enables students to develop their ability to reason by introducing them to elements on formal reasoning.
- The course will help to prepare students for success in future courses, gain skills for the Workplace, and participate as productive citizens in our society
- Defining the type and quantity of data need to be collected. Organizing and summarizing the data. Analyzing the data and drawing conclusions from it.

Course Outcome: The Students will be able

CO 1 : To distinguish the basic elements of arguments and recognize different types of arguments.

CO 2: Symbolize natural language statements in the language of propositional and predicate logic. Identify logical relations among statements; and analyze logically complex statements into their Truth-functional or quantificational components.

CO 3: To Use statistics to make decisions in financial planning and budgeting, while are guided by statistics in financial policy decisions. Banks use statistics to lower risk in lending operations, analyze activity in the financial market, and predict the impact of economic crises

Unit I: Reasoning Ability: Alphabet Test, Analogy, Arithmetical Reasoning, Blood Relations, Calendar and Clock test, Classification, Coding and Decoding, Cubes and Dices Test. **14 hrs**

Unit II: Logical Reasoning: Alpha Numeric Series, Reasoning analogies, Decision Making, Deductive Reasoning / statement Analysis, Pattern of sequences and series, Shape construction. **14 hrs**

Unit III : Probability and distribution, Tabulations, data interpretation, data sufficiency, and quantitative analysis,Bar Graphs, Pie charts, Line Graphs. True Discount & Banker's Discount**. 14hrs**

Books for Refernces:

1. Quantative Aptitude by R.S. Aggrwal

2. Quantative Aptitude by Vikas Experts, S. Chand Publishers

3. The Pearson Guide to Quatative Aptitude by Dinesh Kattar

- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3045202/
- https://www.careerbless.com/aptitude/qa/home.php
- https://www .indiabix.com/

Self Study Topics:

Unit-I: , Arithmetical Reasoning, Blood Relations, Calendar and Clock test

Unit III : Bar Graphs, Pie charts, Line Graphs.

Activities : Shortcut videos on various topics, Seminar / Group discussion on Alpha Numeric Series, Reasoning analogies, Decision Making , Probability and distribution

SEMESTER – III

MACT 201: Ordinary Differential Equations and Real Analysis – I	
Teaching Hours: 4 Hours/Week	**Credits: 4**
Total Teaching Hours: 56 Hours	**Max. Marks: 100** **(SEE- 60 + I.A. - 40)**

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

CO 1 Solve first-order non-linear differential equations and linear differential equations.

CO 2 To model problems in nature using Ordinary Differential Equations.

CO 3 Formulate differential equations for various mathematical models

CO 4 Apply these techniques to solve and analyze various mathematical models.

CO 5 Understand the fundamental properties of the real numbers that lead to define sequence and series, the formal development of real analysis.

CO 6 Learn the concept of Convergence and Divergence of a sequence.

CO 7 Able to handle and understand limits and their use in sequences, series, differentiation, and integration.

CO8 Apply the ratio, root, alternating series, and limit comparison tests for convergence and absolute convergence of an infinite series.

Ordinary Differential Equations:

Unit I: Recapitulation of Differential Equations of first order and first degree, 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. **14hrs**

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 xV (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 $P\,dx + Q\,dy + R\,dz = 0$. **14 hrs**

Unit III: Sequences: Recapitulation of number system - Real line, bounded sets, suprimum and infimum of a set, Archimedean property of R. Intervals, neighborhood of a point, open sets, closed sets, limit points.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. Cauchy's general principle for convergence of a sequence. Subsequence and their properties**.** **14 hrs**

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 hrs**

Reference Books:

1. M. D. Raisinghania, *Ordinary Differential Equations & Partial Differential Equations*, S. Chand & Company, New Delhi, 20 t h Edition- 2020. (For Unit I and Unit II)
2. S. C. Malik, and Savitha Arora, *Mathematical Analysis*, New Age International Publishers, 5th Edition- 2017. (For Unit III and Unit IV)
3. J. Sinha Royand SPadhy: *A Course of Ordinary and Partial Differential Equation*, Kalyani Publishers, New Delhi, 4th Edition - 2014.
4. D. Murray*, Introductory Course in Differential Equations*, Orient Black Swan - 2016
5. W. T. Reid, *Ordinary Differential Equations*, John Wiley, New York - 1971.
6. S. L. Ross, *Differential Equations,* John Wiley and Sons, 3rdEdition - 1984.
7. R. G. Bartle and D. R. Sherbert, *Introduction to Real Analysis*, John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 3rdEdition - 2015.
8. K. A. Ross*, Elementary Analysis: The Theory of Calculus*, Springer, 2ndEdition - 2013
9. S. K. Berberian, *A First Course in Real Analysis,* Springer Verlag, NewYork -1994.
10. T. Apostol, *Mathematical Analysis*, Narosa Publishing House, 2nd Edition - 2002.
11. E. D. Rainville and P. E. Bedient, *Elementary Differential Equations*, Pearson, 8th Edition

- 1996.

Self study topics

Unit I: Recapitulation of Differential Equations of first order & first degree, Exact Differential equations.

Unit III: Sequences Recapitulation of number system - Real line.

Activities:

Unit I: Problem solving TED vedios on Orthogonal trajectories of Cartesian and polar curves problem.

Unit IV: Comparison tests for positive term series. D'Alembert's ratio test, Raabe's test. Cauchy's Root test and Cauchy's integral test.

PRACTICAL

MACP 201: Practical on Ordinary Differential Equations and Real Analysis – I	
Teaching Hours: 4 Hours/Week	**Credits: 2**
Total Teaching Hours: 56 Hours	**Max. Marks: 50 (SEE - 25 + I.A. – 25)**

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

CO 1 Free and Open Source software (FOSS) tools or computer programming.

CO 2 Solving exact differential equations

CO 3 Plotting orthogonal trajectories

CO 4 Finding complementary function and particular integral of linear and homogeneous differential equations.

CO 5 Acquire knowledge of applications of real analysis and differential equations.

CO 6 Verification of convergence/divergence of different types of series

Practical/Lab Work to be performed in Computer Lab

Use open-source software to executive the practical problems. (Maxima/Scilab/MatLab/Mathematica/Python)

1. Fundamentals of Ordinary differential equations and Real analysis using FOSS
2. Verification of exactness of a differential equation
3. Plot orthogonal trajectories for Cartesian and polar curves
4. Solutions of differential equations that are solvable for x, y, p.
5. To find the singular solution by using Clairaut's form.
6. Finding the Complementary Function and Particular Integral of linear and homogeneous differential equations with constant coefficients and plot the solutions.
7. Finding the Particular Integral of differential equations up to second order and plot the solutions.
8. Solutions to the Total and Simultaneous differential equations and plot the solutions.
9. Test the convergence of sequences
10. Verification of exponential, logarithm and binomial series.

11. Verification of geometric series, *p*-series, Cauchy's Integral test, root test, and D Alembert's Test
12. Examples on a series of positive terms.
13. Examples on alternating series using Leibnitz's theorem.
14. Finding the convergence of series using Cauchy's criterion for partial sums.

Open Elective Course

(For students of other than Science stream)

MAOE 201: Quantitative Mathematics	
Teaching Hours : 3 Hours/Week	**Credits: 3**
Total Teaching Hours: 42 Hours	**Max. Marks: 100** **(SEE - 60 + IA - 40)**

Course Outcomes: This course will enable the students to:

CO 1 Understand number system and fundamental operations

CO 2 Understand the concept of linear quadratic and simultaneous equations and their applications in real life problems

CO 3 Understand and solve the problems based on Age.

CO 4 Solve Speed and Distance related problems.

Unit-I: Algebra

Set theory and simple applications of Venn Diagram, relations, functions, indices, logarithms, permutations and combinations. Examples on commercial mathematics. **14 hrs**

Unit-II: 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 Hrs**

Unit-III: Theory of equations

Linear equations, quadratic equations, simultaneous equations in two variables, simple application problems - Problems on Ages, Problems on conditional Age calculations, Present & Past age calculations. **14 Hrs**

Reference Books:

1. R.S. Aggarwal, *Quantitative Aptitude*, S. Chand and Company Limited, New Delhi -2021.
2. Abhijit Guha, *Quantitative Aptitude*, Mc.Grawhill publications, 5th Edition - 2014.
3. R. V. Praveen, *Quantitative Aptitude and Reasoning*, PHI publishers, 3rd Edition – 2016.
4. R. S. Aggarwal, *Objective Arithmetic*, S. Chand & Company Ltd, Revised Edition – 2018.

5. Qazi Zameeruddin,Vijay K. Khanna, S. K. Bhambri, *Business Mathematics, S. Chand* publications, 2nd*Edition - 2009*
6. S. K. Sharma and Gurmeet Kaur, *Business Mathematics*, Sultan Chand & Sons – 2019.
7. Hazarika Padmalochan, *A Text Book of Business mathematics for B.Com and BBA Course,* S. Chand Publication - 2017
8. N. G. Dasand, J. K. Das, *Business Mathematics and Statistics,* Mc.Grawhill Education - 2017.

Self study Topics:

Unit I: Set theory and simple applications of Venn Diagram, relations, functions, indices, logarithms, permutations and combinations.

Unit-III: Linear equations, quadratic equations, simultaneous equations in two variables

Activities: Seminar on Operations on Numbers, Tests on Divisibility, HCF and LCM of numbers, Linear equations, quadratic equations,

Open Elective Course

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

MAOE202: Ordinary Differential Equations	
Teaching Hours: 3 Hours/Week	**Credits: 3**
Total Teaching Hours: 42 Hours	**Max. Marks: 100 (SEE - 60 + I.A. – 40)**

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

CO 1 Understand the concept of the differential equation and their classification

CO 2 Know the meaning of the solution of a differential equation.

CO 3 To solve first-order ordinary differential equations.

CO 4 To solve exact differential equations and Converts to separable and homogenous equations to exact differential equations by integrating factors.

CO 5 To Solve Bernoulli differential equations.

CO 6 To find the solution to higher-order linear differential equations.

Unit I: Recapitulation of Differential Equations of first order and first degree, Exact Differential equations, Necessary and sufficient condition for the equations to be exact, Reducible to the exact differential equations. **14hrs**

Unit II: 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. **14hrs**

Unit III: 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, $e^{ax}V$ where V is a function of x. **14 hrs**

Reference Books:

2. M. D. Raisinghania, *Ordinary Differential Equations & Partial Differential Equations*, S. Chand & Company, New Delhi, 20 t h Edition – 2020. (For Unit I and Unit II)
3. J. Sinha Roy and S Padhy : *Acourse of Ordinary and Partial Differential Equation,*

Kalyani Publishers, New Delhi, 4th Edition - 2014.

4. D. Murray, *Introductory Coursein Differential Equations*, Orient BlackSwan–2016.
5. W. T. Reid, *Ordinary Differential Equations,* John Wiley, New York - 1971.
6. S. L. Ross, *Differential Equations,* John Wiley and Sons, 3rd Edition -1984.

Self study topics

Unit I : Recapitulation of Differential Equations of first order and first degree, Exact Differential equations, Differential equations of the first order and higher degree.

Activities: TED vedios on Various type of solving differential equations,Quizzing on the topics, seminar on the topics.

Open Elective Course

(For Students of other than Science Stream)

MAOE203 : 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:

CO 1 Understand the Vedic methods of arithmetic

CO 2 Understand the Vedic methods of division with two/three digit divisor

CO 3 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 hrs**

Unit-II:

Part A: Division

1. NikhilamNavtashchramamDashtaha (two digits divisor)
2. ParavartyaYojyet method (three digits divisor)

Part B: Divisibility

1. Ekadhikenpurven method (two digits divisor)
2. Eknunenpurven method (two digits divisor) **14 Hours**

Unit-III:

Power and Root Power:

1. Square (two digit numbers)
2. Cube (two digit numbers).

Root:

1. Square root (four digit number)

2. Cube root (six digit numbers).
3. Solution of linear simultaneous equations. **14 Hours**

Reference Books:

1. *Vedic Mathematics*, **Motilal Banarsidass Publishers,** NewDelhi -1990
2. *Vedic Ganita*: Vihangama Drishti-1,SikshaSanskriti Uthana Nyasa,NewDelhi.
3. *Vedic Ganita Praneta*, Siksha Sanskriti Uthana Nyasa, NewDelhi.
4. *Vedic Mathematics:Past, Present and Future*, Siksha Sanskriti Uthana Nyasa,NewDelhi.
5. Leelavati, Chokhambba Vidya Bhavan, Varanasi.
6. *Bharatiya Mathematicians*, Sharda Sanskrit Sansthan, Varanasi.

Self study topics:

Unit III : Finding the square root, Cube roots , solutions on linear equations

Activities: Assignments / Seminars by the students on problems various methods.

SEMESTER – IV

MACT251: Partial Differential Equations and Integral Transforms	
Teaching Hours: 4 Hours/Week	**Credits: 4**
Total Teaching Hours: 56 Hours	**Max. Marks: 100 (SEE - 60 + I.A. – 40)**

Course Learning Outcomes: This course will enable the students to

CO 1 Solve the Partial Differential Equations of the first order and second order

CO 2 Formulate, classify and transform partial differential equations into canonical form.

CO 3 Solve linear and non-linear partial differential equations using various methods; and apply these methods to solving some physical problems.

CO 4 Able to take more courses on wave equation, heat equation, and Laplace equation.

CO 5 Solve PDE by Laplace Transforms and Fourier Transforms

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 $Pp + Qq = R$, Standard types of first order non-linear partial differential equations, The integrals of the non-linear equation by Charpit's method.

14 hrs

Unit II: Homogeneous linear partial differential equations with constant coefficients. Partial differential equations of the second order. Classification of second-order partial differential equations, canonical forms. Classification of second order linear equations as hyperbolic, parabolic, and elliptic. Solutions of the Heat equation, Laplace equation and Wave equation (using separation of variables). **14 hrs**

Unit III: Laplace Transforms: Definition**,** Basic Properties. Laplace transforms 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 Hrs

Unit IV: Fourier Series and Transforms: Periodic functions. Fourier Coefficients. Fourier series of functions with period 2 and period 2L. Fourier series of even and odd functions. Half range Cosine and Sine series. Fourier Transforms - Finite Fourier Cosine and Sine transform. Transforms

of derivates**.** Applications of Fourier Transforms**.** **14 Hrs**

Reference Books:

1. D. A. Murray, *Introductory Course in Differential Equations,* Orient and Longman - 2017
2. H. T. H. Piaggio, *Elementary Treatiseon Differential Equations and their Applications,* CBS Publisher & Distributors, Delhi - 1985.
3. G. F. Simmons, *Differential Equations,* Tata McGrawHill, 1st Edition – 2006.
4. S. L. Ross, *Differential Equations*, JohnWileyand Sons, India, 3rdEdition -2004.
5. M. D. Raisinghania, *Ordinary Differential Equations & Partial Differential Equations*, S. Chand & Company, New Delhi, 20th Edition – 2020.
6. K. Sankara Rao, *Introductionto Partial Differential Equations*, PHI, 3rdEdition -2015.
7. Ion N. Sneddon, *Elements of Partial differential equations*, McGraw-Hill International Editions -1986.
8. R. Murray and L. Spiegal (Schaum's Series), *Laplace Transforms,* McGraw Hill Education – 2005.
9. J. K. Goyal and K. P. Gupta, *Laplace and Fourier Transforms*, Pragathi Prakashan – 2016.
10. Sudhir Kumar, *Integral Transform Methods in Science & Engineering*, CBS Engineering Series - 2017.
11. Earl David Rainville and Philip Edward Bedient, *Ashortcoursein Differential Equations*, Prentice Hall College Div, Pearson College Div, 6th edition - 1981.
12. Sathya Prakash, *Mathematical Physics with classical Mechanics*, S Chand and Sons, New Delhi -2014

Self study topics:

Unit I: Basic concepts–Formation of a partial differential equations by elimination of arbitrary constants and functions. Periodicity of functions and its proierties.

Activities: Seminar on periodicity of functions, TED vedios on Laplace transformations & Fourier transformation application

PRACTICALS

MACP 201: 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)**

Mathematics practical with Free and open Source Software (FOSS) tools for computer programs

Course Learning Outcomes: This course will enable the students to

CO 1 Learn Free and Open Source software (FOSS) tools or computer programming.

CO 2 Solve problems on Partial Differential Equations and Integral Forms

CO 3 To find Laplace transform of various functions

CO 4 To find the Fourier Transform of periodic functions

CO5 To solve differential equation by using Integral transform

Programs using Scilab/Maxima/Python:

1 Elements of Partial differential equations and Integral transforms using FOSS

2 Solutions of Linear Partial differential equations of type1 to type4 and Lagrange's method

3 Solutions of partial differential equation using Charpit's method.

4 Solutions of Second order homogenous partial differential equation with constant coefficients.

5 Solutions to the partial differential equations using separation of variables method (Heat/ Wave/Laplace).

6 Finding the Laplace transforms of some standard and periodic functions.

7 Finding the inverse Laplace transform of simple functions

8 Verification of Convolution Theorem.

9 To solve ordinary linear differential equation using Laplace transform.

10 To solve Integral equation using Laplace transform.

11 To find full range Fourier series of some simple functions with period 2 and 2L

12 To find Half range sine and cosine series of some simple functions and ploting them.

13 To find Cosine Fourier transforms.

14 To find Sine Fourier transforms.

Open Elective Course

(For students of other than Science stream)

MAOE 251: Quantitative Mathematics	
Teaching Hours : 3 Hours/Week	**Credits: 3**
Total Teaching Hours: 42 Hours	**Max. Marks: 100** **(SEE - 60 + IA - 40)**

Course Outcomes: This course will enable the students to:

CO 1 Understand number system and fundamental operations

CO 2 Understand the concept of linear quadratic and simultaneous equations and their applications in real life problems

CO 3 Understand and solve the problems based on Age.

CO 4 Solve Speed a/nd Distance related problems.

Unit-I: Algebra

Set theory and simple applications of Venn Diagram, relations, functions, indices, logarithms, permutations and combinations. Examples on commercial mathematics. **14 hrs**

Unit-II: 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 Hrs**

Unit-III: Theory of equations

Linear equations, quadratic equations, simultaneous equations in two variables, simple application problems - Problems on Ages, Problems on conditional Age calculations, Present & Past age calculations. **14 Hrs**

Reference Books:

1. R.S. Aggarwal, *Quantitative Aptitude*, S. Chand and Company Limited, New Delhi -2021.
2. Abhijit Guha, *Quantitative Aptitude*, Mc.Grawhill publications, 5th Edition - 2014.
3. R. V. Praveen, *Quantitative Aptitude and Reasoning*, PHI publishers, 3rd Edition – 2016.

4. R. S. Aggarwal, *Objective Arithmetic*, S. Chand & Company Ltd, Revised Edition – 2018.
5. Qazi Zameeruddin,Vijay K. Khanna, S. K. Bhambri, *Business Mathematics, S. Chand* publications, 2nd*Edition - 2009*
6. S. K. Sharma and Gurmeet Kaur, *Business Mathematics*, Sultan Chand & Sons – 2019.
7. Hazarika Padmalochan, *A Text Book of Business mathematics for B.Com and BBA Course,* S. Chand Publication - 2017
8. N. G. Dasand, J. K. Das, *Business Mathematics and Statistics,* Mc.Grawhill Education - 2017.

Self study Topics:

Unit I: Set theory and simple applications of Venn Diagram, relations, functions, indices, logarithms, permutations and combinations.

Unit-III: Linear equations, quadratic equations, simultaneous equations in two variables

Activities: Seminar on Operations on Numbers, Tests on Divisibility, HCF and LCM of numbers,Linear equations, quadratic equations

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

MAOE 252: Partial Differential Equations	
Teaching Hours: 3 Hours/Week	**Credits: 3**
Total Teaching Hours: 42 Hours	**Max. Marks: 100 (SEE-60 + I.A. – 40)**

Course Learning Outcomes: This course will enable the students to

CO 1 Explain the concept of the differential equation.

CO 2 Classifies the differential equations concerning their order and linearity.

CO 3 Explains the meaning of the solution of a differential equation.

CO 4 Solve first-order ordinary differential equations.

CO 5 Solves exact differential equations and Converts separable and homogenous equations to exact differential equations by integrating factors.

CO 6 Solves Bernoulli differential equations.

CO 7 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 $Pp + Qq = R$. **14 Hrs**

Unit II : Standard types of first order non-linear partial differential equations, The integrals of the non-linear equation by Charpit's method. Homogeneous Linear partial differential equations with constant coefficients. Partial differential equations of the second order. Classification of second- order partial differential equations, canonical forms. **14 hrs**

Unit III: Classification of second order linear equations as hyperbolic, parabolic, and elliptic. Solutions of the Heat equation, Laplace equation and Wave equation (using separation of variables). **14 hrs**

Reference Books:

1. D. A. Murray, *Introductory Course in Differential Equations,* Orient and Longman - 2017
2. H. T. H. Piaggio, *Elementary Treatiseon Differential Equations and their Applications,* CBS Publisher & Distributors, Delhi - 1985.
3. G. F. Simmons, *Differential Equations,* Tata McGrawHill, 1st Edition – 2006.
4. S. L. Ross, *Differential Equations*, JohnWileyand Sons, India, 3rdEdition -2004.
5. M. R. Speigel, *Schaum's outline of Laplace Transforms* – 2005.
6. M. D. Raisinghania, *Ordinary Differential Equations & Partial Differential Equations*, S. Chand & Company, New Delhi, 20th Edition - 2020
7. K. Sankara Rao, *Introductionto Partial Differential Equations*, PHI, 3rdEdition -2015.
8. Ion N. Sneddon, *Elements of Partial differential equations*, McGraw-Hill International Editions -1986.

Self study topics:

Unit III: Solutions of the Heat equation, Laplace equation and Wave equation (using separation of variables).

Activities: Seminar on Heat equations, wave equations, Laplace equations and problems. Quizzes on the topics

Open Elective Course

(For students of other than science stream)

MAOE 253: Mathematical Finance	
Teaching Hours: 3Hours/week	**Credits: 3**
Total Teaching Hours:42Hours	**Max.Marks:100** **(S.A-60+I.A.-40)**

Course Learning Outcomes: This course will enable the students to

CO 1 Understand how compute profit and loss, discount and Banker's discount.

CO 2 Understand the concept of Linear equations and inequalities and their use in the solving the Linear Programming Problems.

CO 3 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. **14Hrs**

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 Hrs**

Unit-III: Transportation problem : Introduction, Formulation of Transportation problem, Initial basic feasible solution, Steps involving a transportation problem, optimality check, special cases in Transportation problem. The Traveling salesman Problem (Routing Problem). **14 Hrs**

Reference Books:

1. R. S. Aggarwal, *Objective Arithmetic*, S. Chand & Company Ltd, Revised Edition - 2018.
2. Mizrahiand Sullivan, *Mathematics for Business and Social Sciences an Applied approach,* John Wiley & Sons – 1976.
3. Qazi Zameeruddin,Vijay K Khanna, S K Bhambri, *Business Mathematics,* Vikas Publishing House, 2nd Edition.
4. S. Kalavathy*, Operation Research*, Vikas publication house Pvt. Ltd, 4th Edition – 2013.
5. Sreenivasa Reddy M, *Operations Research*, Sanguine Technical publishers, Bangalore, 2ndedition – 2019.

6. S. D. Sharma, *Operation Research*, 20th Edition – 2014.

Self Study topics:

Unit-I : Basic formula related to profit, loss, discount and brokerage

Unit II : Linear equations and inequalities- Rectangular coordinates, straight line, parallel and intersecting lines and linear inequalities,

Unit II : Introduction, Formulation of Transportation problem, Initial basic feasible solution

Activities:

Assignments / Seminars on mathematical formulation of LPP, Solution of a LPP by graphical method, special cases in graphical method, real life application on Traveling salesman Problem (Routing Problem)

Open Elective Course

(For students other than science stream)

MAOET 254: 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

CO 1 Understand the mathematical concept of sets and counting problems.

CO 2 Understand the concept of Probability and its applications in social sciences.

CO 3 Understand the concept of limits and continuity of functions and its applications in business and social sciences.

Unit-I : Sets, counting, permutations, combinations, counting problems, binomial theorem and problems thereon. Probability – Introduction, sample space and assignment of probabilities, properties of the probability of an event, probability of equally likely events, conditional probability, Baye's formula and examples thereon**.** **15 Hours**

Unit-II: Limit and continuity, Derivative- interpretation, derivative formulas, general derivatives for differentiation, composite functions, higher order derivaties 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, Otimal trade-in time, and minimizing inventory cost. **14 Hours**

REFERENCE BOOKS

1. Abe Mizrahi and Michael Sullivan, *Mathematics for Business and Social Sciences and Applied Approach,* John Wiley & Sons, 4th Edition - 1988.
2. Carl P. Simon and Lawrence Blume*, Mathematics for Economists,* Viva Books Private Limited, New Delhi - 2018.
3. L. Peccati, M. D'Amico and M. Cigola*, Maths for Social Sciences,* Springer – 2018.

Self study topics :

Unit I : Sets, counting, permutations, combinations, counting problems

Unit II: Limit and continuity, Derivative- interpretation, derivative formulas

Unit III : Applications of the derivative – Relative maxima and Relative minima.

Activities :Seminars on the topics set theory, permuction & combination topics, sample space and assignment of probabilities, properties of the probability of an event, probability of equally likely events, conditional probability

SEMESTER-V

MACT301: Real Analysis-II and Complex Analysis	
Teaching Hours : 4 Hours/Week	**Credits: 4**
Total Teaching Hours: 60 Hours	**Max. Marks: 100** **(S.A.-60 + I.A. – 40)**

Course Objective:

1.To understand the concept of Improper Integrals & to know about properties of integrals by studying various theorems

2.Test for the convergence and divergence of the integrals

3.Gama and Beta functions for evaluating the improper Integrals

4. Applications to evaluate the definite integrals

5. To understand the concept of complex numbers, Algebra of complex numbers, Polar & exponential forms of complex numbers, Demovier's theorem and applications

6. To understand the limits, continuity, and differentiability of functions

7. To know about analyticity and harmonic properties of compelx functions through related theorems

Course Learning Outcomes:

The overall expectation from this course is that the student builds a basic understanding on Riemann integration and elementary complex analysis. The broader course outcomes are listed as follows. At the end of this course, the student will be able to:

1. Carry out computations of upper and lower Riemann sums as well definite integrals.
2. Describe various criteria for Integrability of functions.
3. Evaluate some improper integrals and Evaluate double integrals by using Beta, Gamma functions.
4. Exhibit certain properties of mathematical objects such as integrable functions, analytic functions, harmonic functions and so on.
5. Prove some statements related to Riemann integration as well as in complex analysis.
6. Carry out the existing algorithms to construct mathematical structures such as analytic functions.
7. Evaluate complex line integrals using definition and some well known theorems.
8. Apply the gained knowledge to solve various other problems.

Real Analysis-II

Unit – I: Riemann Integration

Definition and Existence of the Integral, Riemann Darboux Sums - Upper and lower (Darboux) sums - definition, properties and problems. Riemann Integral - Upper and Lower integrals (definition & problems), Inequalities for Integrals, Refinement of Partitions, Darboux's theorem, Conditions of Integrability, Integrability of Sum, Difference, Product, Quotient and Modulus of integrable functions. Integral as a limit of sum (Riemann sums), Some Applications, Some Integrable Functions – Integrability of continuous functions, monotonic functions, bounded function with finite number of discontinuity. **15 hrs**

Unit –II: Improper Integrals

Improper integrals of the first, second and third kind with examples. Improper integral as the limit of the proper integral. Comparison test, Abel's test and Dirichlet's test for the convergence of the integral of a product of two functions. Beta, Gamma functions - Definitions, properties and examples, Relations between Beta and Gamma functions, Applications to evaluation of definite integrals, Duplication formula and applications. **15hrs**

Complex Analysis

Unit – III: Complex numbers and functions of complex variables:

Complex numbers: Sums and Products, Basic Algebraic Properties, Further Properties, Vectors and Moduli, Complex Conjugates, Exponential Form, Products and Powers in Exponential Form, Arguments of Products and Quotients, Roots of Complex Numbers, and examples, Regions in the complex plane.

Analytic Functions: Functions of a Complex Variable, Mappings, Mappings by the Exponential Function, Limits, Theorems on Limits, Limits Involving the Point at Infinity, Continuity, Derivatives, Differentiation Formulas, Cauchy–Riemann Equations, Sufficient Conditions for Differentiability, Polar Coordinates, Analytic Functions and examples, Harmonic Functions. 15hrs

Unit –IV: Complex Integration

Derivatives and Definite Integrals of Complex valued Functions of Real Variable, Contours, and Contour Integrals with Examples, Examples with Branch Cuts, Upper Bounds for Moduli of Contour Integrals, Antiderivatives, Cauchy–Goursat Theorem, Simply Connected Domains, Multiply Connected Domains, Cauchy Integral Formula, An Extension of Cauchy Integral Formula,

Some Consequences of the Extension. **15hrs**

Reference Books:

[1] S.C. Malik and Savita Arora, *Mathematical Analysis*, 2nd ed. New Delhi, India: New Age international (P) Ltd.

[2] Maurice D. Weir, George B. Thomas, Jr., Joel Hassand Frank R. Giordano, Thomas' Calculus, 11th Ed., Pearson, 2008.

[3] R.V. Churchil & J.W. Brown, *Complex Variables and Applications*, 5th ed, McGraw Hill Companies.

[4] S.C Malik, *Real Analysis,* New Age International (India) Pvt. Ltd.

[5] Richard R Goldberg, *Methods of Real Analysis*, Oxford and IBH Publishing.

[6] Ajit Kumar and S. Kumaresan - *A Basic Course in Real Analysis*, Taylor and Francis Group.

[7] L. V. Ahlfors, *Complex Analysis*, 3rd Edition, McGraw Hill Education.

[8] Bruce P. Palka *, Introduction to the Theory of Function of a Complex Variable*, Springer

[9] Serge Lang, *Complex Analysis*, Springer.

[10] Shanthinarayan, *Theory of Functions of a Complex Variable,* S. Chand Publishers.

[11] S. Ponnuswamy, *Foundations of Complex Analysis*, 2nd Edition, Alpha Science International Limited.

[12] Grewal, B. S., & Grewal, J. S. (1996). Higher engineering mathematics. 42nd Ed., Khanna Publishers, New Delhi.

[13] Shanthi Narayan, P. K. Mittal (2004), Theory of Functions of a Complex Variable, Revised Ed. S. Chand and Company Ltd. New Delhi.

Self Study Topics:

Unit II

1. Improper integrals of the first, second and third kind with examples.

Unit III

1. Complex numbers: Sums and Products, Basic Algebraic Properties, Further Properties, Vectors and Moduli,
2. Complex Conjugates, Exponential Form, Products and Powers in Exponential Form, Arguments of Products and Quotients

Activities: Seminar on Complex numbers and problems, Quizzes and TED videos on the topics.

MACP301: Practicals on Real Analysis-II and Complex Analysis	
Practical Hours : 4 Hours/Week	**Credits: 2**
Total Practical Hours: 60 Hours	**Max. Marks: 50 (S.A.- 25 + I.A. – 25)**

Course Learning Outcomes: This course will enable the students to

1. Learn *Free and Open Source Software* (FOSS) tools for computer programming
2. Solve problem on Real Analysis and Complex Analysis studied in MATDSCT 5.1 by using FOSS softwares.
3. Acquire knowledge of applications of Real Analysis and Complex Analysis through FOSS.

Practical/Lab Work to be performed in Computer Lab

Suggested Software: Maxima/Scilab/Python/R.

Suggested Programs:

1. Program to find upper and lower Riemann sums with respect to given partition
2. Program to test Riemann Integrability.
3. Program to evaluate Riemann integral as a limit of sum.
4. Program to check the convergence of the given improper integral using Abel's test.
5. Program to check the convergence of the given improper integral using Dirichlet's test.
6. Programs to evaluate improper integrals using Beta/Gamma Functions.
7. Program to illustrate applications of duplication formula for Beta/Gamma functions.
8. Program to find the nth roots of a given complex number.
9. Program on verification of Cauchy – Riemann equations (Cartesian form) or test for analyticity.
10. Program on verification of Cauchy – Riemann equations (Polar form) or test for analyticity.
11. Program to check whether a function is harmonic or not.
12. Program to construct analytic functions (through Milne–Thompson method).
13. Program to evaluate Definite Integrals of Complex valued Functions of Real Variable.
14. Program to illustrate evaluation of integrals using Cauchy's integral theorem.

MACT302: Algebra and Graph Theory	
Teaching Hours : 4 Hours/Week	**Credits: 4**
Total Teaching Hours: 60 Hours	**Max. Marks: 100** **(S.A.-60 + I.A. – 40)**

Course Objectives:

1. To understand the significance of normal subgroups and quotient groups.
2. To identify and analyze the algebraic structures such as ring, field and integral domain
3. To understand the basic terminologies used in the theory of graphs.
4. To understand the importance of cutsets, connectivity, planarity and colorability in the theory of graphs.
5. To apply graph theoretic tools to solve real life problems.

Course Learning Outcomes: The overall expectation from this course is that the student builds a basic understanding on the theory of groups and some elementary concepts of graph theory. This course will enable the students to:

1. Know the significance of normal subgroups and quotient groups.
2. Understand structure preserving mapping between two algebraic structures of the same type.
3. Know the algebraic structures having the same structure with different elements.
4. Identify and analyze the algebraic structures such as ring, field and integral domain
5. Know the basic terminologies used in the theory of graphs.
6. Study the graphs which are used to model pair wise relations between the objects which will help in understanding the networking, optimization, matching and operation.
7. Understand the importance of cutsets, connectivity, planarity and colorability in the theory of graphs.
8. Apply graph theoretic tools to solve real life problems.

Algebra

Unit I: More on Groups: Congruence relation in subgroups, Cosets, Theorem on cosets, Lagrange's theorem and applications, Index of a subgroup, Normal Subgroups, Quotient groups. Homomorphism, Kernel of a homomorphism, Isomorphism, First Isomorphism theorem, Automorphisms. Permutation

groups, Cycles, Transpositions, Type of permutations, Length of a cycle, Index of S_n, Alternating group, Order of a permutation. **15 hrs**

Unit II: Rings, Integral Domains, Fields

Rings : Definition and examples, Commutative Rings, Subrings, Integral Domain, Division Ring, Fields, Properties of Rings, Characteristic of an Integral Domain, Homomorphism, Kernel, Isomorphism, Ideals, First Isomorphism theorem in Rings, Prime and Maximal Ideals, Quotient Rings**.** **15 hr**

Unit III:

Graph Theory

Graphs, Finite and infinite graphs, Incidence and degree, Isolated vertex, Pendent vertex, Null graph, Isomorphism, Sub graph, Walks, Paths, Circuits, Connected and Disconnected graphs, components, Euler graphs, Operation on graphs, Hamiltonian paths, Circuits, Tees and some properties of trees, Rooted and Binary trees, Spanning tree and Fundamental circuit. **15 hrs**

Reference Books

[1] I N Herstein (1990), Topics in Algebra, 2nd Edition, Wiley Eastern Ltd., New Delhi.

[2] Vijay K Khanna and S K Bhambri (1998), A Course in Abstract Algebra, Vikas Publications.

[3] Michael Artin (2015), Algebra, 2nd ed., Pearson.

[4] Joseph A, Gallian (2021), Contemporary Abstract Algebra, 10th ed., Taylor and Francis Group.

[5] C. L. Liu (2000), Elements of Discrete Mathematics, Tata McGraw-Hill.

[6] Hari Kishan and Shiv Raj Pundir (2015), Discrete Mathematics, Pragathi Prakashan, 10th ed.

[7] W D Wallis (2017), A Beginner's Guide to Discrete Mathematics for Computer Science, Wiley Publishers.

[8] Kenneth H. Rossen, Discrete Mathematics and its Applications, Mc-Graw Hill, 8th ed., 2021.

[9] Frank Harary (1969), Graph Theory, Addison-Wesley Pub. Company.

[10] N. Deo (1990), Graph Theory: Prentice Hall of India Pvt. Ltd. New Delhi.

[11] D B West (2001), Introduction to graph theory 2nd Ed., Pearson.

Self Study Topics:

Unit I (2 hours)

1. Congruence relation in subgroups, Cosets,
2. Theorem on cosets, Lagrange's theorem and applications, Index of a subgroup

MACP302:Practicals Algebra and Graph Theory	
Teaching Hours : 4 Hours/Week	**Credits: 2**
Total Teaching Hours: 60 Hours	**Max. Marks: 50 (S.A.-25 + I.A. – 25)**

Course Learning Outcomes: This course will enable the students to

1. Learn *Free and Open Source Software (FOSS)* tools for computer programming
2. Solve problems related to Algebra and Graph Theory using FOSS software.

Practical/Lab Work to be performed in Computer Lab (FOSS) Suggested Software: Maxima/Scilab /Python/R.

Suggested Programs:

1. Verification of Lagrange's theorem
2. Examples to find left and right cosets and finding index of a group
3. Finding all Normal Subgroups of a group.
4. Finding whether a given Permutation is even and odd and its order.
5. Checking whether a given set is a ring with respect to given binary operations.
6. Checking whether a given set is an integral domain or field with respect to given binary operations.
7. Finding zero divisors and units in finite rings.
8. Verification of the given mapping for ring homomorphism.
9. Drawing some standard graphs like Dodecahedron, wheel graph, Peterson graph.
10. Checking planarity, finding number of edges, vertex and edge connectivity, center, radius, and diameter.
11. Checking for Hamiltonian path/circuit in a graph.
12. Checking for Eulerian path/cycle in a graph.
13. Finding shortest path between two vertices.
14. Finding vertex coloring and redrawing the graph with colouring for vertices and finding chromatic number.

SEMESTER – VI

MACT351:Linear Algebra	
Teaching Hours : 4 Hours/Week	**Credits: 4**
Total Teaching Hours: 60 Hours	**Max. Marks: 100 (S.A.-60 + I.A. – 40)**

Course Learning Outcomes:

The overall expectation from this course is that the student will build a basic understanding in few areas of linear algebra such as vector spaces, linear transformations and inner product spaces. Some broader course outcomes are listed as follows. At the end of this course, the student will be able to

1. Understand the concepts of Vector spaces, subspaces, bases dimension and their properties.
2. Find a basis and compute the dimension of a given finite dimensional vector space.
3. Use matrix representation of linear transformations in various computations.
4. Become familiar with the concepts Eigen values and Eigen vectors, minimal polynomials, linear transformations etc.
5. Learn properties of inner product spaces and determine orthogonality in inner product spaces.
6. Prove various statements in the context of vectors spaces.
7. Realize importance of adjoint of a linear transformation and its canonical form.
8. Apply the techniques of diagonalization in solving various problems related to matrices.

Unit – I: Vector spaces: Vector spaces - Definition, Examples and properties, Subspaces - Examples, Criterion for a sub- set to be a subspace and some properties. Linear Combination - Linear span, Linear dependence and Linear independence, Basic properties of linear dependence and independence, Techniques of determining linear dependence and independence in various vector spaces and related problems. Basis and dimension - Co-ordinates, Ordered basis, Some basic properties of basis and dimension and subspace spanned by given set of vectors, Quotient space, Dimension of quotient space (derivation in finite case). Sum and Direct sum of subspaces - Dimensions of sum and direct sum spaces (derivation in finite case). 15hrs

Unit – II: Linear Transformations: Linear transformation - Definition, Examples, Equivalent criteria, Some basic properties, Matrix representation, Change of basis and effect on associated

matrix, Similar matrices; Rank - Nullity theorem - Null space, Range space, Proof of rank nullity theorem and relatedproblems. **15hrs**

Unit – III: Isomorphism, Eigenvalues and Diagonalization Homomorphism, Isomorphism and automorphism - Examples, Order of automorphism and Fundamental theorem of homomorphism; Eigenvalues and Eigen vectors - Computation of eigen values, Algebraic multiplicity and some basic properties of eigen values, Determination of eigenvectors and eigen space and geometric multiplicity. Diagonalizability of linear transformation - Meaning, Condition based on algebraic and geometric multiplicity and related problems. **15hrs**

Unit – IV: Invertible Transformation and Inner product spaces: Invertible transformation - Some basic properties of invertible, singular and non-singular transformations, Conditions for existence of inverses, Minimal polynomial of a transformation**,** Relation between characteristic and minimal polynomials and related problems.Inner product and normed linear spaces - Definitions, Examples, Cauchy-Schwartz inequality and related problems; Gram-Schmidt orthogonalization - Orthogonal vectors, orthonormal basis, Gram-Schmidt orthogonalization process. **15hrs**

Reference Books:

[1] I. N. Herstein, *Topics in Algebra*, 2nd Edition, Wiley.

[2] Stephen H. Friedberg, Arnold J. Insel & Lawrence E. Spence (2003), Linear Algebra(4^{th} Edition), Printice-Hall of India Pvt. Ltd.

[3] F. M. Stewart, *Introduction to Linear Algebra*, Dover Publications.

[4] S. Kumaresan, *Linear Algebra*, Prentice Hall India Learning Private Limited.

[5] Kenneth Hoffman & Ray Kunze (2015), Linear Algebra, (2^{nd} Edition), PrenticeHall India Leaning Private Limited.

[6] Gilbert Strang (2015), Linear Algebra and its applications, (2^{nd} Edition), Elsevier.

[7] Vivek Sahai & Vikas Bist (2013), Linear Algebra (2^{nd} Edition) Narosa Publishing.

[8] Serge Lang (2005), Introduction to Linear Algebra (2^{nd} Edition), Springer India.

[9] T. K. Manicavasagam Pillai and K S Narayanan, Modern Algebra Volume 2.

Self Study Topics:

Unit II (2 hours):Linear transformation - Definition, Examples, Equivalent criteria, Some basic properties

Unit III (2 hours):Homomorphism, Isomorphism and automorphism - Examples, Order of automorphism and Fundamental theorem of homomorphism

MACP351: Practicals on Linear Algebra	
Practical Hours : 4 Hours/Week	**Credits: 2**
Total Practical Hours: 60 Hours	**Max. Marks: 50** **(S.A.-25 + I.A. – 25)**

Course Learning Outcomes: This course will enable the students to

1. Learn *Free and Open Source Software (FOSS)* tools for computer programming
2. Solve problem on Linear Algebra studied in MATDSCT 6.1 by using FOSS softwares.
3. Acquire knowledge of applications of Linear Algebra through FOSS.

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

Maxima/Scilab /Python/R.

Suggested Programs:

1. Program to verify linear dependence and independence.
2. Program to find basis and dimension of the subspaces.
3. Program to verify if a function is linear transformation or not.
4. Program to find the matrix of linear transformation.
5. Program to illustrate the effect of change of basis on the matrix of linear transformation.
6. Program to check invertibility of the given linear transformation and finding the inverse if exists.
7. Program to find the Eigen values and Eigen vectors of a given linear transformation.
8. Program on Rank – nullity theorem.
9. Program to find the characteristic polynomial of given transformation.
10. Program to find the minimal polynomial of given transformation.
11. Program to find the algebraic multiplicity of the Eigen values of the given linear transformation.
12. Program on diagonalization.
13. Program to verify that the given basis is orthogonal or not.
14. Program to illustrate Gram-Schmidt orthogonalization process.

MACT352: Numerical Analysis	
Teaching Hours : 4 Hours/Week	**Credits: 4**
Total Teaching Hours: 60 Hours	**Max. Marks: 100** **(S.A.-60 + I.A. – 40)**

Course Learning Outcomes:

The overall expectation from this course is that the student will get equipped with certain numerical techniques for various computations such as finding roots, finding the integrals and derivatives, and finding solutions to differential equations. Some broader course outcomes are listed as follows. At the end of this course, the student will be able to

1. Compute approximate roots of algebraic and transcendental equations using iterations.
2. Describe various operators arising in numerical analysis such as difference operators, shift operators and so on.
3. Articulate the rationale behind various techniques of numerical analysis such as in finding roots, integrals and derivatives.
4. Reproduce the existing algorithms for various tasks as mentioned previously in numerical analysis.
5. Apply the rules of calculus and other areas of mathematics in justifying the techniques of numerical analysis.
6. Solve problems using suitable numerical technique.
7. Obtain approximate solutions to initial value problems using various numerical techniques.
8. Appreciate the profound applicability of techniques of numerical analysis in solving real life problems and also appreciate the way the techniques are modifiedto improve the accuracy.

Unit – I: Algebraic and Transcendental Equations: Solutions to algebraic and transcendental equations -Bisection method, Regula-Falsi method, Iterative methods, Newton-Raphson method and Secant method (Plain discussion of the rationale behind techniques and problems on their applications).System of Linear Algebraic Equations: Direct Methods – Gauss elimination method, Gauss- Jordan elimination method and Tringularization method; Iterative methods – Jacobi method, Gauss-Jacobi method, Gauss- Seidal method. **15hrs**

Unit – II: Polynomial Interpolations: Finite differences - Forward, Backward differences and shift operators: definitions, properties and problems; Polynomial interpolation - Newton-Gregory forward and backward interpolation formulas, Gauss's Forward and backward interpolation formulas, Lagrange interpolation polynomial, Newton's divided differences and Newton's general interpolation formula (Discussion on setting up the polynomials and problems on their applications). **15hrs**

Unit-III: Numerical Differentiation and Integration: Formula for derivatives (till second order) based on Newton-Gregory forward and backward interpolations (Derivations and problems based on them). Numerical Integration - General quadrature formula, Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule (derivations for only general quadrature formula, trapezoidal rule and Simpson's $1/3^{rd}$ rule and problems on the applications of all formulas). **15hrs**

UNIT-IV: Numerical Solution of Ordinary Differential Equations: Introduction, Solution by Taylor's series method, Picard's method, Euler's method, Modified Euler's method, Runge-Kutta Methods, Predictor-Corrector Methods- Milne's method, Adam's Bashforth Method, Adam Moulton Method. **15 hrs**

Reference Books :

1. S. S. Sastry, *Introductory methods of Numerical Analysis*, 5th Edition, PHI Learning Private Limited.
2. E. Isaacson and H. B. Keller, *Analysis of Numerical methods*, Dover Publications.
3. E Kreyszig, *Advanced Engineering Mathematics*, Wiley India Pvt. Limited.
4. B. S. Grewal, *Numerical Methods for Scientists and Engineers*, Khanna Publishers.
5. M. K. Jain, S. R. K. Iyengar and R. K. Jain, *Numerical Methods for Scientific and Engineering computation*, 4th Edition, New Age International
6. H. C. Saxena, *Finite Difference and Numerical Analysis,* S. Chand Publishers
7. B. D. Gupta, *Numerical Analysis*, Konark Publishers Pvt. Ltd.

Self Study Topics:

Unit I (4 hours)

Solutions to algebraic and transcendental equations -Bisection method

System of Linear Algebraic Equations: Direct Methods – Gauss elimination method

MACP352: Practicals on Numerical Analysis	
Practical Hours : 4 Hours/Week	**Credits: 2**
Total Practical Hours: 60 Hours	**Max. Marks: 50 (S.A.-25 + I.A. – 25)**

Course Learning Outcomes: This course will enable the students to

1. Learn *Free and Open Source Software (FOSS)* tools for computer programming
2. Solve problem on numerical Analysis studied in **MATDSCT 6.2 by** using FOSS softwares.
3. Acquire knowledge of applications of Numerical Analysis through FOSS.

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

Suggested Softwares: Maxima/Scilab /Python/R.

Suggested Programs:

1. Program to find root of an equation using Bisection, Regula-Falsi and Secant methods.
2. Program to find root of an equation using Newton-Raphson method.
3. Program to solve system of algebraic equations using Gauss-elimination method.
4. Program to solve system of algebraic equations using Gauss-Jordan method.
5. Program to solve system of algebraic equation using Gauss-Jacobi method.
6. Program to solve system of algebraic equation using Gauss-Seidel method.
7. Program to evaluate integral using Simpson's 1/3 and 3/8 rules.
8. Program to evaluate integral using Trapezoidal and Weddle rules
9. Program to find the sums of powers of successive natural numbers using Newton – Gregory technique.
10. Program to find differentiation at specified point using Newton-Gregory interpolation method.
11. Program to find the missing value of table using Lagrange method.
12. Program to find the solution of given initial value problem using Picard's method.
13. Program to find the solution of given initial value problem using Euler's method and Modified Euler's method.
14. Program to find the solution of given initial value problem using Runge-Kutta methods.

References

1. The Hundred-Page Machine Learning Book, Andriy Burkov, January 13, 2019.
2. Introduction to Machine Learning with Python: A Guide for Data Scientists 1st Edition by Andreas Müller, Sarah Guido, O'Reilly Media, November 15, 2016

List of Activities:

1. Introduction to Scikit, Numpy, Scipy and Tensor Flow
2. Linear Regression – Single Variable Linear Regression
3. Linear Regression – Multi Variable Linear Regression

4. Classification – Logistic Regression
5. Classification – Support Vector Machines (SVM)
6. Classification using Neural Networks
7. Unsupervised Learning – Principal Component Analysis (PCA)

Unsupervised Learning – K-Means Clustering

SCHEME OF QUESTION PAPERS
Question paper Pattern for Semester End Examinations

CODE NO: Reg. No:

SRI DHARMASTHALA MANJUNATHESHWARA COLLEGE (AUTONOMOUS), UJIRE

CORE SUBJECT-SEMESTER END EXAMINATIONS - CBCS
B.Sc.-MATHEMATICS
PAPER-SEMESTER
TOPIC-

TIME: 2HRS **Max Marks 60**

Note: Answer all Parts

PART- A

I). Answer any SIX of the following 2X6=12

1)
2)
3)
4)
5)
6)
7)
8)

PART B

II) Answer any TWO Question from each unit and each unit carries 12 marks

UNIT-I

1. a) (6x2=12)
b)
c)
d)

UNIT-II

2) a) (6x2=12)
b)
c)
d)

UNIT-III

3) a) (6x2=12)
b)
c)
d)

UNIT-IV

4) a) (6x2=12)
b)
c)
d)

xxxxxxxxxx

Question paper Pattern for I, II,III,IV Semester End Examinations

CODE NO: Reg No:

SRI DHARMASTHALA MANJUNATHESHWARA COLLEGE (AUTONOMOUS), UJIRE

OPEN ELECTIVE - SEMESTER END EXAMINATIONS - CBCS
B.Sc.-MATHEMATICS

PAPER-SEMESTER I/II/III/IV
TOPIC-

TIME: 2HRS Max Marks: 60

Note: Answer all Parts

PART- A

I. **Answer any FIVE of the following** (3X5=15)

1)
2)
3)
4)
5)
6)

PART B

II) Answer any one Three Question from each and each unit carries 15 marks

UNIT-1

1) a) (5x3=15)
b)
c)
d)

UNIT-II

2) a) (5x3=15)
b)
c)
d)

UNIT-III

3) a) (5x3=15)
b)
c)
d)

SRI DHARMASTHALA MANJUNATHESHWARA COLLEGE (AUTONOMOUS), UJIRE

CORE/OPEN ELECTIVES - INTERNAL EXAMINATIONS
MATHEMATICS

CODE NUMBER **PAPER -** **SEMESTER- I/II**

TOPIC-

Time: 1 hr **Max marks: 30**

I Answer any FIVE of the following **2X5=10**

1.

2.

3.

4.

5.

6.

II Answer any two questions

1 a) 4 Marks
b) 6 Marks

2)a) 4Marks

b) 6Marks

3 a) 4Marks

b) 6 Marks