RANI CHANNAMMA UNIVERSITY, BELAGAVI

PROGRAM /COURSE STRUCTURE AND SYLLABUS

as per the Choice Based Credit System (CBCS) designed in accordance with
Learning Outcomes-Based Curriculum Framework (LOCF)
of National Education Policy (NEP) 2020
for

Bachelor of Science

(Mathematics)

w.e.f.

Academic Year 2021-22 and onwards

Board of studies (UG) committee

S.No.	Name	Designation
1.	Dr.Vijayalaxmi S. Shigehalli	Chairperson
2.	Dr. D. Radhakrishna	Member
3.	Dr.VithalYashavantPatil	Member
4.	Shri. S.K. Girigol	Co-opted Member
5.	Shri. Nagasuresh	Co-opted Member

Dr.Vijayalaxmi S. Shigehalli
Dean of Science Faculty
Rani Channamma University, Belagavi

Dr.Vijayalaxmi S. Shigehalli
Chairperson BoS(UG)
Dearment of Mathematics,
RCU Belagavi

BOS COMMITTEE (NEP- MATHEMATICS)

B.Sc. MATHEMATICS (III & IV SEM) PROGRAM 2022-23

1	Prof. Vishwanath B. Awati, Department of Mathematics, RCU Belagavi	Chairman
2	Dr. L. M. Angadi, Govt First Grade College, Chikkodi	Member
3	Prof. (Smt) M. S. Shobani Sri Jagadamba Arts and Science First Grade College, Hittanallitanda LT, Sindagi	Member

PREAMBLE

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

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

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

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

The subject expert committee designed the Course Learning Outcome (CO) to help the learners to understand the main objectives of studying the courses by keeping in mind of the Programme outcomes (PO) of the graduate degree with honors in Mathematics or a graduate degree with Mathematics as a major subject.

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

PROGRAM OUTCOMES:

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.
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 modelling and solving of real-life problems.
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.
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.
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.
6. **Information/digital Literacy:** The completion of this programme will enable the learner to use appropriate software's to solve system of algebraic equation and differential equations.
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.
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.
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.
10. Ability to peruse advanced studies and research in pure and applied Mathematical sciences.

RANI CHANNAMMA UNIVERSITY
Vidyasangama, NH-4, Belagavi. -591156

Proposed Curricular and Credits Structure under Choice Based Credit System [CBCS] of Mathematics Major& One Minor Discipline Scheme for the Four Years Mathematics B.Sc. Undergraduate Honors Programme with effect from 2021-22.

SEMESTER-I											
Category	**Course code**	**Title of the Paper**	**Marks**			**Teaching hours/ week**			**Credit**	**Duration of exams (Hrs)**
			IA	**SEE**	**Total**	**L**	**T**	**P**		
L1	21BSC1L1LK1	Kannada	40	60	100	4	-	-	3	2
	21BSC1L1LFK1	Functional Kannada								
L2	21BSC1L2LEN2	English	40	60	100	4	-	-	3	2
	21BSC1L2LHI2	Hindi								
	21BSC1L2LSN2	Sanskrit								
	21BSC1L2LTE2	Telugu								
	21BSC1L2LUR2	Urdu								
DSC1	21BSC1C1MAT1L	Algebra - I and Calculus – I	40	60	100	4	-	-	4	2
	21BSC1C1MAT1P	Theory based Practical's on Algebra -I and Calculus – I	25	25	50	-	-	4	2	3
DSC1	Another Department Code	Another Department Course Title	40	60	100	4	-	-	4	2
			25	25	50	-	-	4	2	3
SEC1	21BSC1SE1CS1	Digital Fluency	25	25	50	1	-	2	2	2
VBC1	21BSC1V1PE1	Physical Education-Yoga	25	-	25	-	-	2	1	-
VBC2	21BSC1V2HW1	Health & Wellness	25	-	25	-	-	2	1	-
OEC1	21BSC1O1MAT1-A	Mathematics – I	40	60	100	3	-	-	3	2
	21BSC1O1MAT1-B	Business Mathematics – I								
			Total Marks		**700**	**Semester Credits**			**25**	

SEMESTER-III

SEMESTER-II

Category	Course code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
			IA	SEE	Total	L	T	P		
L3	21BSC2L3LK2	Kannada	40	60	100	4	-	-	3	2
	21BSC2L3FKL2	Functional Kannada								
L4	21BSC2L4EN2	English	40	60	100	4	-	-	3	2
	21BSC2L4HI2	Hindi								
	21BSC2L4SN2	Sanskrit								
	21BSC2L4TE2	Telugu								
	21BSC2L4UR2	Urdu								
DSC2	21BSC2C2MAT2L	Algebra - II and Calculus –II	40	60	100	4	-	-	4	2
	21BSC2C2MAT2P	Theory based Practical's on Algebra- II and Calculus – II	25	25	50	-	-	4	2	3
DSC2	Another Department Code	Another Department Course Title	40	60	100	4	-	-	4	2
			25	25	50	-	-	4	2	3
AECC1	21BSC2AE1ES2	Environmental Studies	20	30	50	3	-	-	2	2
VBC3	21BSC2V3PE2	Physical Education- Sports	25	-	25	-	-	2	1	-
VBC4	21BSC2V4NC1	NCC/NSS/R&R(S&G) / Cultural	25	-	25	-	-	2	1	-
OEC2	21BSC2O2MAT2-A	Mathematics – II	40	60	100	3	-	-	3	2
	21BSC2O2MAT2-B	Business Mathematics-II								
Total Marks					**700**	**Semester Credits**			**25**	

Category	Course code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
			IA	SEE	Total	L	T	P		
L5	21BSC3L5LK3	Kannada	40	60	100	4	-	-	3	2
	21BSC3L5LFK3	Functional Kannada								
L6	21BSC3L6EN3	English	40	60	100	4	-	-	3	2
	21BSC3L6HI3	Hindi								
	21BSC3L6SN3	Sanskrit								
	21BSC3L6TE3	Telugu								
	21BSC3L6UR3	Urdu								
DSC3	21BSC3C3MAT1L	Ordinary Differential Equations and Real Analysis-I	40	60	100	4	-	-	4	2
	21BSC3C3MAT1P	Theory based Practical's on Ordinary Differential Equations and Real Analysis-I	25	25	50	-	-	4	2	3
DSC3	Another Department Code	Another Department Course Title	40	60	100	4	-	-	4	2
			25	25	50	-	-	4	2	3
SEC2	21BSC3SE2ES2	Artificial Intelligence	25	25	50	1	-	2	2	2
VBC5	21BSC3V5PE3	Physical Education- Sports	25	-	25	-	-	2	1	-
VBC6	21BSC3V6NC2	NCC/NSS/R&R(S&G) / Cultural	25	-	25	-	-	2	1	-
OEC3	21BSC3O3MAT3-A	Ordinary Differential Equations	40	60	100	3	-	-	3	2
	21BSC3O3MAT3-B	Quantitative Mathematics								
	21BSC3O3MAT3-C	Vedic Mathematics								
Total Marks					**700**	**Semester Credits**			**25**	

SEMESTER-IV										
Category	**Course code**	**Title of the Paper**	**Marks**			**Teaching hours/week**			**Credit**	**Duration of exams (Hrs)**
			IA	**SEE**	**Total**	**L**	**T**	**P**		
L7	21BSC4L7LK4	Kannada	40	60	100	4	-	-	3	2
	21BSC4L7LFK4	Functional Kannada								
L8	21BSC4L8EN4	English	40	60	100	4	-	-	3	2
	21BSC4L8HI4	Hindi								
	21BSC4L8SN4	Sanskrit								
	21BSC4L8TE4	Telugu								
	21BSC4L8UR4	Urdu								
DSC4	21BSC4C4MAT2L	Partial Differential Equations and Integral Transforms	40	60	100	4	-	-	4	2
	21BSC4C4MAT2P	Theory based Practical's on Partial Differential Equations and Integral Transforms	25	25	50	-	-	4	2	3
DSC4	Another Department Code	Another Department Course Title	40	60	100	4	-	-	4	2
			25	25	50	-	-	4	2	3
AECC2	21BSC4AE1ES2	Constitution of India	20	30	50	3	-	-	2	2
VBC7	21BSC4V5PE4	Physical Education-Sports	25	-	25	-	-	2	1	-
VBC8	21BSC4V6NC3	NCC/NSS/R&R(S&G)/Cultural	25	-	25	-	-	2	1	-
OEC4	21BSC4O4MAT4-A	Partial Differential Equations	40	60	100	3	-	-	3	2
	21BSC4O4MAT4-B	Mathematical Finance								
	21BSC4O4MAT4-C	Mathematics for Social Science								
			Total Marks		**700**	**Semester Credits**			**25**	

SEMESTER-V										
Category	**Course code**	**Title of the Paper**	**Marks**			**Teaching hours/week**			**Credit**	**Duration of exams (Hrs)**
			IA	**SEE**	**Total**	**L**	**T**	**P**		
Mathematics as Major Discipline										
DSC5	21BSC5C5MATMJ1L	Real Analysis-II and Complex Analysis	40	60	100	4	-	-	4	2
	21BSC5C5MATMJ1P	Theory based Practical's on Real Analysis-II and Complex Analysis	25	25	50	-	-	4	2	3
DSC6	21BSC5C5MATMJ2L	Vector Calculus and Analytical Geometry	40	60	100	4	-	-	4	2
	21BSC5C5MATMJ2P	Theory based Practical's on Vector Calculus and Analytical Geometry	25	25	50	-	-	4	2	3
DSC7	Another Department Code as a Major Subject	Another Department Course Title	40	60	100	4	-	-	4	2
			25	25	50	-	-	4	2	3
DSC8	Another Department Code as a Major Subject	Another Department Course Title	40	60	100	4	-	-	4	2
			25	25	50	-	-	4	2	3
SEC4	21BSC5SE3MAT3	Employability skills/ Cyber Security	25	25	50	2	-	2	3	2
				Total Marks	**650**	**Semester Credits**			**27**	

SEMESTER-VI										
Category	**Course code**	**Title of the Paper**	**Marks**			**Teaching hours/week**			**Credit**	**Duration of exams (Hrs)**
			IA	**SEE**	**Total**	**L**	**T**	**P**		
Mathematics as Major Discipline										
DSC7	21BSC6C6MATMJ1L	Linear Algebra	40	60	100	4	-	-	4	2
	21BSC6C6MATMJ1P	Theory based Practical's on Linear Algebra	25	25	50	-	-	4	2	3
DSC8	21BSC6C6MATMJ2L	Numerical Analysis	40	60	100	4	-	-	4	2
	21BSC6C6MATMJ2P	Theory based Practical's on Numerical Analysis	25	25	50	-	-	4	2	3
DSC6	Another Department Code as a Minor Subject	Another Department Course Title	40	60	100	4	-	-	4	2
			25	25	50	-	-	4	2	3
DSC6	Another Department Code as a Minor Subject	Another Department Course Title	40	60	100	4	-	-	4	2
			25	25	50	-	-	4	2	3
INT1	21BSC6 INT1L	Internship/ Project	25	25	50	-	-	-	2	2
Total Marks					**650**	**Semester Credits**			**26**	
Total Marks for BSC Program					**4100**	**Total Credits for BSC Program**			**146**	

Concept Note, Abbreviation Explanation and Coding:

Concept Note:

1. **CBCS** is a mode of learning in higher education which facilitates a student to have some freedom in selecting his/her own choices, across various disciplines for completing a UG/PG program.
2. A credit is a unit of study of a fixed duration. For the purpose of computation of workload as per UGC norms the following is mechanism be adopted in the University:
   One credit (01) = One Theory Lecture (L) period of one (1) hour.
   One credit (01) = One Tutorial (T) period of one (1) hour.
   One credit (01) = One practical (P) period of two (2) hours.
3. Course: paper/subject associated with AECC, DSC, DSEC, SEC, VBC, OEC, VC, IC and MIL
4. In case of **B.Sc**. **Once a candidate chose two courses/subjects of a particular two department in the beginning, he/she shall continue the same till the end of the degree, then there is no provision to change the course(s) and Department(s).**
5. A candidate shall choose **one of the Department's courses as major and other Department course as minor in fifth and sixth semester and major course will get continued in higher semester.**
6. Wherever there is a practical there will be no tutorial and vice-versa
7. A major subject is the subject that's the main focus of Core degree/concerned.
8. A minor is a secondary choice of subject that complements core major/ concerned.
9. Vocational course is a course that enables individual to acquire skills set that are required for a particular job.
10. Internship is a designated activity that carries some credits involving more than **25 days** of working in an organization (either in same organization or outside) under the guidance of an identified mentor. Internship shall be an integral part of the curriculum.
11. **OEC: For non-mathematics students. Mathematics students have to opt for OEC from departments other than major and minor disciplines.**

Abbreviation Explanations:

1. AECC: Ability Enhancement Compulsory Course.
2. DSC: Discipline Specific Core Course.
3. DSEC: Discipline Specific Elective Course.
4. SEC: Skill Enhancement Course.
5. VBC: Value Based Course.
6. OEC: Open/Generic Elective Course
7. VC: Vocational Course.
8. IC: Internship Course
9. L1: Language One
10. L2: MIL
11. L= Lecture; T= Tutorial; P=Practical.
12. MIL= Modern Indian Language; English or Hindi or Telugu or Sanskrit or Urdu

Program Coding:

1. Code 21: Year of Implementation
2. Code BSC: BSC Program under the faculty of Applied Science of the University
3. Code 1: First Semester of the Program, (2 to 6 represent higher semesters)
4. Code AE: AECC, (C for DSC, S for SEC, V for VBC and O for OEC)
5. Code 1: First "AECC" Course in semester, similarly in remaining semester for such other courses
6. Code LK: Language Kannada, similarly Language English, Language Hindi, Language Telugu, Language Sanskrit, &Language Urdu
7. Code 1: Course in that semester.
8. MAT: Mathematics

ASSESSMENT METHODS

Evaluation Scheme for Internal Assessment:

Theory:

Assessment Criteria	40 marks
1st Internal Assessment Test for 30 marks of duration 1 hr after 8 weeks (**to be reduced to 10 marks**).	10
Assignment	10
2nd Internal Assessment Test for 30 marks of duration 1 hr after 12 weeks **(to be reduced to 10 marks).**	10
Seminar	10
Total	**40**

Practical:

Assessment Criteria	25 marks
Semester End Internal Assessment Test for 20 marks of duration 3 hrs	20
Journal (Practical Record)	05
Total	**25**

Question Paper Pattern:
RANI CHANNAMMA UNIVERSITY
Department of Mathematics

I Semester B.Sc. (Mathematics)

Sub: Code: Maximum Marks: 60

a. Answer any Six Questions from Question 1

b. Answer any Three Questions from Question 2,3,4 and 5

Q.No.1.	**Answer any Five Questions (Two question from Each Unit)** **a.** **b.** **c.** **d,** **e.** **f.** **g.** **h.**	**2X6=12**
Q.No.2.	**(Should cover Entire Unit-I)** **a.** **b.** **c.** **d.**	**4X3=12**
Q.No.3.	**(Should cover Entire Unit-II)** **a.** **b.** **c.** **d.**	**4X3=12**
Q.No.4.	**(Should cover Entire Unit-III)** **a.** **b.** **c.** **d.**	**4X3=12**
Q.No.5.	**(Should cover Entire Unit-IV)** **a.** **b.** **c.** **d.**	**4X3=12**

COURSE-WISE SYLLABUS

Semester I

Year	I	**Course Code:** 21BSC1C1MAT1L	**Credits**	04
Sem.	1	**Course Title:** Algebra - I and Calculus – I	**Hours**	56

Course Pre-requisites, if any	NA	
Formative Assessment Marks: 40	Summative Assessment Marks: 60	Duration of ESA:.02 hrs.

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

Unit No.	**Course Content**	**Hours**
Unit I	**Matrix:** Recapitulation of Symmetric and Skew Symmetric matrices, Cayley-Hamilton theorem, inverse of matrices by Cayley-Hamilton theorem (Without Proof). Algebra of Matrices; Row and column reduction to Echelon form. Rank of a matrix; Inverse of a matrix by elementary operations; Solution of system of linear equations; Criteria for existence of non-trivial solutions of homogeneous system of linear equations. Solution of non-homogeneous system of linear equations. Eigen values and Eigen vectors of square matrices, real symmetric matrices and their properties, reduction of such matrices to diagonal form.	**14**
Unit II	**Polar Co-ordinates:** Polar coordinates, angle between the radius vector and tangent. Angle of intersection of two curves (polar forms), length of perpendicular from pole to the tangent, pedal equations. Derivative of an arc in Cartesian, parametric and polar forms, curvature of plane curve-radius of curvature formula in Cartesian, parametric and polar and pedal forms, centre of curvature, asymptotes, evolutes and envelops.	**14**
Unit III	**Differential Calculus-I:** Limits, Continuity, Differentiability and properties. Properties of continuous functions. Intermediate value theorem, Rolle's Theorem , Lagrange's Mean Value theorem, Cauchy's Mean value theorem and examples. Taylor's theorem, Maclaurin's series, Indeterminate forms and evaluation of limits using L'Hospital rule.	**14**
Unit IV	**Successive Differentiation**: nth Derivatives of Standard functions e^{ax+b}, $(ax+b)^m$, $\log(ax+b)$, $\sin(ax+b)$, $\cos(ax+b)$, $e^{ax}\sin(bx+c)$, $e^{ax}\cos(bx+c)$, Leibnitz theorem and its applications. Tracing of curves (standard curves)	**14**

Recommended Leaning Resources	
Print Resources	**References:** **1.** University Algebra - N.S. Gopala Krishnan, New Age International (P) Limited **2.** Theory of Matrices - B S Vatsa, New Age International Publishers. **3.** Matrices - A R Vasista, Krishna Prakashana Mandir. **4.** Differential Calculus - Shanti Narayan, S. Chand & Company, New Delhi. **5.** Applications of Calculus, Debasish Sengupta, Books and Allied (P) Ltd., 2019. **6.** Calculus – Lipman Bers, Holt, Rinehart & Winston. **7.** Calculus - S Narayanan & T. K. Manicavachogam Pillay, S. Viswanathan Pvt. Ltd., vol. I & II. **8.** Schaum's Outline of Calculus - Frank Ayres and Elliott Mendelson, 5th ed. USA: Mc. Graw. **9.** Text Book of B.Sc. Mathematics, G K Ranganath, S Chand & Company.

Year	I	**Course Code:** 21BSC1C1MAT1P	**Credits**	02
Sem.	I	**Course Title:** Practical's on Algebra - I and Calculus – I	**Hours**	56

Course Pre-requisites, if any:	Knowledge of Programming	
Formative Assessment Marks: 25	Summative Assessment Marks: 25	Duration of ESA: 03 hrs.

Course Outcomes	This course will enable the students to • Learn Free and Open Source Software (FOSS) tools for computer programming Solve problem on algebra and calculus theory studied in MATDSCT 1.1 by using FOSS software. Acquire knowledge of applications of algebra and calculus through FOSS Practical/Lab Work to be performed in Computer Lab (FOSS) • Suggested Software's: Maxima/Scilab/Maple/MatLab/Mathematica/Phython/R	
	Course Content	**Hours**
	Lab Practical's: **Part A:** Introduction to the software and commands related to the topic. 1. Computation of addition and subtraction of matrices, 2. Computation of Multiplication of matrices. 3. Computation of Trace and Transpose of Matrix 4. Computation of Rank of matrix and Row reduced Echelon form. 5. Computation of Inverse of a Matrix using Cayley-Hamilton theorem. 6. Solving the system of homogeneous and non-homogeneous linear algebraic equations. **Part B:** 7. Finding the nth Derivative of e^{ax}, trigonometric and hyperbolic functions 8. Finding the nth Derivative of algebraic and logarithmic functions. 9. Finding the nth Derivative of $e^{ax+b}\sin(bx+c)$, $e^{ax+b}\cos(bx+c)$. 10. Finding the Taylor's and Maclaurin's expansions of the given functions. 11. Finding the angle between the radius vector and tangent. 12. Finding the curvatures of the given curves. 13. Tracing of standard curves (Cartesian, polar and parametric)	**56**

Evaluation Scheme for Lab Examination

Assessment Criteria		Marks
Program – 1 from Part A	Writing Program	03
	Execution of Program	07
Program -2 from Part B	Writing Program	03
	Execution of Program	07
Viva-Voce		05
Total		**25**

OPEN-ELECTIVE SYLLABUS:

Year	I	**Course Code:** 21BSC1O1MAT1	**Credits**	03
Sem.	I	**Course Title:** Business Mathematics – I	**Hours**	42

Course Pre-requisites, if any	NA	
Formative Assessment Marks: 40	Summative Assessment Marks: 60	Duration of ESA:.02 hrs.

Course Outcomes	This course will enable the students to • Translate the real word problems through appropriate mathematical modellling. • Explain the concepts and use equations, formulae and mathematical expression and relationship in a variety of context. • Finding the extreme values of functions. • Analyze and demonstrate the mathematical skill require in mathematically intensive areas in economics and business.	
Unit No.	**Course Content**	**Hours**
Unit I	**Algebra** – Set theory and simple applications of Venn Diagram, relations, functions, indices, logarithms, permutations and combinations. Examples on commercial mathematics.	**14**
Unit II	**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.	**14**
Unit III	**Differential Calculus**: Constant and variables, functions, Limits & continuity. Differentiability and Differentiation, partial differentiation, rates as a measure, maxima, minima, Partial Derivatives up to second order; Homogeneity of functions and Euler's Theorem; Total Differentials; Differentiation of implicit function with the help of total differentials, Maxima and Minima; cases of one variable involving second or higher order derivatives; Cases of two variables involving not more than one constraint	**14**
Recommended Leaning Resources		
Print Resources	**References:** **1.** Basic Mathematics, Allel R.G.A, Macmillan, New Delhi. **2.** Mathematics for Economics, Dowling, E.T. ,Schaum's Series, McGraw Hill, London. **3.** Quantitative Techniques in Management, Vohra, N.D., Tata McGraw Hill, New Delhi. **4.** Business Mathematics, Soni R.S., Pitamber Publishing House, Delhi	

Semester II

Year	I	**Course Code:** 21BSC1C1MAT1L	**Credits**	04
Sem.	II	**Course Title:** Algebra - II and Calculus –II	**Hours**	56

Course Pre-requisites, if any	NA	
Formative Assessment Marks: 40	Summative Assessment Marks: 60	Duration of ESA:.02 hrs.

Course Outcomes	This course will enable the students to • Recognize the mathematical objects called Groups. • Link the fundamental concepts of groups and symmetries of geometrical objects. • Explain the significance of the notions of Cosets, normal subgroups and factor groups. • Understand the concept of differentiation and fundamental theorems in differentiation and various rules. • Find the extreme values of functions of two variables.

Unit No.	**Course Content**	**Hours**
Unit I	**Real Number System:** Recapitulation of number system. Countable and uncountable sets, standard theorems. Real line, bounded sets, suprimum and infimum of set, completeness properties of R, Archimedean property of R. Intervals, neighbourhood of a point, open sets, closed sets, limit points and Bolzano-Weierstrass theorem (Without proof).	**14**
Unit II	**Groups:** Definition of a group with examples and properties, congruence, problems. Subgroups, centre of groups, order of an element of a group and its related theorems, cyclic groups, Coset decomposition, Factor groups, Lagrange's theorem and its consequences. Fermat's theorem, Euler's ϕ	**14**
Unit III	**Partial Derivatives**: Functions of two or more variables-explicit and implicit functions, partial derivatives. Homogeneous functions- Euler's theorem, total derivatives, differentiation of implicit and composite functions, Jacobians and standard properties and illustrative examples. Taylor's and Maclaurin's series for functions of two variables, Maxima-Minima of functions of two variables	**14**
Unit IV	**Integral Calculus**: Recapitulation of definite integrals and its properties. Line integral: Definition of line integral and basic properties, examples on evaluation of line integrals. Double integral: Definition of Double integrals and its conversion to iterated integrals. Evaluation of double integrals by changing the order of integration and change of variables. Computation of plane surface areas, volume underneath a surface of revolution using double integral. Triple integral: Definition of triple integrals and evaluation-change of variables, volume as triple integral. Differentiation under the integral sign by Leibnitz rule.	**14**

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

Year	I	**Course Code:** 21BSC1C1MAT1P	**Credits**	02
Sem.	II	**Course Title:** Practical's on Algebra - II and Calculus – II	**Hours**	56

Course Pre-requisites, if any:	Knowledge of Programming	
Formative Assessment Marks: 25	Summative Assessment Marks: 25	Duration of ESA: 03 hrs.

Course Outcomes	This course will enable the students to • Learn Free and Open Source Software (FOSS) tools for computer programming • Solve problem on algebra and calculus by using FOSS software's. • Acquire knowledge of applications of algebra and calculus through FOSS Practical/Lab Work to be performed in Computer Lab Suggested Software's: Maxima/Scilab/Maple/MatLab/Mathematica/Phython/R.	
	Course Content	**Hours**
	Lab Practical's: **Part A:** 1. Program for verification of binary operations. 2. Computation of identity and inverse elements of a group. 3. Program to construct Cayley's table and test abelian for given finite set. 4. Program to find all possible cosets of the given finite group. 5. Program to find generators and corresponding possible subgroups of a cyclic group. 6. Programs to verification of Lagrange's theorem with suitable examples. **Part B:** 7. Program to verify the Euler's ϕfunction for a given finite group. 8. Program to verify the Euler's theorem and its extension 9. Programs to construct series using Maclaurin's expansion for functions of two variables. 10. Program to evaluate the line integrals with constant and variable limits. 11. Program to evaluate the Double integrals with constant and variable limits 12. Program to evaluate the Triple integrals with constant and variable limits.	**56**

Evaluation Scheme for Lab Examination

Assessment Criteria		Marks
Program – 1 from Part A	Writing Program	03
	Execution of Program	07
Program -2 from Part B	Writing Program	03
	Execution of Program	07
Viva-Voce		05
Total		**25**

OPEN-ELECTIVE SYLLABUS:

Year	I	**Course Code:** 21BSC1O1MAT1	**Credits**	03
Sem.	I	**Course Title:** Business Mathematics – II	**Hours**	42
Course Pre-requisites, if any		NA		
Formative Assessment Marks: 40		Summative Assessment Marks: 60	Duration of ESA:.02 hrs.	

Course Outcomes	This course will enable the students to • Translate the real word problems through appropriate mathematical modellling. • Explain the concepts and use equations, formulae and mathematical expression and relationship in a variety of context. • Finding the extreme values of functions. • Analyze and demonstrate the mathematical skill require in mathematically intensive areas in economics and business.	
Unit No.	**Course Content**	**Hours**
Unit I	**Commercial Arithmetic:** Interest: Concept of Present value and Future value, Simple interest, Compound interest, Nominal and Effective rate of interest, Examples and Problems Annuity: Ordinary Annuity, Sinking Fund, Annuity due, Present Value and Future Value of Annuity, Equated Monthly Instalments (EMI) by Interest of Reducing Balance and Flat Interest methods, Examples and Problems.	**14**
Unit II	**Measures of central Tendency and Dispersion:** Frequency distribution: Raw data, attributes and variables, Classification of data, frequency distribution, cumulative frequency distribution, Histogram and give curves. Requisites of ideal measures of central tendency, Arithmetic Mean, Median and Mode for ungrouped and grouped data. Combined mean, Merits and demerits of measures of central tendency, Geometric mean: definition, merits and demerits, Harmonic mean: definition, merits and demerits, Choice of A.M., G.M. and H.M. Concept of dispersion, Measures of dispersion: Range, Variance, Standard deviation (SD) for grouped and ungrouped data, combined SD, Measures of relative dispersion: Coefficient of range, coefficient of variation. Examples and problems.	**14**
Unit III	**Correlation and regression:** Concept and types of correlation, Scatter diagram, Interpretation with respect to magnitude and direction of relationship. Karl Pearson's coefficient of correlation for ungrouped data. Spearman's rank correlation coefficient. (with tie and without tie) Concept of regression, Lines of regression for ungrouped data, predictions using lines of regression. Regression coefficients and their properties (without proof). Examples and problems.	**14**

Recommended Leaning Resources	
Print Resources	**References:** **1.** Practical Business Mathematics, S. A. Bari New Literature Publishing Company New Delhi. **2.** Mathematics for Commerce, K. Selvakumar Notion Press Chennai **3.** Business Mathematics with Applications, Dinesh Khattar & S. R. Arora S. Chand Publishing New Delhi **4.** Business Mathematics and Statistics, N.G. Das &Dr. J.K. Das McGraw Hill New Delhi **5.** Fundamentals of Business Mathematics, M. K. Bhowal, Asian Books Pvt. Ltd New Delhi **6.** Mathematics for Economics and Finance: Methods and Modelling, **7.** Martin Anthony and Norman, Biggs Cambridge University Press Cambridge **8.** Financial Mathematics and its Applications, Ahmad Nazri Wahidudin Ventus Publishing APS Denmark **9.** Fundamentals of Mathematical Statistics, Gupta S. C. and Kapoor V. K.:, Sultan Chand and Sons, New Delhi. **10.** Statistical Methods, Gupta S. P.: Sultan Chand and Sons, NewDelhi. **11.** Applied Statistics, Mukhopadhya Parimal New Central Book Agency Pvt. Ltd. Calcutta. **12.** Fundamentals of Statistics, Goon A. M., Gupta, M. K. and Dasgupta, B. World Press Calcutta. **13.** Fundamentals of Applied Statistics, Gupta S. C. and Kapoor V. K.:, Sultan Chand and Sons, New Delhi.

SEMESTER – III

Year	II	**Course Code:** 21BSC3C3MAT1L	**Credits**	04
Sem.	III	**Course Title: Ordinary Differential Equations and Real Analysis – I**	**Hours**	56

Course Pre-requisites, if any	NA	
Formative Assessment Marks: 40	Summative Assessment Marks: 60	Duration of ESA:.02 hrs.

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

Unit No.	**Course Content**	**Hours**
Unit I	**Ordinary Differential Equations:** 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.	**14**
Unit II	Linear differential equations of the nth order with constant coefficients. Particular Integrals when the RHS is of the form e^{ax}, sin(ax+b), cos(ax+b), x^n, e^{ax} V and x V (with proofs), where V is a function of x. Cauchy – Euler equations, Legendre differential equations, Method of variation of parameters. Simultaneous differential equations with two and more than two variables. Condition for integrability of total differential equations P dx +Q dy+ R dz = 0.	**14**
Unit III	**Real Analysis – I :** **Sequences**: Sequences of real numbers, Bounded sequences. Limit of a sequence. Convergent, divergent, and oscillatory sequences. Monotonic sequences. Algebra of convergent sequences. Limit points of a sequence. Bolzano Weierstrass theorem for sequence. Limit superior and limit inferior of sequences. Cauchy's first and second theorem on limits of a sequence. Cauchy's general principle for convergence of a sequence. Subsequence and their properties.	**14**
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**

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

Practicals

Year	II	**Course Code:** 21BSC3C3MAT1P	**Credits**	02
Sem.	III	**Course Title: Practicals on Ordinary Differential Equations and Real Analysis – I**	**Hours**	56
Course Pre-requisites, if any		NA		
Formative Assessment Marks: 25		Summative Assessment Marks: 25	Duration of ESA:.02 hrs.	
Course Outcomes		**Course Learning Outcomes**: This course will enable the students to gain handson experience of • Free and Open Source software (FOSS) tools or computer programming. • Solving exact differential equations • Ploting orthogonal trajectories • Finding complementary function and particular integral of linear and homogeneous differential equations. • Acquire knowledge of applications of real analysis and differential equations. • Verification of convergence/divergence of different types of series		
		Course Content		**Hours**
		Practicals/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.		**56**

Open Elective Course

Year	II	**Course Code:** 21BSC3O3MAT3-B	**Credits**	03
Sem.	III	**Course Title: Quantitative Mathematics**	**Hours**	42
Course Pre-requisites, if any		NA		
Formative Assessment Marks: 40		Summative Assessment Marks: 60	Duration of ESA:.02 hrs.	
Course Outcomes		**Course Outcomes:** This course will enable the students to: • Understand number system and fundamental operations • Understand the concept of linear quadratic and simultaneous equations and their applications in real life problems • Understand and solve the problems based on Age. • Solve Speed and Distance related problems.		
Unit No.		**Course Content**		**Hours**
Unit I		**Number System:** Numbers, Operations on Numbers, Tests on Divisibility, HCF and LCM of numbers. Decimal Fractions, Simplification, Square roots and Cube roots - Problems thereon. Surds and Indices. Illustrations thereon.		**14**
Unit II		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**
Unit III		Quantitative Aptitude Percentage, Average, Average Speed-problems. Time and distance, problems based on trains, problems on-work and time, work and wages, clock and calendar.		**14**
Recommended Leaning Resources				
Print Resources		**References:** **1.** R.S. Aggarwal, Quantitative Aptitude, S. Chand and Company Limited, NewDelhi-110 055. **2.** Abhijit Guha, Quantitative Aptitude, 5th Edition, Mc. Graw hill publications, 2004. **3.** R V Praveen, Quantitative Aptitudeand Reasoning, PHI publishers. **4.** R S Aggarwal, Objective Arithmetic, S. Chand & Company Ltd. **5.** Qazi Zameerddin,Vijay K Khanna, S K Bhambri, Business Mathematics-II Edition. **6.** S. K. Sharma and Gurmeet Kaur, Business Mathematics, Sultan Chand & Sons. **7.** Hazarika Padmalochan, A Text Book of Business mathematics for B.Com and BBA Course, Chand Publication. **8.** J K Thukrol, Business Mathematics, abci book: 2020 First Edition. **9.** N. G. Das and J. K. Das, Business Mathematics and Statics, Mc Graw Hill Education, 2017.		

Open Elective Course

Year	II	**Course Code:** 21BSC3O3MAT3-C	**Credits**	03
Sem.	III	**Course Title: Vedic Mathematics**	**Hours**	42
Course Pre-requisites, if any		NA		
Formative Assessment Marks: 40		Summative Assessment Marks: 60	Duration of ESA:.02 hrs.	

Course Outcomes	**Course Outcomes:** This course will enable the students to: • Understand number system and fundamental operations • Understand the concept of linear quadratic and simultaneous equations and their applications in real life problems • Understand and solve the problems based on Age. • Solve Speed and Distance related problems.

Unit No.	**Course Content**	**Hours**
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**
Unit II	**Division and Divisibility** **Part A: Division** 1. Nikhilam Navtashchramam Dashtaha (two digits divisor) 2. Paravartya Yojyet method (three digits divisor) **Part B:Divisibility** 1. Ekadhikenpurven method (two digits divisor) 2. Eknunenpurven method (two digits divisor)	**14**
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). Solution of linear simultaneous equations.	**14**
Recommended Leaning Resources		
Print Resources	**Reference Books:** **1.** Vedic Mathematics, MotilalBanarsi Das, New Delhi. **2.** Vedic Ganita: Vihangama Drishti-1, SikshaSanskritiUthana Nyasa, New Delhi. **3.** Vedic GanitaPraneta, SikshaSanskritiUthana Nyasa, New Delhi. **4.** Vedic Mathematics: Past, Present and Future, SikshaSanskritiUthana Nyasa, New Delhi. **5.** Leelavati, ChokhambbaVidyaBhavan, Varanasi. **6.** Bharatiya Mathematicians, Sharda Sanskrit Sansthan, Varanasi.	

SEMESTER – IV

Year	II	**Course Code:** 21BSC4C4MAT2L	**Credits**	04
Sem.	IV	**Course Title: Partial Differential Equations and Integral Transforms**	**Hours**	56

Course Pre-requisites, if any	NA	
Formative Assessment Marks: 40	Summative Assessment Marks: 60	Duration of ESA:.02 hrs.

Course Outcomes

Course Learning Outcomes: This course will enable the students to

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

Unit No.	**Course Content**	**Hours**
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**
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**
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**
Unit IV	**Fourier Series and Transforms:** Periodic functions. Fourier Coefficients. Fourier series of functions with period 2π 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**

Recommended Leaning Resources

Print Resources

References:

1. D. A. Murray, Introductory Course in Differential Equations, Orient and Longman
2. H.T. H.Piaggio, Elementary Treatise on Differential Equations and their Applications, CBS Publisher & Distributors, Delhi, 1985.
3. G.F.Simmons, Differential Equations, Tata McGraw Hill.
4. S.L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons, India, 2004.
5. M. D. Raisinghania, Ordinary Differential Equations & Partial Differential Equations, S. Chand & Company, New Delhi.
6. K.Sankara Rao, Introduction to Partial Differential Equations: PHI, Third Edition, 2015.

	7. I. N. Sneddean, Elements of Partial differential equations, McGraw-Hill International Editions, 1986. **8.** R. Murray and L. Spiegal(Schaum's Series), Laplace Transforms **9.** Goel and Gupta, Laplace Transform. **10.** Sudhir Kumar, Integral Transform Methods in Science & Engineering, CBS Engineering Series, 2017. **11.** Murray R. SpiegalL, Fourier Transforms, Schaum' Series, **12.** Earl David Rainville and Philip Edward Bedient–A short course in Differential Equations, Prentice Hall College Div; 6th Edition. **13.** Sathya Prakash, Mathematical Physics, S Chand and Sons, New Delhi.

Practicals

Year	II	**Course Code:** 21BSC4C4MAT2P	**Credits**	02
Sem.	IV	**Course Title: Practical's on Partial Differential Equations and Integral Transforms**	**Hours**	56
Course Pre-requisites, if any		NA		
Formative Assessment Marks: 25		Summative Assessment Marks: 25	Duration of ESA:.02 hrs.	
Course Outcomes		**Course Learning Outcomes**: This course will enable the students to • Learn Free and Open Source software (FOSS) tools or computer programming. • Solve problems on Partial Differential Equations and Integral Forms • To find Laplace transform of various functions • To finf the Fourier Transform of periodic functions • To solve differential equations by using Integral transforms.		
		Course Content		**Hours**
		Practicals/Lab Work to be performed in Computer Lab Programs using Scilab/Maxima/Python: Elements of Partial differential equations and Integral transforms using FOSS **1.** Solutions of Linear Partial differential equations of type1 to type4 and Lagrange's method **2.** Solutions of partial differential equation using Charpit's method. **3.** Solutions of Second order homogenous partial differential equation with constant coefficients. **4.** Solutions to the partial differential equations using separation of variables method (Heat/ Wave/Laplace). **5.** Finding the Laplace transforms of some standard and periodic functions. **6.** Finding the inverse Laplace transform of simple functions. **7.** Verification of Convolution Theorem. **8.** To solve ordinary linear differential equation using Laplace transform. **9.** To solve Integral equation using Laplace transform. **10.** To find full range Fourier series of some simple functions with period 2π and 2L **11.** To find Half range sine and cosine series of some simple functions and ploting them. **12.** To find Cosine Fourier transforms. **13.** To find Sine Fourier transforms.		**56**

Open Elective Course

Year	II	**Course Code:** 21BSC4O4MAT4-B	**Credits**	03
Sem.	IV	**Course Title: Mathematical Finance**	**Hours**	42
Course Pre-requisites, if any		NA		
Formative Assessment Marks: 40		Summative Assessment Marks: 60	Duration of ESA:.02 hrs.	
Course Outcomes		Course Learning Outcomes: This course will enable the students to • Understand how compute profit and loss, discount and Banker's discount. • Understand the concept of Linear equations and inequalities and their use in the solving the Linear Programming Problems. • Formulation of Transportation Problem and its application in routing problem.		
Unit No.		**Course Content**		**Hours**
Unit I		**Commercial Arithmetic:** Bill of exchange, Bill of discounting procedure. Basic formula related to profit, loss, discount and brokerage, Successive discount, True discount, Banker's discount.		**14**
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**
Unit III		**Transportation problem:** Introduction, Formulation of Transportation problem, Initial basic feasible solution, Steps in solving a transportation problem, optimality check, special cases in Transportation problem. The Travelling salesman Problem (Routing Problem).		**14**
Recommended Leaning Resources				
Print Resources		Reference Books: **1.** R S Aggarwal, Objective Arithmetic, S. Chand & Company Ltd. **2.** Mizrahi and Sullivan, Mathematics for Business and Social Sciences an Application approach. **3.** Qazi Zameeruddin, Vijay K Khanna, S K Bhambri, Business Mathematics-II Edition, Vikas Publishing House. **4.** S.Kalavathy, Operation Research, Fourth edition, Vikas publication house Pvt.Ltd. **5.** Sreenivasa Reddy M, Operations Research 2nd edition, Sanguine Technical publishers, Bangalore. **6.** S. D. Sharma, Operation Research		

Year	II	**Course Code:** 21BSC4O4MAT4-C	**Credits**	03
Sem.	IV	**Course Title: Mathematics for Social Sciences**	**Hours**	42

Course Pre-requisites, if any	NA	
Formative Assessment Marks: 40	Summative Assessment Marks: 60	Duration of ESA:.02 hrs.

Course Outcomes	Course Learning Outcomes: This course will enable the students to • Understand the mathematical concept of sets and counting problems. • Understand the concept of Probability and its applications in social sciences. • Understand the concept of limits and continuity of functions and its applications in business and social sciences.

Unit No.	**Course Content**	**Hours**
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.	**14**
Unit II	Limit and continuity, Derivative- interpretation, derivative formulas, general derivatives for differentiation, composit functions, higher order derivatives and problems thereon.	**14**
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**

Recommended Leaning Resources

Print Resources

REFERENCE BOOKS

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

SEMESTER – V

Year	III	**Course Code:**	**Credits**	04
Sem.	V	**Course Title: 5.1 Real Analysis-II and Complex Analysis**	**Hours**	60

Course Pre-requisites, if any	NA	
Formative Assessment Marks: 40	Summative Assessment Marks: 60	Duration of ESA:02 hrs.

Course Outcomes	**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 follow. At the end of this course, the student will be able to: • Carry out certain computations such as computing upper and lower Riemann sums as well integrals. • Describe various criteria for Integrability of functions. • Exhibit certain properties of mathematical objects such as integrable functions, analytic functions, harmonic functions and soon. • ProvesomestatementsrelatedtoRiemannintegrationaswellasincomplexanalysis. • Carry out the existing algorithms to construct mathematical structures such as analytic functions. • Applies the gained knowledge to solve various other problems.	
Unit No.	**Course Content**	**Hours**
	Real Analysis-II	
Unit I	**Riemann Integration:** Definition & examples for partition of an interval, refinement of a partition and common refinement. **Riemann Darboux Sums –** Upper and lower (Darboux) sums–definition, properties & problems. Riemann Integral–Upper and Lower integrals (definition & problems), Darboux's theorem and Criterion for Integrability, Integrability of sum, difference, product, quotient and modulus of integrable functions. **Integral as a limit of sum (Riemann sum)**–Problems. Integrability of continuous functions, monotonic functions, bounded function with finite number of discontinuity. Fundamental theorem of Calculus–related problems, change of variables, integration by parts, first and second mean value theorems of integral calculus	**15**
Unit II	**Improper Integral and Beta & Gamma functions:**. Improper integrals of the first, second and third kind with examples. Improper integral has 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, standard theorems, duplication formula and applications.	**15**
	Complex Analysis	
Unit III	**Complex numbers and functions of complex variables:** Complex numbers-Cartesian and polar form-geometrical representation – complex-Plane- Euler's formula -$e^{i\gamma}$=cosγ+*i*sinγ. Functions of a complex variable-limit, continuity and differentiability of a complex function. Analytic function, Cauchy-Riemann equations in Cartesian form conditions for analyticity, Harmonic function-standard properties of analytic functions-construction of analytic function when real or imaginary part is given-Milne Thomson method.	**15**

Unit IV	**Transformations and Complex integration**: Transformations: Definition – Jacobian of a transformation –Identity transformation –Reflection – Translation – Rotation – Stretching – Inversion-Linear transformation – Definitions-Bilineartrans formations –Cross- ratio of four points - Cross-ratio preserving property- Preservation of the family of straight lines and circles-Conformal mappings- Discussion of the transformations $w=z^2$,$w=\sin z$,$w=e^z$,$w=\frac{z+\bar{z}}{2}$. Complex integration–definition, Line integral, properties and problems. Cauchy's Integral theorem –proof using Green's theorem-direct consequences. Cauchy's Integral formula with proof-Cauchy's generalized formula for the derivatives with proof and applications for evaluation of simple line integrals.	**15**
Recommended Leaning Resources		
Print Resources	**References:** **1.** S.C. Malik, Real Analysis, New Age International (India) Pvt. Ltd. **2.** S.C.Malikand Savita Arora, Mathematical Analysis, 2nded. NewDelhi, India: New Age international (P) Ltd. **3.** Richard R Goldberg, Methods of Real Analysis, Oxford and IBH Publishing **4.** Ajit Kumrand S. Kumaresan-A Basic Coursein Real Analysis, Taylor and Francis Group. **5.** L.V.Ahlfors,ComplexAnalysis,3rd Edition, McGraw Hill Education **6.** Bruce P.Palka,IntroductiontotheTheoryofFunctionofaComplexVariable,Springer Serge Lang, Complex Analysis, Springer. **7.** Shanthinarayan, Theory of Functions of a Complex Variable, S. Chand Publishers. **8.** S. Ponnuswamy, Foundations of Complex Analysis, 2nd Edition, Alpha Science International Limited. **9.** R. V. Churchil & J. W. Brown, Complex Variables and Applications, 5th ed, McGraw Hill Companies.	

<table>
<tr><td>Year</td><td>III</td><td colspan="3">Course Code:</td><td>Credits</td><td>02</td></tr>
<tr><td>Sem.</td><td>V</td><td colspan="3">Course Title: 5.1 Practical’s on Real Analysis-II and Complex Analysis</td><td>Hours</td><td>60</td></tr>
<tr><td colspan="2">Course Pre-requisites, if any</td><td colspan="5">NA</td></tr>
<tr><td colspan="2">Formative Assessment Marks: 25</td><td colspan="2">Summative Assessment Marks: 25</td><td colspan="3">Duration of ESA:02 hrs.</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">Course Learning Outcomes: This course will enable the students to:
• Learn Free and Open-Source Software (FOSS) tools for computer programming.
• Solve problem on Real Analysis and Complex Analysis studied in MAT DSCT 5.1 by using FOSS software’s.
• Acquire knowledge of applications of Real Analysis and Complex Analysis through FOSS.</td></tr>
<tr><td></td><td colspan="5">Course Content</td><td></td></tr>
<tr><td></td><td colspan="5">Practical/Lab Work to be performed in Computer Lab (FOSS) Suggested Software’s:Maxima/Scilab/Python/R.

Suggested Programs:
1. Program to check whether a given set of real numbers attains supremum or infimum.
2. Program to find upper and lower Riemann sums with respect to given partition.
3. Program to test Riemann Integrability.
4. Program to evaluate Riemann integral as a limit of sum.
5. Evaluation of $\Gamma(n)$) for n is integer and non-integer.
6. Evaluation of $\beta(m\ ,\ n)$ for $m\ > 0\ and\ n > 0$..
7. Program on verification of Cauchy –Riemann equations for analyticity.
8. Program to check whether a function is harmonic or not.
9. Program to construct analytic functions (through Milne–Thompson method)
10. Program to find Cross ratio of points and related aspects.
11. Program to find fixed points of bilinear transformations.
12. Program to verify De-Moivre’s theorem.</td><td>60</td></tr>
</table>

Year	III	**Course Code:**	**Credits**	04
Sem.	V	**Course Title: 5.2 Vector Calculus and Analytical Geometry**	**Hours**	60
Course Pre-requisites, if any		NA		
Formative Assessment Marks: 40		Summative Assessment Marks: 60	Duration of ESA:02 hrs.	

Course Outcomes	**Course Learning Outcomes**: This course will enable the students to: • Get introduced to the fundamentals of vector differential and integral calculus. • Get familiar with the various differential operators and their properties. • Get acquainted with the various techniques of vector integration. • Learn the applications of vector calculus. • Recollect the fundamentals of Analytical Geometry in 3D. • Interpret the geometrical aspects of planes and lines in3D.	
Unit No.	**Course Content**	**Hours**
	Vector Calculus	
Unit I	**Vector Algebra:** Multiple product–scalar triple product, vector triple product, geometrical interpretation, related problems; vector function of a scalar variable–interpretation as a space curve, derivative, tangent, normal and binormal vectors to a space curve; Curvature and Torsion of a space curve - definitions, derivation and problems, Serret –Frenet formulae. **Scalar field -** Gradient of a scalar field, geometrical meaning, directional derivative, unit normal using surfaces- tangent plane and normal to the surface; Vector field –divergence and curl of a vector field, geometrical meaning, solenoidal and irrotational fields; Laplacian of a scalar field; Vector identities.	**15**
Unit II	**Vector Integration**: Definition and basic properties, vector line integral, surface integral and volume integral; **Green's theorem in the plane** – Proof and related problems, Direct consequences of the theorem; **Gauss' Divergence theorem** – Proof and related problems, Direct consequences of the theorem; **Stokes' theorem**–Proof and related problems, Direct consequences of the theorem.	**15**
	Analytical Geometry	
Unit III	Planes, Straight Lines and Spheres Planes: Distance of a pointfromaplane,Anglebetweentwoplanes,pairofplanes,Bisectorsofanglesbetweentwoplanes;Straight lines: Equations of straight lines, Distance of a point from a straight line, Distance between two straight lines, Distance between a straight line and a plane; Spheres: Different forms, Intersection of two spheres, Orthogonal intersection, Tangents and normal, Radical plane, Radical line, Coaxial system of spheres, Pole, Polar and Conjugacy.	**15**
Unit IV	Locus, Surfaces, Curves and Conicoids Space curves, Algebraic curves, Ruled surfaces, Some standard surfaces ,Classification of quadric surfaces, Cone, Cylinder, Central conicoids, Tangent plane, Normal, Polar planes, and Polar lines.	**15**

Recommended Leaning Resources	
Print Resources	**References:** **1.** Robert J. T. Bell (1994). An Elementary Treatise on Coordinate Geometry of Three Dimensions. Macmillan India Ltd. **2.** D.Chatterjee(2009). Analytical Geometry: Two and Three Dimensions. Narosa Publishing House. **3.** Shanthi Narayan and P. K. Mittal, Analytical Solid Geometry, S.Chand Publications. **4.** A.N.Das, Analytical Geometry of Two and Three Dimensions, New Central Book Agency Pvt. Ltd. **5.** M. D. Raisinghania, Vector Calculus, S Chand Co. Pvt.Ltd., 2013. **6.** M. Spiegel, Vector Analysis, 2nd Edition, Schaum's Outline Series, Mc-Graw Hill, Education, 2017. **7.** C. E. Weatherburn, Elementary Vector Analysis, Alpha edition ,2019. **8.** P. N. Wartikar and J. N. Wartikar, A Textbook of Applied Mathematics, Vol. II, Pune Vidyarthi Griha Prakashan, Pune, 2009. **9.** C. E. Weatherburn, Differential Geometry of Three Dimension, Khosla Publishing House, 2020. **10.** B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers. **11.** G. B. Thomasand R. L. Finney, Introduction to Calculus and Analytical Geometry, Narosa Publishing House,2010.

Year	III	**Course Code:**	**Credits**	02
Sem.	V	**Course Title: 5.2 Practical's on Analytical Geometry and Vector Calculus**	**Hours**	60

Course Pre-requisites, if any	NA	
Formative Assessment Marks: 25	Summative Assessment Marks: 25	Duration of ESA:02 hrs.

Course Outcomes	**Course Learning Outcomes**: This course will enable the students to: • Learn Free and Open-Source Software (FOSS) tools for computer programming. • Solve problem on Analytical Geometry and Vector Calculus studied in **MAT DSCT 5.2** by using FOSS software's.	
	Course Content	**Hours**
	Practical/Lab Work to be performed in Computer Lab (FOSS) **Suggested Software's**: Maxima/Scilab/Python/R. **Suggested Programs**: **1.** Program on multiple product of vectors–Scalar and Cross product. **2.** Program on vector differentiation and finding unit tangent. **3.** Program to find curvature and torsion of a space curve. **4.** Program to find the gradient and Laplacian of a scalar function, divergence and curl of a vector function. **5.** Program to demonstrate the physical interpretation of gradient, divergence and curl. **6.** Program to evaluate vector line integral. **7.** Program to evaluate a surface integral. **8.** Program to evaluate a volume integral. **9.** Program to verify Green's theorem. **10.** Program to find equation and plot sphere, cone and cylinder **11.** Program to find distance between a straight line and a plane. **12.** Program to construct and plot some standard surfaces.	**60**

SEMESTER – VI

Year	III	**Course Code:**		**Credits**	04
Sem.	VI	**Course Title: 6.1Linear Algebra**		**Hours**	60
Course Pre-requisites, if any		NA			
Formative Assessment Marks: 40		Summative Assessment Marks: 60	Duration of ESA:02 hrs.		
Course Outcomes		**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 vectors spaces, linear transformations. Some broader course outcomes are listed as follows. At the end of this course, the student will be able to • Understand the concepts of Vector spaces, subspaces, bases dimension and their properties. • Become familiar with the concepts of Eigen values and Eigen vectors, linear transformations etc. • Prove various statements in the context of vectors spaces.			
Unit No.		**Course Content**		**Hours**	
Unit I		**Rings and integral domains:** Rings, Properties of rings, sub rings, ideals, principal and maximal ideals in commutative ring, quotient ring, homomorphism and isomorphism, and integral domains.		**15**	
Unit II		**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).		**15**	
Unit III		**Linear transformations**: Definition, examples, equivalent criteria, some basic properties and matrix representation and change of basis and effect on associated matrix, similar matrices; Rank - Nullity theorem - Null space, Range space, proof of rank nullity theorem and related problems.		**15**	

Unit IV	**Isomorphism, Eigen values and Diagonalization:** Homomorphism, Isomorphism and automorphism-Examples, order of automorphism and Fundamental theorem of homomorphism; Eigen values and Eigen vectors-Computation of Eigen values, algebraic multiplicity, 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 (mentioning) and related problems(Only verification of diagonalizability).	**15**
Recommended Leaning Resources		
Print Resources	**References:** **1.** I. N. Herstein, Topics in Algebra, 2nd Edition,Wiley. **2.** Stephen H. Friedberg, Arnold J. Insel & Lawrence E. Spence (2003), Linear Algebra (4th Edition), Printice- Hall of India Pvt. Ltd. **3.** F. M. Stewart, Introduction to Linear Algebra, Dover Publications. **4.** S .Kumaresan, LinearAlgebra, Prentice Hall India Learning Private Limited. **5.** Kenneth Hoffman & Ray Kunze (2015), Linear Algebra, 2ndEdition), Prentice Hall India Leaning Private Limited. **6.** Gilbert. Strang (2015), Linear Algebra and its applications, (2ndEdition), Elsevier. **7.** Vivek Sahai & Vikas Bist(2013), Linear Algebra (2nd Edition) Narosa Publishing. **8.** Serge Lang (2005), Introduction to Linear Algebra (2nd Edition), Springer India. **9.** T. K. Manicavasagam Pillaiand K S Narayanan, Modern Algebra Volume2.	

<table>
<tr><td>Year</td><td>III</td><td colspan="2">Course Code:</td><td>Credits</td><td>02</td></tr>
<tr><td>Sem.</td><td>VI</td><td colspan="2">Course Title: 6.1Practical’s on Linear Algebra</td><td>Hours</td><td>60</td></tr>
<tr><td colspan="2">Course Pre-requisites, if any</td><td colspan="4">NA</td></tr>
<tr><td colspan="2">Formative Assessment Marks: 25</td><td colspan="2">Summative Assessment Marks: 25</td><td colspan="2">Duration of ESA:02 hrs.</td></tr>
<tr><td>Course Outcomes</td><td colspan="5">Course Learning Outcomes: This course will enable the students to:
• Learn Free and Open-Source Software (FOSS) tools for computer programming.
• Solve problem on Linear Algebra studied in MAT DSCT 6.1 by using FOSS softwares.
• Acquire knowledge of applications of Linear Algebra through FOSS.</td></tr>
<tr><td></td><td colspan="4">Course Content</td><td>Hours</td></tr>
<tr><td></td><td colspan="4">Practical/Lab Work to be performed in Computer Lab (FOSS)
Suggested Software’s: Maxima/ Scilab /Python/R.
Suggested Programs:
1. Program to find whether given finite set is ring or not.
2. Programs on sub-rings, ideals.
3. Program to verify homomorphism of rings.
4. Program to verify isomorphism of rings.
5. Program on linear combination of vectors.
6. Program to verify linear dependence and independence.
7. Program to find basis and dimension of the subspaces.
8. Program to verify if a function is linear transformation or not.
9. Program to find the matrix of linear transformation.
10. Program to find the Eigen values and Eigen vectors of a given linear transformation.
11. Program on Rank–nullity theorem.
12. Program to verify if the given linear transformation is singular/non-singular.</td><td>60</td></tr>
</table>

Year	III	**Course Code:**	**Credits**	04
Sem.	VI	**Course Title: 6.2NumericalAnalysis**	**Hours**	60
Course Pre-requisites, if any		NA		
Formative Assessment Marks: 40		Summative Assessment Marks: 60	Duration of ESA:02 hrs.	

Course Outcomes	**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 • Describe various operators arising in numerical analysis such as difference operators, shift operators and so on. • Articulate the rationale behind various techniques of numerical analysis such as in finding roots, integrals and derivatives. • Reproduce the existing algorithms for various tasks as mentioned previously in numerical analysis. • Apply the rules of calculus and other areas of mathematics in justifying the techniques of numerical analysis. • Solve problems using suitable numerical technique. • Appreciate the profound applicability of techniques of numerical analysis in solving real life problems and also appreciate the way the techniques are modified to improve the accuracy.

Unit No.	**Course Content**	**Hours**
Unit I	**Algebraic and Transcendental Equations:** Errors-Significant digits, absolute, relative, percentage errors, rounding off and truncation errors (meanings and related problems), general error formula(derivation of formula and problems based on it), error in series approximation: Taylor series approximations (problems only), Solutions to algebraic and transcendental equations- Bisection method, Regula-Falsi method, iterative method Newton-Raphson method and secant method (Plain discussion of the rationale behind techniques and problems on their applications).	**15**
Unit II	**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, Successive- Over Relaxation method(SOR) method.	**15**
Unit III	**Polynomial Interpolations:** Finite differences. Forward and backward differences and shift operators: definitions, properties and problems; Polynomial interpolation-Newton-Gregory forward and backward interpolation formulae, Gauss's Forward and backward interpolation formulae, Lagrange interpolation polynomial, Newton's general interpolation formula (Discussion on setting up	**15**

	the polynomials, differences between them and problems on their applications).	
Unit IV	**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 1/3rule, Simpson's 3/8 rule and Weddell's rule (derivations for only general quadrature formula, trapezoidal rule and Simpson's $1/3^{rd}$ rule and problems on the applications of all formulas).	**15**
Recommended Leaning Resources		
Print Resources	**References:** **1.** E. Isaacson and H. B. Keller, Analysis of Numerical methods, Dover Publications. **2.** S. S. Sastry, Introductory methods of Numerical Analysis, 5^{th} Edition, PHI Learning Private Limited. **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, 4^{th} 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.	

Year	III	**Course Code:**		**Credits**	02
Sem.	VI	**Course Title: 6.2 Practical's on Numerical Analysis**		**Hours**	60
Course Pre-requisites, if any		NA			
Formative Assessment Marks: 25		Summative Assessment Marks: 25	Duration of ESA:02 hrs.		
Course Outcomes		**Course Learning Outcomes**: This course will enable the students to: • Learn Free and Open-Source Software(FOSS) tools for computer programming. • Solve problem on numerical Analysis studied in **MAT DSC T 6.2** by using FOSS software's. • Acquire knowledge of applications of numerical Analysis through FOSS.			
		Course Content			**Hours**
		Practical/Lab Work to be performed in Computer Lab (FOSS) **Suggested Software's**: Maxima /Scilab /Python/R. **Suggested Programs**: **1.** Program to find root of an equation using bisection and Regula - Falsi methods. **2.** Program to find root of an equation using Newton - Raphson and Secant methods. **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 solve the system of algebraic equations using SOR method **8.** Program to evaluate integral using Simpson's1/3 and 3/8 rules. **9.** Program to evaluate integral using Trapezoidal and Weddle rules. **10.** Program to find the sums of powers of successive natural numbers using Newton–Gregory technique. **11.** Program to find differentiation at specified point using Newton-Gregory interpolation method. **12.** Program to find the missing value of table using Lagrange method.			**60**

Internship for graduate Programme (As per UGC)

Course title	Internship Discipline specific
No. of contact hours	90
No. of credits	2
Method of evaluation	Presentation/Report of submission/Activity etc.,

- Internship shall be Discipline Specific of 90 hours (2 credits) with a duration 4-6 weeks.
- Internship may be full-time/part-time (full-time during semester holidays and part-time in the academic session).
- Internship mentor/supervisor shall avail work allotment during 6^{th} semester for a maximum of 20 hours.
- The student should submit the final internship report (90 hours of Internship) to the mentor for completion of the internship.
- The detailed guidelines and formats shall be formulated by the universities separately as prescribed in accordance to UGC guidelines.