HSNC UNIVERSITY, MUMBAI

Board of Studies

in

Faculties of Science & Technology

Board of Studies in Mathematics

1. **Name of Chairperson**
   Mrs. Usha G. Hemasundar ,Head, Department of Mathematics, M Sc Mathematics
   Associate Professor, K. C. College Ph: 9892234921 Email id: usha.gollakota@kccollege.edu.in

   Name of Co-Chairperson
   Ms. Shubhada Kanchan ,MSc Mathematics,Department of Mathematics and Statistics
   Assistant Professor,H. R. College ,Ph: 9975673087 Email id: shubhadark@yahoo.co.in

2. **Two to five teachers each having minimum five years teaching experience amongst the full-time teachers of the Departments, in the relevant subject.**
   a.) Dr. Pankit Gandhi, MSc (Mathematics), M Phil, Ph.D., LL.B., Associate Professor, K. C. College, Ph: 8169381936 Email id: pankit.gandhi@kccollege.edu
   b.) Mrs. Suman Gupta,MSc Operations Research,Assistant Professor,H. R. College,Ph: 9869003141; Email id: suman11262@gmail.com
   c.) Mrs. Vijayalaxmi Suvarna ,M Sc Mathematics, M.Phil ,Assistant Professor,H. R. College, Ph: 9987395783; Email id: vijayalaxmi_suvarna@rediffmail.com
   d.) Mrs. Mrunal Hardikar ,M Sc Mathematic, Assistant Professor, K. C. College, Ph: 9653227252; Email id: mrunal.hardikar@kccollege

3. **One Professor / Associate Professor from other Universities or professor / Associate Professor from colleges managed by Parent Body; nominated by Parent Body;-**
   a.) Dr Sushil Kulkarni ,Ph.D. Matthematics,Associate Professor, Head, Department of Mathematics and Controller of Examinations, Jai Hind (Autonomous) College., Ph No 9870126536; Email id: sushil.kulkarni@jaihindcollege.edu.in

4. **External experts from Industry / Research / eminent scholar in the field relevant to the subject nominated by the Parent Body**;
    a.) Dr Ajit Kumar , Ph.D. Mathematics,Associate Professor and Head, Department of Mathematics, Institute of Chemical Technology, Mumbai,Ph No. 99690 31202; E Mail id ajit72@gmail.com
    b.) Mrs. Jayashree Shetty, Associate Professor, KPB Hinduja College, Mumbai,Ph: 9821690011; Email Id: shettyju@live.in
    c.) Dr. Amiya Ranjan Bhowmick, Ph.D. Applied Mathematics and Statistics; Assistant Professor, Institute of Chemical Technology, Mumbai, Ph no: 08334835300/7738101583; amiyaiitb@gmail.com/ar.bhowmick@ictmumbai.edu.in
    d.) Mr. Prashant Shukla,MSc statistics, Masters in Financial Management JBIMS; Chief Investment Officer, Aston Capital Advisor Pvt Ltd,Partner at HBD Consulting LLP; Ph no:9821470975; Email id: sprash@rediffmail.com
    e.) Mr. Nikunj Sharma ,Zonal Head, Tata Portfolio JLL,Ph: 9920475159; Email id: nikunj.sharma@ap.jll.com
    f.) Mr. Kaushal Shah,M.Com, PGDBA(Finance),Senior Manager, Treasury Reliance Power, Ph no: 9320105703; Email id: krushalshah78@gmail.com
    g.) Mr. Ravi Vyas ,Founder S.MONK School of Actuaries,Ph: 8169914289; Email id: ravivyas1993@gmail.com

5. **Top rankers of the Final Year Graduate and Final Year Post Graduate examination of previous year of the concerned subject as invitee members for discussions on framing or revision of syllabus of that subject or group of subjects for one year.**
    a.) Divya Srivastav, MSc. Statistics MIT-WPU, Pune., BSc. Statistics, K.C. College, Mumbai. Email: divyasrivastav20@gmail.com; Phone no. 8879240305

Part –I

Outline of Choice Based Credit System as outlined by University Grants Commission:

R. **: The Definitions of The Key Terms Used in The Choice Based Credit System And Grading System Introduced From TheAcademicYear2020-2021AreAs Under:**

1. **Core Course:** A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

2. **Elective Course:** Generally, a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course.

   2.1 **Discipline Specific Elective (DSE) Course**: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).
   2.2 **Dissertation/Project:** An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project. A Project/Dissertation work would be of 6 credits. A Project/Dissertation work may be given in lieu of a discipline specific elective paper.
   2.3 **Generic Elective (GE) Course:** An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective. P.S.: A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective.

3. **Choice Base Credit System:** CBCS allows students to choose inter- disciplinary, intra-disciplinary courses, skill-oriented papers (even from other disciplines according to their learning needs, interests and aptitude) and more flexibility for students.
4. **Honors Program:** To enhance employability and entrepreneurship abilities among the learners, through aligning Inter Disciplinary / Intra Disciplinary courses with Degree Program. Honours Program will have 40 additional credits to be undertaken by the learner across three years essentially in Inter / Intra Disciplinary course.

   A learner who joins Regular Undergraduate Program will have to opt for Honours Program in the first year of the Program. However, the credits for honours, though divided across three years can be completed within three years to become eligible for award of honours Degree.

5. **Program:** A Program is a set of course that are linked together in an academically meaningful way and generally ends with the award of a Degree Certificate depending on the level of knowledge attained and the total duration of study, B.Sc. Programs.

6. **Course:** A 'course' is essentially a constituent of a 'program' and may be conceived of as a composite of several learning topics taken from a certain knowledge domain, at a certain level. All the learning topics included in a course must necessarily have academic coherence, i.e. there

must be a common thread linking the various components of a course. A number of linked courses considered together are in practice, a 'program'.

7. **Bridge Course:** Bridge course is visualized as Pre semester preparation by the learner before commencement of regular lectures. For each semester the topics, whose knowledge is considered as essential for effective and seamless learning of topics of the Semester, will be specified. The Bridge Course can be conducted in online mode. The Online content can be created for the Bridge Course Topics.

8. **Module and Unit:** A course which is generally an independent entity having its own separate identity, is also often referred to as a 'Module' in today's parlance, especially when we refer to a 'modular curricular structure'. A module may be studied in conjunction with other learning modules or studied independently. A topic within a course is treated as a Unit. Each course should have exactly 3 Units.

9. **Self-Learning: 20% of the topics will be marked for Self-Learning.** Topics for Self-Learning are to be learned independently by the student, in a time- bound manner, using online and offline resources including online lectures, videos, library, discussion forums, fieldwork, internships etc.

   Evaluative sessions (physical/online), equivalent to the credit allocation of the Self Learning topics, shall be conducted, preferably, every week for each course. Learners are to be evaluated real time during evaluative sessions. The purpose of evaluative sessions is to assess the level of the students' learning achieved in the topics are marked for Self-Learning.

   The teacher's role in these evaluative sessions will be that of a Moderator and Mentor, who will guide and navigate the discussions in the sessions, and offer concluding remarks, with proper reasoning on the aspects which may have been missed by the students, in the course of the Self-Learning process.

   The modes to evaluate self-learning can be a combination of the various methods such as written reports, handouts with gaps and MCQs, objective tests, case studies and Peer learning. Groups can be formed to present self- learning topics to peer groups, followed by Question-and-Answer sessions and open discussion. The marking scheme for Self-Learning will be defined under Examination and Teaching.

   The topics stipulated for self-learning can be increased or reduced as per the recommendations of the Board of Studies and Academic Council from time to time. All decisions regarding evaluation need to be taken and communicated to the stakeholders preferably before the commencement of a semester. Some exceptions may be made in exigencies, like the current situation arising from the lockdown, but such adhoc decisions are to be kept to the minimum possible.

10. **Credit Point:** Credit Point refers to the 'Workload' of a learner and is an index of the number of learning hours deemed for a certain segment of learning. These learning hours may include a variety of learning activities like reading, reflecting, discussing, attending lectures / counseling sessions, watching especially prepared videos, writing assignments, preparing for examinations, etc. Credits assigned for a single course always pay attention to how many hours it would take for a learner to complete a single course successfully. A single course should have, by and large a course may be assigned anywhere between 2 to 8 credit points wherein 1 credit is construed as corresponding to approximately 30 to 40 learning hours.

11. **Credit Completion and Credit Accumulation:** Credit completion or Credit acquisition shall be considered to take place after the learner has successfully cleared all the evaluation criteria with respect to a single course. Thus, a learner who successfully completes a 4 CP (Credit Point) course may be considered to have collected or acquired 4 credits. learner level of performance above the minimum prescribed level (viz. grades / marks obtained) has no bearing on the number of credits collected or acquired. A learner keeps on adding more and more credits as he completes successfully more and more courses. Thus, the learner 'accumulates' course wise credits.

12. **Credit Bank:** A Credit Bank in simple terms refers to stored and dynamically updated information regarding the number of Credits obtained by any given learner along with details regarding the course/s for which Credit has been given, the course-level, nature, etc. In addition, all the information regarding the number of Credits transferred to different programs or credit exemptions given may also be stored with the individual's history.

13. **Credit Transfer:** (performance transfer) When a learner successfully completes a program, he/she is allowed to transfer his/her past performance to another academic program having some common courses and Performance transfer is said to have taken place.

14. **Course Exemption:** Occasionally, when two academic programs offered by a single university or by more than one university, may have some common or equivalent course-content, the learner who has already completed one of these academic programs is allowed to skip these 'equivalent' courses while registering for the new program. The Learner is 'exempted' from 'relearning' the common or equivalent content area and from re-appearing for the concerned examinations. It is thus taken for granted that the learner has already collected in the past the credits corresponding to the exempted courses.

Part-II

O*** The fees for transfer of credits or performance will be based on number of credits that a learner has to complete for award of the degree.**

The Scheme of Teaching and Examination:

The performance of the learners shall be evaluated in two components: Internal Assessment with 40% marks by way of continuous evaluation and by Semester End Examination with 60% marks by conducting the theory examination.

INTERNAL ASSESSMENT: - It is defined as the assessment of the learners on the basis of continuous evaluation as envisaged in the credit-based system by way of participation of learners in various academic and correlated activities in the given semester of the programme.

A). Internal Assessment– 40% 40 marks

Practical's (internal Components of the Practical Course
1. For Theory Courses

Sr. No.	Particulars	Marks
1	**ONE** class test/online examination to be conducted in the given semester	15 Marks
2	One assignment based on curriculum (to be assessed by the teacher Concerned	10 Marks
3	Self-Learning Evaluation	10 Marks
4	Active participation in routine class instructional deliveries	05 Marks

2. For Courses with Practicals
Each practical course can be conducted out of 50 marks with 20 marks for internal and 30 marks for external

Practical's (Internal component of the Practical Course)

Sr. No	Evaluation type	Marks
1	Two Best Practicals /Assignments/Presentation /Preparation of models/ Exhibits **Or** One Assignment/ project with class presentation to be assessed by teacher concerned	10
2	Journal	05
3	Viva	05

The semester end examination (external component) of 60 % for each course will be as follows:
i) **Duration – 2 Hours** ii) **Theory Question Paper**

Pattern: -

1. There shall be four questions each of 15 marks. On each unit there will be one question and the fourth one will be based on entire syllabus.
2. All questions shall be compulsory with internal choice within the questions. (Each question will be of 20 to 23 marks with options.)
3. Question may be subdivided into sub-questions a, b, c… and the allocation of marks depend on the weightage of the topic.

   The marks will be given for all examinations and they will be converted into grade (quality) points. The semester-end, final grade sheets and transcripts will have only credits, grades, grade points, SGPA and CGPA.

3. **Project and Assignment:**
Project or Assignment, which can in the following forms

- Case Studies
- Videos
- Blogs
- Research paper (Presented in Seminar/Conference)
- Field Visit Report
- Presentations related to the subject (Moot Court, Youth Parliament, etc.)
- Internships (Exposition of theory into practice)
- Open Book Test
- any other innovative methods adopted with the prior approval of Director Board of Examination and Evaluation.

4. **Self-Learning Evaluation**

- **20% OF THE TOPICS OF CURRICULUM ARE LEARNED BY THE STUDENT THROUGH SELF LEARNING USING ONLINE / OFFLINE ACADEMIC RESOURSE SPECIFIED IN THE CURRICULUM.**

- **HENCE 20% OF THE LECTURES SHALL BE ALLOCATED FOR EVALUATION OF STUDENTS ON SELF LEARNING TOPICS**

- The identified topics in the syllabus shall be learnt independently by the students in a time bound manner preferably from online resources. Evaluative sessions shall be conducted by the teachers and will carry 10 Marks.

- CLUB The self-learning topics into 3-4 GROUPS OF TOPICS ONLY FOR EVALUATION.

- **PRESCRIBE TIME DURATION (IN DAYS) FOR COMPLETION OF EACH GROUP OF TOPIC AND EARMARK SELF LEARNING EVALUATION LECTURES IN THE TIMETABLE. HENCE EACH GROUP OF TOPIC CAN BE ASSIGNED 3 REGULAR LECTURES FOR THIS EVALUATION FOR ENTIRE CLASS**

  3 Sub Topics
  Each evaluative session shall carry 3 Marks (3 x 3 Units = 9 Marks). Students who participate in all evaluative sessions shall be awarded 1 additional Mark.
  4 Sub Topics
  Each evaluative session shall carry 2.5 Marks (2.5 x 4 Units = 10 Marks)

- **EVALUATION OF SELF LEARNING TOPICS CAN COMMENCE IN REGULAR LECTURES ASSIGNED FOR SELF LEARNING EVALUATION IN THE TIMETABLE**

  3 Evaluative sessions
  Each evaluative session shall carry 3 Marks (3 x 3 = 9 Marks). Students who participate in all evaluative sessions shall be awarded 1 additional Mark
  4 **Evaluative sessions**
  Each evaluative session shall carry 2.5 Marks (2.5 x 4 = 10 Marks).

  Methods for Evaluation of Self-learning topics:

- Seminars/presentation (PPT or poster), followed by Q&A – Objective questions /Quiz / Framing of MCQ questions.
- Debates
- Group discussion
- You-Tube videos (Marks shall be based on the quality and viewership)
- Improvisation of videos
- Role Play followed by question-answers
-

TEACHERS CAN FRAME OTHER METHODS OF EVALUATION ALSO PROVIDED THAT THE METHOD, DULY APPROVED BY THE COLLEGE EXAMINATION COMMITTEE, IS NOTIFIED TO THE STUDENTS AT LEAST 7 DAYS BEFORE THE COMMENCEMENT OF THE EVALUATION SESSION AND IS FORWARDED FOR INFORMATION AND NECESSARY ACTION AT LEAT 3 DAYS BEFORE THE COMMENCEMENT OF THE EVALUATION SESSION

- Viva Voce
- Any other innovative method

SEMESTER END EXAMINATION: - It is defined as the examination of the learners on the basis of performance in the semester end theory / written examinations.

B. Semester End Examination- 60 % ***60 Marks***

1) Duration – These examinations shall be of 2 Hours duration.
2) Question Paper Pattern: -
   i. There shall be four questions each of 15 marks.
   ii. All questions shall be compulsory with internal choice within the questions.
   iii. Question may be sub-divided into sub-questions a, b, c, d & e only and the allocation of marks depends on the weightage of the topic.

THE MARKS OF THE INTERNAL ASSESSMENT SHOULD NOT BE DISCLOSED TO THE STUDENTS TILL THE RESULTS OF THE CORRESPONDING SEMESTER IS DECLARED.

HSNC University Mumbai

(2021-2022)

Ordinances and Regulations

With Respect to

Choice Based Credit System

(CBCS)

For the Programmes Under

The Faculty of Science and Technology

For the Course

MATHEMATICS

Semester-III and Semester -IV

With effect from the Academic year 2021-2022

Part 1-

Preamble

- The subject of Pure Mathematics is one of the most original creation of the human mind. It is a contemporary subject whose concepts and methodologies are being used by Physicists, Statisticians, Computer Scientists, Chemists, Biologists, Economists and financial advisors to name a few.
- This proposed curriculum is drafted with a view to create an option for B.Sc. in both Pure and Applied Mathematics.
- There are two courses of Mathematics for Science students at the F.Y.B.Sc. level in Semesters I as well as II and at S.Y.B.Sc. level, three courses each in semester III and IV.
- The assignments, projects which will be part of internal assessment aims to improve the problem-solving ability of the learners and also their ability to do teamwork. It will help the learner to get an in depth understanding of the topic. The presentations which will be part of the internal assessment will improve presentation and interpersonal communication skills.
- In addition to traditional problem-solving sessions, there will be few hands-on training sessions using Computer Algebra System (CAS)like Sage Math.

1. Course Objectives:

- Imparting knowledge to the students on very important basic concepts of Pure Mathematics in Calculus and Discrete Mathematics which are applied and needed in various branches of science and humanities.
- Giving a broad overview and introduction to the nature of the subject and develop Mathematical tools for continuing further study in various other disciplines.

2. Process adopted for curriculum Designing:

- After several rounds of discussion, at the departmental level, the members of the Department of Mathematics drafted the syllabus. The draft syllabus was shown to Industry Partners, Academic Partners and Research Institute Partners, through meetings and mails They suggested some changes. These changes were incorporated.

3. Salient features, how it has been made more relevant.

- The subject of Mathematics is the blend of Pure Mathematics and applied mathematics. Apart from the theorems and proofs which gives them better understanding of the basic concepts in mathematics, we have added practical sessions with CAS like Sage Math, which will teach them how to use mathematics as a tool in real life problems without doing rigorous theory and tedious calculations.
- The course would give the learners option to develop skills in areas which have direct relevance to employability in industry, finance, banking, and computer software designing apart from research in mathematics and teaching profession.

4. Learning Outcomes:

- The learner's understanding and problem-solving skills on the basic mathematical concepts of Calculus and Discrete Mathematics will get enhanced and they will start developing affinity for the subject of Mathematics.
- The learner's mathematical abilities will be enhanced due to in depth study of Logic and they will gradually be able to use appropriate mathematical language: notations, symbols, terminology, in both oral and written explanations.
- Since the theory of Mathematics has been applied using CAS techniques and numerical methods, the Learner's ability to synthesize the acquired knowledge, understanding and experience for a better and improved comprehension of the real-life problems will enhance.
- The learner will be able to mathematically formulate problems arising in the other subjects like Physics, Statistics, Operations Research, Law, Economics etc. will enhance and also will be able to solve these problems applying the mathematical tools learnt.

- The introduction of the self-learning of certain topics will enhance the learners' ability to understand, apply and experiment, which can give them the ability to think differently.

- The learner will be ready with the knowledge of computer software which will have the job opportunities.

5. **Input from stakeholders:**

- As per the suggestions given by the stake holders following changes were made in the draft syllabus.
- The Unit I: Differential Equations in Semester II (Calculus II) in the draft syllabus has been shifted to Semester I (Calculus I) and Limits and Continuity has been shifted to Semester II (Calculus II).
- Existence of square root of a non-square positive integer in Unit II SEM I has been added.
- In Semester I (Discrete Mathematics I) the concept of Family of set has been added.
- The Semester II, Course II (Linear Algebra I) has been replaced by a Course on Discrete Mathematics (Discrete Mathematics II).

Part 2. The Scheme of Teaching and Examination
Semester – I

Sr. No.	Choice Based Credit System			Subject Code	Remarks
1	Core Course (Mathematics)			US-FMA-101, US-FMA-102, US-FMA- P-1	
2	Elective Course	Discipline Specific Elective (DSE) Course			
		2.1	Interdisciplinary Specific Elective (IDSE) Course		
		2.2	Dissertation/Project		
		2.3	Generic Elective (GE) Course		
3	Ability Enhancement Courses (AEC)				
	Skill Enhancement Courses (SEC)				

First year Semester-I Internal and External Assessment
Detail Scheme:

Sr. No.	Subject Code	Subject Title	Periods Per Week						Seasonal Evaluation Scheme				Total Marks
			Units	S. L.	L	T	P	Credit	S. L. E	CT	TA	SEE	
1	US-FMA-101	Calculus-I	3	20% *	3	0	0	2	10	20	10	60	100
2	US-FMA-102	Discrete Mathematics I	3	20% *	3	0	0	2	10	20	10	60	100
3	US-FMA-P-1	Practical Sessions Based US-FMA--101 + Practical Sessions Based US-FMA—102			0	0	6	2				100 (80+20)	100
	Total Hours / Credit							06	Total Marks				300

One to two lectures to be taken for CONTINUOUS self-learning Evaluation.

Semester – I Units – Topics – Teaching Hours

S.N	Subject Code	Subject Unit Title		Hours/Lectures	Total No. of hours/lectures	Credit	Tot al Marks
		I	Ordinary Differential Equations	15	45 L	2	100

1	US-FMA-101	II	Real Number System	15			(60+40)
		III	Sequences	15			
2	US-FMA-102	I	Elementary Logic and Naive Set Theory	15	45L	2	100 (60+40)
		II	Integers and Divisibility	15			
		III	Relations and Functions	15			
3	US-FMA-P-1	I	Practical sessions based on US-FMA-101	3	45x2= 90L lectures per batch	2	100 (80+20)
		II	Practical sessions based on US-FMA-102	3			
			TOTAL			6	300

- **Lecture Duration – 45 Minutes = 0 .75 Hours. (45 Lectures equivalent to 33.75 hours)**
- **One Credit =16.87 hours equivalent to 17 Hours**

L: Lecture: Tutorials P: Practical Ct-Core Theory, Cp-Core Practical, SLE- Self learning evaluation CT-Commutative Test, SEE- Semester End Examination, PA-Project Assessment, AT- Attendance

Part3: Detail Scheme Theory
F.Y.B.SC. MATHEMATICS SYLLABUS
(SEMESTER BASED CREDIT AND GRADING SYSTEM)
TO BE IMPLEMENTED FROM THE ACADEMIC YEAR 2020-2021

Curriculum Topics along with Self-Learning Topics - to be covered, through self-learning mode along with the respective Unit. Evaluation of self-learning topics to be undertaken before the concluding lecture instructions of the respective UNIT.

Course I: **Course Code: US-FMA-101**
Title of course: **Calculus-I** Total credits: 02
Objectives:

1. After studying the topic of Real numbers learner will understand how Mathematical structures are developed from axioms and some of them will start developing affinity for the subject of Pure Mathematics.
2. Learners' problem-solving skills in the basic mathematical concepts in Calculus like sequences, differential equation will get enhanced.

Unit	Content	No. of Lectures
1	**1. Ordinary Differential Equations.** **1.1** Definition of a differential equation, order, degree, ordinary differential equation and partial differential equation, linear and nonlinear ODE. **1.2** Methods for solving first order ordinary differential equation. (Homogeneous, nonhomogeneous, linear, Bernoulli's equations) **1.3** Exact equation, General Solution of Exact equation of first order and first degree, Necessary and sufficient condition for M dx + N dy = 0 to be exact. Non-exact equations. Rules for finding integrating factors (without proof) for non-exact equations. **1.4** Applications of first order ordinary differential equation.	**15**
2	**2. Real Number System.** 2.1. The Algebraic and Order properties of $\mathbb{R}$, Absolute value and its properties. 2.2. AM-GM inequality, Cauchy-Schwarz inequality, Intervals, and neighborhoods, Hausdorff property. 2.3. Bounded sets, Greatest lower bound (Supremum) and least upper bound (infimum) of subsets of IR, Maximum and minimum, l.u.b. axiom (Order Completeness axiom) and its consequences, Existence of square root of any nonnegative integer. 2.4. Archimedean property and its applications, The Density Theorem. 2.5. Nested Interval Property.	**15**
3	**3. Sequences.** 3.1. Definition of a sequence and examples, convergence of a sequences, relation between convergent sequence and bounded sequence. Limit of a convergent sequence and uniqueness of limit, Divergent sequences. 3.2. Convergence of standard sequences like $\left(\frac{1}{1+na}\right) \forall\ a > 0$, (b^n) for all $0 < b < 1$, $\left(c^{\frac{1}{n}}\right) \forall\ c > 0$ & $\left(n^{\frac{1}{n}}\right)$. Algebra of convergent sequences, Sandwich (Squeeze) theorem.	**15**

	3.3. Monotone sequences, monotone convergence theorem and consequences such as convergence of $\left(\left(1+\frac{1}{n}\right)^n\right)$. 3.4. Subsequences, subsequence of a convergent sequence is convergent and converges to the same limit. 3.5. Cauchy sequences. Every convergent sequence is a Cauchy sequence and converse. 3.6. Bolzano–Weierstrass' Theorem	

Self-Learning topics (Unit wise)

Unit	Topics
1	1.1 Definition of a differential equation, order, degree, ordinary differential equation and partial differential equation.
1	1.3. Rules for finding integrating factors (without proof) for non-exact equations
1	1.4. Applications of first order ordinary differential equation.
3	3.2 convergence of $f\left(c^{\frac{1}{n}}\right) \forall\ c > 0$ & $\left(n^{\frac{1}{n}}\right)$ 3.3 convergence of $\left(\left(1+\frac{1}{n}\right)^n\right)$

Online Resources

1. "Differential Equation for engineers "by Prof. Srinivasa Manam, https://nptel.ac.in/courses/111/106/111106100/ lecture 1,2,3,4,7
2. Basic Real Analysis' **by Prof. I K Rana , IIT Mumbai** https://nptel.ac.in/courses/111/101/111101134/ lectures ,3,4,5,6

Subject to change if any new relevant course is available .

Reference Books

1. Differential equations with applications and historical notes, by G. F. Simmons, McGraw Hill (unit1)
2. Introduction to Real Analysis -R. G. Bartle- D. R. Sherbert,, John Wilely & Sons, 1994,Chapter2., 3.1,3.2,3.3,3.4,3.5,3.6,(Unit2,3)
3. Numerical methods by E Balaguruswamy, McGraw Hill
4. A Basic Course in Real Analysis, Ajit kumar, S. Kumaresan, CRC Press, 2014.
5. Calculus and Analytic Geometry, Thomas and Finny ,9th edition
6. Calculus, T.M. Apostol, Volume I, Wiley & Sons (Asia) Pte, Ltd.
7. Calculus, James Stewart, Third Edition, Brooks/ cole Publishing Company, 1994
8. An introduction to ordinary differential equations E. A. Coddington,

Course II: **Course Code: US-FMA-102**
Title of course: **Discrete Mathematics-I** Total credits: 02

Objectives:

1. The learner's understanding and problem-solving skills in the basic mathematical concepts of Discrete Mathematics will get enhanced and as a result he will start developing affinity for the subject.
2. The learner's mathematical abilities will be enhanced due to in depth and proper study of Logic and thus he will gradually be able to use appropriate mathematical language: notations, symbols and terminology, in both oral and written explanations.

Unit	Content	No. of Lectures
1	**1**: **Elementary Logic and Naive Set Theory** 1.1. Propositions and Logical Connectives (Negation, Conjunction, Disjunction, Conditional, Biconditional), Types of Propositions, Truth values and Truth Tables, Tautology and Contradiction, Logical equivalence (Inverse, Converse and Contrapositive), Quantifiers (Universal and Existential), Negation of Quantifiers. 1.2. Sets, the universal set and the empty set, describing sets (Roaster and Set Builder notations), Subsets, Union, intersection and Cartesian Product of Sets. Some standard sets ($\mathbb{N}$, $\mathbb{Z}$, $\mathbb{W}$, $\mathbb{Z}^+$, $\mathbb{R}$, Q, Q', $\mathbb{C}$). Finite, Infinite, Denumerable, Countable and Uncountable sets (definitions and examples only).	15
2	**2. Integers and Divisibility** 2.1. Well Ordering Property (W.O.P) for N / W. Mathematical Induction: First and second principles of Induction with examples. 2.2. Divisibility in Z: Definition and elementary properties. Division Algorithm, G.C.D. and L.C.M of two integers. Basic properties of G.C.D. including G.C.D. for any two integers a and b if it exists, is unique, and can be expressed as ua+vb. Euclidean Algorithm. 2.3. Primes. Euclid's Lemma, Unique Factorization Theorem. Examples. 2.4. Congruences: Definition and elementary properties. Examples.	**15**
3	**3. Relations and Functions** 3.1. Definition of a Relation with examples. Definition of function as a Relation. Domain, co domain and the range of a function. Direct and inverse images. Injective, surjective, and bijective functions. Composite and inverse functions. 3.2. Equivalence relations, Equivalence classes, properties such as two equivalences classes are either identical or disjoint, Definition of a partition, every partition gives an equivalence relation and vice versa. 3.3. Congruence relation as an equivalence relation on Z. The set Zn, of residue classes modulo n under addition and multiplication modulo n. Addition and multiplication and inverse in Zn.	**15**

Self-Learning topics (Unit wise)

Unit	Topics
1	1. 1 Propositions and Logical Connectives (Negation, Conjunction, Disjunction, Conditional, Biconditional), Types of Propositions, Truth values and Truth Tables, Tautology and Contradiction, Logical equivalence (Inverse, Converse and Contrapositive), Quantifiers (Universal and Existential), Negation of Quantifiers.
1	1.2 Sets, the universal set and the empty set, describing sets (Roaster and Set Builder notations), Subsets, Union, intersection and Cartesian Product of Sets.

Online Resources

1. 'Discrete Mathematics', by Prof. Sourav from Chennai Mathematical Institute, available on Swayam-NPTEL portal https://nptel.ac.in/courses/111/106/111106086/

*Subject to change if any new relevant course is available.

Reference Books:

1. Elementary Number Theory: David Burton; Tata McGraw Hill.
2. Discrete Mathematics: Norman L. Biggs, second Edition, Oxford University Press.
3. A Foundation Course in Mathematics: Ajit Kumar, S. Kumaresan, Bhabha Kumar Sarma,2018, Narosa Publishing House.

Part -4 Detailed Scheme Practicals
Code: US-FMA- 1P1

Course -I- Practical **Total Credit: 01**

Title of Paper: Calculus– I

Course Code:US-FMA-P101			
Unit	**Content**	**No. of Lectures**	**Reference Books**
I	1. Solving differential equations of first order, first degree. 2. Solving exact differential equations, finding integrating factor and solving non-exact differential equations of first order, first degree. 3. Applications of first order ordinary differential equations.	03 Lectures per Practical per Batch	Reference No. 1, 2,3
II	4 Order axioms, intervals, neighborhood. Consequences of l.u.b axiom, infimum and supremum of set. 5. Application based examples of Archimedean property, Decimal representation using Nested Interval Theorem		
III	3. Calculating limits of sequences, Cauchy sequences, 4. Monotone sequences, subsequences		

Course -II-Practical **Total Credit: 01**

Title of Paper: Discrete Mathematics-I

Course Code:US-FST-P102			
Unit	**Content**	**No. of Lectures**	**Reference Books**
I	1. Examples based on Elementary Logic 2. Examples based on Set Theory	03 Lectures per Practical per Batch	
II	3. Examples based on Mathematical Induction, Euclidean algorithm to find G.C.D. of integers, L.C.M. of integers. 4. Examples based on Primes and the Unique Factorization		

	Theorem, Examples based on Congruence modulo n.		Reference No. 1, 2,3
III	5. Examples on Relations and Functions including finding direct image and inverse image of functions, injective, surjective, bijective functions, finding inverses of bijective functions. 6. Examples based on equivalence relations and partitions including examples on congruence relation modulo n.		

Online Reference (For Practical) https://ajitmathsoft.wordpress.com/sagemath/

Part 5
First Year Semester – II
Summary

Sr. No.	Choice Based Credit System			Subject Code	Remarks
1	Core Course (Mathematics)			US-FMA-201, US-FMA-202, US-FMA-P-2	
2	Elective Course	Discipline Specific Elective (DSE) Course			
		2.1	Interdisciplinary Specific Elective (IDSE) Course		
		2.2	Dissertation/Project		
		2.3	Generic Elective (GE) Course		
3	Ability Enhancement Courses (AEC)				
	Skill Enhancement Courses (SEC)				

First year Semester-II Internal and External Assessment
Detail Scheme

Sr. No.	Subject Code	Subject Title	Periods Per Week						Seasonal Evaluation Scheme				Total Marks
			Units	S. L.	L	T	P	Credit	S. L. E	CT	TA	SEE	
1	US-FMA-201	Calculus-II	3	20 %*	3	0	0	2	10	20	10	60	100
2	US-FMA-202	Discrete Mathematics -II	3	20 %*	3	0	0	2	10	20	10	60	100
3	US-FMA-P-2	Practicals Based US-FMA--201 + Practicals Based US-FMA—202			0	0	6	2				100(80+20)	100
	Total Hours / Credit							06	Total Marks				300

***One to two lectures to be taken for self -learning Evaluation.**

First Year Semester – II Units – Topics – Teaching Hours

S. N	Subject Code	Subject Unit Title		Hours/Lectures	Total No. of hours/lectures	Credit	Total Marks
1	US-FMA-201	I	Continuity and Limits	15	45	2	100 (60+40)
		II	Differentiation of real valued function of one variable:	15			
		III	Applications of differentiation	15			
2	US-FMA-202	I	Preliminary Counting	15	45	2	100 (60+40)
		II	Advanced Counting	15			
		III	Introduction to Graph Theory	15			
3	US-FMA-P-2	I	Practicals based on US-FMA-201	3	45x2= 90 lectures per batch	2	100 (80+10+10)
		II	Practicals based on US-FMA-202	3			
			TOTAL			6	300

● Lecture Duration – 48 Minutes ● One Credit =15 Classroom hours

L: Lecture: Tutorials P: Practical Ct-Core Theory, Cp-Core Practical, SLE- Self learning evaluation CT-Commutative Test, SEE- Semester End Examination, PA- Project Assessment, AT- Attendance

Part 6: Detail Scheme Theory

Curriculum Topics along with Self-Learning topics - to be covered, through self-learning mode along with the respective Unit. Evaluation of self-learning topics to be undertaken before the concluding lecture instructions of the respective UNIT

Course I: Course Code: US-FMA-201

Title of course: Calculus II **Total credits 02**

Objectives:

1. Learners' problem-solving skills in the basic mathematical concepts in Calculus like Continuity, differentiation, curve sketching will get enhanced.
2. The learner will be introduced to numerical methods, for problem solving.

Unit	Content	No. of Lectures
1	**1. Continuity and Limits** 1.1. Graphs of some standard functions such as absolute value function, x^2, $ax^2 + bx + c$, $\frac{1}{x}$, tan x, sin x, cosx, $\sin^{-1}x$, x $\sin\frac{1}{x}$, $x^2\sin\frac{1}{x}$ over suitable intervals of $\mathbb{R}$. 1.2. Definition of Limit of a function, evaluation of limit of simple functions using the $\varepsilon-\delta$ definition, uniqueness of limit if it exists, algebra of limits, sandwich theorem, left-hand limit, right-hand limit, non-existence of limit. 1.3. Continuous functions: Continuity of a real valued function on a set in terms of limits, examples, Continuity of a real valued function at end points of domain, Sequential continuity, limits of a composite function, Algebra of continuous functions, discontinuous functions, examples of removable and essential discontinuity.	**15**

	1.4. Properties of continuous Function: 1.4.1 Boundedness theorem, Minimax Theorem 1.4.2. Intermediate value theorem 1.4.3 Applications of Intermediate Value Theorem, including Bisection method to find approximate root of equation f(x)=0.	
2	**2.Differentiation of real valued function of one variable:** 2.1 Review of limit definition of differentiation of real valued function of one variable. Algebra of differentiable functions. Definition of differentiation at a point of an open interval using $\varepsilon - \delta$, one sided derivative. 2.2 Examples of differentiable and non-differentiable functions, differentiable functions are continuous but not conversely, chain rule. 2.3 Higher order derivatives, Leibnitz rule, Derivative of inverse functions. 2.4. Implicit differentiation (only examples)	**15**
3	**3. Applications of differentiation** 3.1 Definition of local maximum and local minimum, Absolute maximum, Absolute minimum, stationary(critical) points, second derivative test, examples, graphing of functions using first and second derivatives, convex, concave functions, points of inflection. 3.2 Rolle's theorem, Lagrange's and Cauchy's mean value theorems, applications and examples, Monotone increasing and decreasing function, examples. 3.3 L-Hospital rule without proof, Taylor's theorem and its applications. 3.4 Numerical Solution for ordinary differential equation using Taylor series method, Euler's method, Runge-Kutta method of order second and fourth.	**15**

Self-Learning topics (Unit wise)

Unit	Topics
2	2.1 Review of limit definition of differentiation of real valued function of one variable. Algebra of differentiable functions. One sided derivatives. 2.4. Implicit differentiation (only examples)
3	3.1 Definition of local maximum and local minimum, Absolute maximum, Absolute minimum, stationary(critical) points, second derivative test. 3.2 Monotone increasing and decreasing function.

.Online Resources

1.Basic Real Analysis by Prof Rana ,IIT Baomay,
https://nptel.ac.in/courses/111/101/111101134/
2"Calculus of One Real variable" by Prof Joydeep Dutta, IIT Kanpur
https://nptel.ac.in/courses/109/104/109104124/Week1 lecture5,week 2 lectures1,2,3,4.
3.Numerical Methods by Prof. Ameeya Kumar Nayak, Prof. Sanjeev Kumar by IIT Roorkee
https://nptel.ac.in/courses/111/107/111107105/unit8 lecture1,2,3,4
Subject to change if any new relevant course is available.

Reference Books

1.Introduction to Real Analysis, John Wilely & Sons, 1994 by.R. G. Bartle-D. R. Sherbert, Chapter 4,5, (unit1) Chapter6:6.1(unit 2) 6.2,6.3,6.4(unit3)

2. A Basic Course in Real Analysis, Ajit kumar, S. Kumaresan, CRC Press, 2014.
3. Thomas' Calculus by Weir, Hass, Giordano, *Eleventh Edition*, Pearson
4. Calculus T.M. Apostol, Volume I, Wiley & Sons (Asia) Pte, Ltd.
5. Calculus James Stewart, , Third Edition, Brooks/ cole Publishing Company, 1994
6. Numerical methods by E Balaguruswamy, McGraw Hill. (unit1)

Course II: Course Code: US-FMA-202
Title of Course: Discrete Mathematics II **Total credits :02**
Objectives:

1. The counting Principles studied in units 1 and 2 will help the learner master quantitative techniques required for many competitive examinations.
2. In unit3: Graph Theory, the learner is introduced to the study of graphs which have applications in many diverse areas like ecology, chemistry, information technology, computer science, electronics, statistics, sociology and management to name a few.

Unit	Content	No. of Lectures
1	**1. Preliminary Counting** 1.1 Addition and Multiplication Principles, counting sets of pairs, two-way counting. 1.2 Stirling numbers of second kind. Simple recursion formulae satisfied by S(n, k) for k = 1, 2, · · · , n − 1, n. 1.3 Pigeonhole principle: Simple, Extended and Strong form with examples, its applications to geometry. 1.4 Principle of Inclusion and Exclusion with applications.	**15**
2	**2. Advanced Counting** 2.1 Permutation and combination of sets and multi-sets, circular permutations, emphasis on solving problems. 2.2 Binomial and Multinomial Theorem, Pascal's identity. 2.3 Recurrence Relations, definition of homogeneous, non-homogeneous, linear, non-linear recurrence relation, obtaining recurrence relations of Tower of Hanoi, Fibonacci sequence, etc. in counting problems, solving homogeneous as well as non-homogeneous recurrence relations by using iterative methods, solving a homogeneous recurrence relation of second degree using algebraic method proving the necessary result. 2.4 Non-negative integer solutions of equation $x_1 + x_2 + \cdots + x_k = n$.	**15**
3	**Unit III: Introduction to Graph Theory** 3.1. Introduction to graphs: Types of graphs: Simple graph, Multigraph, pseudograph, directed graph, directed multigraph. One example/graph model of each type to be discussed. 3.2. (i) Graph Terminology: Adjacent vertices, degree of a vertex, isolated vertex, pendant vertex in a undirected graph. (ii) The handshaking Theorem for an undirected graph. An undirected graph has an even number odd vertex. 3.3. Some special simple graphs: Complete graph, cycle, Wheel in a graph, Bipartite graph, Regular graph. 3.4. Representing graphs and graph isomorphism. (i) Adjacency matrix of a simple graph. (ii) Incidence matrix of an undirected graph.	**15**

	(iii) Isomorphism of simple graphs. 3.5. Connectivity: (i) Paths, circuit (or cycle) in a graph. (ii) Connected graphs, connected components in an undirected graph. (iii) Connecting paths between vertices. (iv) Paths and isomorphisms. (v) Euler paths and circuits, Hamilton paths and circuits. Dirac's Theorem, Ore's Theorem (Statement only).	

Self-Learning topics (Unit wise)

Unit	Topics
3	3.1. Introduction to graphs: Types of graphs: Simple graph, Multigraph, pseudograph, directed graph, directed multigraph. One example/graph model of each type to be discussed.
3	3.2. (i) Graph Terminology: Adjacent vertices, degree of a vertex, isolated vertex, pendant vertex in a undirected graph.
3	3.3. Some special simple graphs: Complete graph, cycle, Wheel in a graph, Bipartite graph, Regular graph.

Online Resources

For Course II (Discrete Mathematics - II)

1. 'A course in Graph theory' available on UGC MOOCs portal
   http://ugcmoocs.inflibnet.ac.in/ugcmoocs/view_module_ug.php/39

Subject to change if any new relevant course is available.

Reference Books

1. Norman Biggs: Discrete Mathematics, Oxford University Press.
2. Richard Brualdi: Introductory Combinatorics, John Wiley and sons.
3. V. Krishnamurthy: Combinatorics-Theory and Applications, Affiliated East West Press.
4. Discrete Mathematics and its Applications, Tata McGraw Hills.
5. Applied Combinatorics: Allen Tucker, John Wiley and Sons.
6. Kenneth H. Rosen: Discrete Mathematics and Its Applications, McGraw Hill Edition.
7. Bernard Kolman, Robert Busby, Sharon Ross: Discrete Mathematical Structures, Prentice-Hall India.
8. Norman Biggs: Discrete Mathematics, Oxford.
9. Douglas B. West: Introduction to Graph Theory, Pearson.

Part – 7- Detailed Scheme Practicals

Course Code: US-FMA-P-2

Course -I- Practical **Total Credit: 01**

Title of Paper: Calculus– II

Course Code: US-FMA-P201			
Unit	**Content**	**No. of Lectures**	**Reference Books**
I	1.Graph of standard functions from IR to IR 2.Limits and continuity 3.Intermediate value theorem and its applications including Bisection method.	03 Lectures per Practical per Batch	Reference No. 1, 2,3
II	4.Differentiation, properties, Examples 5.Higher order derivatives, Leibnitz theorem.		
III	6.Applications of differentiation 7.Applications of Taylor's theorem including Newton Raphson method to solve equation f(x)=0. 8.Numerical Solution for ordinary differential equation using Taylor series method, Euler's method, Runge-Kutta method of order second and fourth.		

Course -II-Practical **Total Credit: 01**

Title of Paper: Discrete Mathematics-II

Course Code: US-FMA-P202			
Unit	**Content**	**No. of Lectures**	**Reference Books**
I	1. Problems based on Addition and multiplication Principle, counting sets of pairs, two ways counting and Stirling numbers of second kind. 2. Problems based on Pigeonhole principle and Principle of inclusion and exclusion	03 Lectures per Practical per Batch	Reference No. 6, 7, 9
II	3. Problems based on Permutation and combination of sets and multi-sets, circular permutations, Binomial and Multinomial Theorem and Pascal's identity. 4. Problems based on Recurrence Relations and Non-negative integer solutions of equation $x_1 + x_2 + \cdots + x_k = n$.		
III	5. Problems based on Types of Graphs, Graph terminology, Handshaking Lemma and Representation of Graphs 6. Problems based on Isomorphism of Graphs and Graph Connectivity.		

Online Reference (For Practical) https://ajitmathsoft.wordpress.com/sagemath/

Second Year Semester – III
Part 8. The Scheme of Teaching and Examination
Semester – III

Sr. No.	Choice Based Credit System			Subject Code	Remarks
1	Core Course (Mathematics)			US-FMA-301, US-FMA- 302, US-FMA- 3P1	
2	Elective Course	Discipline Specific Elective (DSE) Course		US-FMA- 303,	
		2.1	Interdisciplinary Specific Elective (IDSE) Course		
		2.2	Dissertation/Project		
		2.3	Generic Elective (GE) Course		
3	Ability Enhancement Courses (AEC)				
	Skill Enhancement Courses (SEC)				

Second year Semester-III Internal and External Assessment
Detail Scheme:

Sr. No.	Subject Code	Subject Title	Periods Per Week						Seasonal Evaluation Scheme				Total Marks
			Units	S. L.	L	T	P	Credit	S. L. E	CT	TA	SEE	
1	US-SMA-301	Calculus-III	3	20% *	3	0	0	2	10	20	10	60	100
2	US-SMA-302	Linear Algebra-I	3	20% *	3	0	0	2	10	20	10	60	100
3	US-SMA-303	Introduction to Python	3	20% *	3	0	0	2	10	20	10	60	100
3	US-SMA-P-1	Practical Sessions Based US-SMA--301 + Practical Sessions Based US-SMA—302+ Practical Sessions Based US-SMA—303			0	0	6	3				100 (80+20)	150
	Total Hours / Credit							09	Total Marks				450

One to two lectures to be taken for CONTINUOUS self-learning Evaluation.

Semester – III Units – Topics – Teaching Hours

S.N	Subject Code	Subject Unit Title		Hours/Lectures	Total No. of hours/lectures	Credit	Total Marks
1	US-SMA-301	I	Infinite Series of Real Numbers	15	45 L	2	100 (60+40)
		II	Integration I: Riemann Integration	15			
		III	Integration II	15			
2	US-SMA-302	I	Vectors	15	45L	2	100 (60+40)
		II	System of linear equations	15			
		III	Matrix and Matrix Algebra	15			
3	US-SMA-303	I	Introduction to Python Programming	15	45L	2	100 (60+40)
		II	Introduction to NumPy	15			
		III	Introduction To Symbolic Computing and Plotting	15			
4	US-SMA-P-3		Practical Sessions Based US-SMA--301 + Practical Sessions Based US-SMA—302+ Practical Sessions Based US-SMA—303		45x2= 90L lectures per batch	3	150 (120+30)
			TOTAL			9	450

- **Lecture Duration – 45 Minutes = 0 .75 Hours. (45 Lectures equivalent to 33.75 hours)**
- **One Credit =16.87 hours equivalent to 17 Hours**

L: Lecture: Tutorials P: Practical Ct-Core Theory, Cp-Core Practical, SLE- Self learning evaluation CT-Commutative Test, SEE- Semester End Examination, PA-Project Assessment, AT- Attendance

Part 9: Detail Scheme Theory

S.Y.B.SC. MATHEMATICS SYLLABUS

(SEMESTER BASED CREDIT AND GRADING SYSTEM)

TO BE IMPLEMENTED FROM THE ACADEMIC YEAR 2021-2022

Curriculum Topics along with Self-Learning Topics - to be covered, through self-learning mode along with the respective Unit. Evaluation of self-learning topics to be undertaken before the concluding lecture instructions of the respective UNIT.

Course I: Course Code: US-SMA-301

Title of course: Calculus III **Total credits: 02**

Objectives:

1. After studying the topic of Integration with Newton's/Leibnitz definition of integral as an anti-derivative in the higher Secondary school, the learner is first time introduced to a new definition which gives integral of functions which are not continuous.
2. The learners are introduced to many applications of integration and Beta, Gamma functions which are the mathematical tools to get values for various integrals directly and introduced to numerical integration, for problem solving.

Unit	Content	No. of Lectures
1	**I. Infinite Series of real numbers** 1.1 Introduction to Infinite Series of real numbers, simple examples of series, The Sequence of partial sums of a series, convergent series, divergent series, Algebra of Convergent Series, Convergence of geometric series and p-series. 1.2 The nth term Test for series, Cauchy criterion, Cauchy's Condensation Test, divergence of harmonic series, convergence of p-series, absolute convergence, conditional convergence. 1.3 Comparison test, limit comparison test, D Alembert's Ratio test, Root test. 1.4 Alternating series, Leibnitz's test for convergence of alternating series.	**15**
2	**II. Integration I: Riemann Integration** 2.1 Darboux Integrability: Partition of closed and bounded interval, Upper and Lower Riemann sums, Refinement of a partition, and properties of upper, lower Reimann sums, Upper and Lower Riemann integrals, Definition of Darboux Riemann integral on a closed and bounded interval, Examples of R-integrable functions, Dirichlet's function, Reimann's Original Definition of integration. 2.2 Criterion for Integrability, its Corollary and problems based on Criterion for Integrability. 2.3 Properties of Reimann Integral. 2.4 Indefinite Riemann integral, First and second Fundamental theorem of Calculus, Mean value theorem for integrals. Integration by parts, Change of variable formula.	**15**
3	**III. Integration II** 3.1 Improper integrals-type 1 and type 2, Absolute convergence of improper integrals, Comparison tests, Abel's and Dirichlet's tests for conditional convergence. 3.2 Beta, Gamma functions. Properties of Beta Gamma functions.	**15**

	3.3 Applications of definite integral: Area between curves, finding volumes by slicing, volumes of solids of revolution-Disks and Washers, Cylindrical Shells, Lengths of plane curves, Areas of surfaces of revolution. 3.4 Approximate integration using the Trapezoidal Rule and Simpson's 1/3rd Rule.	

Self-Learning topics (Unit wise)

Unit	Topics
3.1	Abel's and Dirichlet's tests for conditional convergence.
3.2	Properties of Beta Gamma functions
3.3	Lengths of plane curves, Areas of surfaces of revolution.
3.4	Approximate integration using the Trapezoidal Rule and Simpson's 1/3rd Rule

Online Resources

1. " Calculus of One Real variable" by Prof Joydeep Dutta, IIT Kanpur https://nptel.ac.in/courses/109/104/109104124/ week 5,6,7
2. Numerical Methods by Prof. Ameeya Kumar Nayak, Prof. Sanjeev Kumar by IIT Roorkee https://nptel.ac.in/courses/111/107/111107105/unit8 lecture https://nptel.ac.in/courses/111/106/111106149/week 5,6 lecture 28 to 34

Subject to change if any new relevant course is available.

Reference Books

1. A Basic Course in Real Analysis, Ajit kumar, S. Kumaresan, CRC Press, 2014. (Chapter 5(5.1),6
2. Introduction to Real Analysis, John Wilely & Sons, 1994 by.R. G. Bartle-D. R. Sherbert, Chapter 3(3.7),7
3. Calculus and Analytic Geometry, Thomas and Finny ,9th edition, Pearson
4. Calculus T.M. Apostol, Volume I, Wiley & Sons (Asia) Pte, Ltd.
5. Calculus James Stewart, Third Edition, Brooks/ Cole Publishing Company, 1994

Course II: Course Code: US-SMA-302
Title of course: Linear Algebra-I **Total credits: 02**
Objective:

The objective of the course is to introduce the student to the subject of Linear Algebra and to lay a strong foundation for further study in the subject.

Unit	Content	No. of Lectures
1	**I. Vectors.** 1.1 Vectors in n-space: Scalars and Vectors, Vector Addition and Scalar Multiplication, Vectors in $\mathbb{R}^2$ and $\mathbb{R}^3$, Equivalence of Vectors, generalization to $\mathbb{R}^n$, linear Combination of Vectors. 1.2 Inner product and orthogonality: concepts of vector length (norm or magnitude), distance between two vectors, dot product (or Euclidean inner product) of two vectors, The Cauchy–Schwarz inequality (Statement Only), angle between two vectors, as well as vector parallelism and orthogonality in $\mathbb{R}^n$, Triangle Inequality for vectors (Statement Only), standard unit vectors or coordinate vectors in $\mathbb{R}^n$. 1.3 Vector equations of lines and planes: Point-Slope (Direction Vector) Equation of a Line, Point-Normal Equation of Planes, Vector Projection and Components, Distance Between a Point and a Plane.	**15**

2	**II. System of linear equations.** 2.1 Linear System of Equations: Linear Equations, System of Linear Equations, Solution of a System of linear Equations, Matrix (definition), Coefficient and Augmented matrix of a System of linear Equations. 2.2 Solving Linear System of Equations: Gaussian elimination and Gauss-Jordan elimination, Elementary Row Operations (ERO), Row echelon form (REF) and reduced row echelon form (RREF), Elementary Row Operation (ERO), Type 1, 2, 3 Row Equivalent Matrices. Two linear systems whose augmented matrices are row equivalent are equivalent (Statement Only), Gaussian elimination method, Gauss-Jordan elimination method.	**15**
3	**III. Matrix and Matrix Algebra**. 3.1 Matrix, Matrix types and Matrix operations: Equality of matrices; addition, scalar multiplication and multiplication of Matrices and associated properties, the zero matrix, diagonal matrix, square matrix, scalar matrix and the identity matrix, triangular matrix, symmetric and skew symmetric matrix, the trace of a square matrix, Properties. 3.2 Inverse Matrix: invertible matrix, If A is an invertible square matrix of order n, then an inverse of A is unique, properties of inverse. Elementary matrix, Property of elementary matrix. The inverse of an elementary matrix is an elementary matrix. Invertible matrix, Equivalent statements (Statement Only.) Computation of an inverse. 3.3 Subspaces and Linear Independence: subspace, column space and row space, linearly independent and linearly dependent sets, Equivalent formulations for linearly independent (and linearly dependent) sets. Lines and planes (from the viewpoint of subspace)	15

Self-Learning topics (Unit wise)

Unit	Topics
1	1.1 Vectors in n-space: Scalars and Vectors, Vector Addition and Scalar Multiplication, Vectors in $\mathbb{R}^2$ and $\mathbb{R}^3$, Equivalence of Vectors, generalization to $\mathbb{R}^n$, linear Combination of Vectors. 3.1 Matrix, Matrix types and Matrix operations: Equality of matrices; addition, scalar multiplication and multiplication of Matrices and associated properties, the zero matrix, diagonal matrix, square matrix, scalar matrix and the identity matrix, triangular matrix, symmetric and skew symmetric matrix, the trace of a square matrix, Properties.

Online Resources

1. Online book on "Linear Algebra with Sage" with Sang-Gu Lee and others.
2. Basic Linear Algebra By Prof. I. K. Rana, IIT Bombay available on NPTEL portal at https://onlinecourses.nptel.ac.in/noc20_ma08/preview
3. Linear Algebra Co-ordinated by IIT Kanpur, available on NPTEL portal at https://nptel.ac.in/courses/111/104/111104137/

Subject to change if any new relevant course is available.

Reference Books:

1. Big-Book-LinearAlgebra-Eng-2015, by Kyobobook (ISBN-978-89-24-03105-8)
2. A First Course in Linear Algebra, by Robert A. Beezer, Version 3.50 (Created: 2015-12-30T15:06:58-08:00; Technical Refresh: 2017-04-14)

3. Elementary Linear Algebra, by Howard Anton, WileyPlus, 11th Edition 2019 (ISBN-978-1-119-62569-8)
4. Linear Algebra: A Geometric Approach by S. Kumaresan, Prentice Hall of India, 2000.
5. Linear Algebra and its Applications, by Gilbert Strang, Thomson Learning Inc., 1988.

Course III: Course Code: US-SMA-303
Title of course: Introduction to Python **Total credits: 02**
Objectives:
1. After completing this course, learners will be able to write their own programs in Python.
2. Learners will be able to use Python libraries to solve simple mathematical problems and plot simple graphs.

Unit	Content	No. of Lectures
I	**1. Introduction to Python programming** 1.1 Environment/s for computing with Python, Types of cells- text and code. Formatting of text cells using Markdown, Variables, expressions, Assignment statements, operators, operands, and precedence, Data types and Data Structures- list, tuple and dictionary. 1.2 Boolean, Comparison and logical operators (==,=,>,<,>=,<=) 1.3 Conditional Statements, Nested conditional: if, if-else, if-elif-else, nested if-else 1.4 Iterations: for and while loops 1.5 Simple programs in Python (Printing multiplication tables, print prime numbers in given range, GCD of given two integers)	**15**
II	**2. Introduction to NumPy** 2.1. Importing NumPy library, The NumPy array objects, Basic datatypes supported by NumPy 2.2. NumPy functions for generating arrays – *np.array, np.zeros, np.ones, np.diag, np.arange*. 2.3. Creating matrix arrays, Indexing and slicing. Arithmetic operations on NumPy arrays.	**15**
III	**3. Introduction to Symbolic Computing and Plotting** 3.1 Importing SymPy, symbols, numbers, constants and special symbols. 3.2 Expressions, simplification, *expand, factor, collect, combine, apart, together, cancel* and substitution. 3.3 Differential and integral calculus, Series expansion using SymPy. 3.4 Importing Matplotlib, creating simple graphs with Matplotlib.	**15**

Self-Learning topics (Unit wise)

Unit	Topics
1.	1.3 Conditional Statements, Nested conditional – if, if-else, if-elif-else, nested if-else 1.4 Iterations- for and while loops 1.5 Simple programs in Python (Printing multiplication tables, Print prime numbers in given range, GCD of given two integers

Online Resources

1. **Computational Mathematics with Sage Math** by Dr. Ajit Kumar, Institute of Chemical Technology, Mumbai (Lectures 6,7,8) NPTEL :: Mathematics - NOC:Computational Mathematics with SageMath
2. **The joy of computing using Python** by Prof. Sudarshan Iyengar Department of Computer Science and Engineering IIT Ropar and Prof. Yayati Gupta Department of Computer Science and Engineering IIIT Dharwad NPTEL :: Computer Science and Engineering - NOC:The Joy of Computing using Python

Reference Books:

1. How to think like a Computer Scientist: Learning with Python, by Downey, A. et al John Wiley, 2015.
2. Fundamentals of Python - First Programs, by Lambert K. A., Cengage Learning India, 2015
3. Numerical Python: Scientific Computing and Data Science Applications with NumPy, SciPy and Matplotlib by Robert Johnson, Second Edition, Apress

Part -10 Detailed Scheme Practicals
Code: US-SMA- 3P-3

Course -I- Practical **Total Credit: 01**

Title of Paper: Calculus– III

Course Code:US-SMA-P301			
Unit	**Content**	**No. of Lectures**	**Reference Books**
I	1. Calculating limit of series, Alternating Series 2. Convergence tests	03 Lectures per Practical per Batch	Reference No. 1, 2,3
II	3. Calculation of upper sum, lower sum and Riemann integral 4. Properties of Reimann Integration, Problems on fundamental theorem of calculus, mean value theorems, integration by parts		
III	5. Convergence of improper integrals, applications of comparison tests, Abel's and Dirichlet's tests 6. Beta Gamma Functions, Problems on area, volume, length		

Course -II-Practical **Total Credit: 01**

Title of Paper: Linear Algebra-I

Course Code:US-SMA-P302			
Unit	**Content**	**No. of Lectures**	**Reference Books**
I	1. Vectors in n-space, Inner product and orthogonality. Vector equations of lines and planes. 2. Linear System of Equations, Solving Linear System of Equations.	03 Lectures per Practical per Batch	Reference No. 1, 2,3
II	3. Matrix, Matrix types and Matrix operations, Inverse Matrix., Subspaces and Linear Independence. 4. Vectors in n-space, Inner product and orthogonality. Vector equations of lines and planes.		
III	5. Linear System of Equations, Solving Linear System of Equations. 6. Matrix, Matrix types and Matrix operations, Inverse Matrix, Subspaces and Linear Independence.		

N.B.: The use of CAS like SageMath to solve problems will be demonstrated and encouraged during Practicals in addition to the traditional problem-solving methods.
Online Reference (For Practical) https://ajitmathsoft.wordpress.com/sagemath/

Course -III-Practical **Total Credit: 01**

Title of Paper: Introduction to Python

Course Code:US-SMA-P303			
Unit	**Content**	**No. of Lectures**	**Reference Books**
I	1. Introduction to Google Colab/Jupyter Notebook. Formatting of text cells using Markdown, Introduction to mathematical Typesetting. Basic arithmetic operations, Handling datatypes: *str*, a*rray, string, list, tuple and dictionary.* 2. Programs using conditional statements, Nested Conditionals. Programs using *for* and while *loops.* String Traversal using *while* and *for* loops, Programs on user defined functions.	03 Lectures per Practical per Batch	Reference No. 1, 2,3
II	3. Handling ndarrays, The NumPy array objects, NumPy functions for generating arrays. 4. Creating matrix arrays, Indexing and slicing, Arithmetic operations on NumPy arrays		
III	5. Expressions, simplification, expand, factor, collect, combine, apart, together, cancel and substitution. 6. Creating simple graphs with Matplotlib, plotting a function with its derivative, plotting a function with its series expansion.		

Part 11. The Scheme of Teaching and Examination
Semester – IV

Sr. No.	Choice Based Credit System			Subject Code	Remarks
1	Core Course (Mathematics)			US-SMA-401, US-SMA-402, US-SMA- P-4	
2	Elective Course	Discipline Specific Elective (DSE) Course		US-SMA-403	
		2.1	Interdisciplinary Specific Elective (IDSE) Course		
		2.2	Dissertation/Project		
		2.3	Generic Elective (GE) Course		
3	Ability Enhancement Courses (AEC)				
	Skill Enhancement Courses (SEC)				

Second year Semester-IV Internal and External Assessment
Detail Scheme:

Sr. No.	Subject Code	Subject Title	Periods Per Week						Seasonal Evaluation Scheme				Total Marks
			Units	S. L.	L	T	P	Credit	S. L. E	CT	TA	SEE	
1	US-SMA-401	Calculus-IV	3	20 %*	3	0	0	2	10	20	10	60	100
2	US-SMA-402	Linear Algebra-II	3	20 %*	3	0	0	2	10	20	10	60	100
3	US-SMA-403	Ordinary Differential Equations and Interpolation	3	20 %*	3	0	0	2	10	20	10	60	100
3	US-SMA-P-4	Practical Sessions Based US-SMA--401 + Practical Sessions Based US-SMA—402+ Practical Sessions Based US-SMA—403			0	0	6	3				150 (120 +30)	150
	Total Hours / Credit							09	Total Marks				450

One to two lectures to be taken for CONTINUOUS self-learning Evaluation.

Semester – IV Units – Topics – Teaching Hours

S. N	**Subject Code**		**Subject Unit Title**	**Hours/Lectures**	**Total No. of hours/ lectures**	Credit	Total Marks
1	US-SMA-401	I	Vectors in $\mathbb{R}^2$ and $\mathbb{R}^3$.	15	45 L	2	100 (60+40)
		II	Vector Valued Functions on $\mathbb{R}$.	15			
		III	Real Valued Functions on $\mathbb{R}^2$ and $\mathbb{R}^3$.	15			
2	US-SMA-402	I	Matrix and Matrix Algebra (continued from Semester III).	15	45L	2	100 (60+40)
		II	Determinant	15			
		III	Linear Transformations	15			
3	US-SMA-403	I	Second order Linear Differential Equations	15	45L	2	100 (60+40)
		II	Linear System of ODEs	15			
		III	Interpolation:	15			

4	US-SMA-P-4		Practical Sessions Based US-SMA--401 + Practical Sessions Based US-SMA—402+ Practical Sessions Based US-SMA—403		45x2= 90L lectures per batch	3	150 (120+30)
			TOTAL			9	450

- **Lecture Duration – 45 Minutes = 0 .75 Hours. (45 Lectures equivalent to 33.75 hours)**
- **One Credit =16.87 hours equivalent to 17 Hours**

Part 12: Detail Scheme Theory

S.Y.B.SC. MATHEMATICS SYLLABUS

(SEMESTER BASED CREDIT AND GRADING SYSTEM)

TO BE IMPLEMENTED FROM THE ACADEMIC YEAR 2021-2022

Curriculum Topics along with Self-Learning Topics - to be covered, through self-learning mode along with the respective Unit. Evaluation of self-learning topics to be undertaken before the concluding lecture instructions of the respective UNIT.

Course I: Course Code: US-SMA-401

Title of course: Calculus-IV Total credits: 02

Objectives:

1. In this course on multivariable calculus, learners will understand how the concepts of neighborhood of a point and limit of a function will be generalized to two and three dimensions.
2. Apart from theoretical background learners will be able to apply the concepts to find maxima and minima of functions of two variables, level curves, tangent planes and normal line to the surfaces in $\mathbb{R}^3$.

Unit	Content	No. of Lectures
1	**I. Vectors in $\mathbb{R}^2$ and $\mathbb{R}^3$.** 1.1 Vectors in plane and space, norm of a vector, vector addition and scalar multiplication, unit vectors. 1.2 Dot product of two vectors, Properties of dot product, geometric interpretation of dot product, Cauchy-Schwarz inequality, projection and component direction angles, direction cosines. 1.3 Cross product of two vectors, Properties of cross product, Scalar triple product, components of cross product. 1.4 Vector parametrization, parametric equations of lines, intersecting lines and parallel lines, distance between a point and a line. 1.5 Parametric equations of planes, Collinear and coplanar vectors, unit normal, parallel, and intersecting planes, distance between a line and a plane, introduction to cylinders and quadratic surfaces.	15
2	**I. Vector Valued Functions on $\mathbb{R}$.** 2.1 Definition and examples of vector valued function on $\mathbb{R}$, Finding domain and range, Limits and Continuity of functions $f: \mathbb{R} \to \mathbb{R}^n$ (Examples for n= 2 and 3) 2.2 Derivative of a function $f: \mathbb{R} \to \mathbb{R}^n$, Sum and Difference Rule, Dot Product Rule, Cross Product Rule and Chain rule of derivatives. Application to find Velocity and Acceleration.	15

	2.3 Curves in $\mathbb{R}^3$, Definition of a smooth curve, Parametric equations of smooth curve, Tangent vector to the curve. 2.4 Definition of a curvature of a plane curve, Curvature of straight line, circle and ellipse. 2.5 Principal Unit Normal.	
3	**I. Real Valued Functions on $\mathbb{R}^2$ and $\mathbb{R}^3$.** 3.1 Definition and examples of real valued function (scalar field) of $'n'$ variables, Finding domain and range of functions of 2 and 3 variables, Interior, Exterior and Boundary points of subsets of $\mathbb{R}^2$ and $\mathbb{R}^3$, Sequences in $\mathbb{R}^2$ and $\mathbb{R}^3$. 3.2 Graphs of real valued functions of 2 variables, Level curves and Level Surfaces. 3.3 Limits of functions of 2 variables, algebra of limits, Iterated limits, Two-Path test for non-existence of limit, continuous functions of 2 variables. 3.4 Partial Derivatives of functions of 2 variables, Second order partial derivatives, Mixed partial derivatives, Partial derivatives and Continuity, Sufficient condition of equality of mixed partial derivatives. 3.5 Derivative of a scalar field $w.r.t$ a vector, Directional derivative, Example showing "existence of all directional derivatives at a point fails to imply continuity at that point.", Definition of total derivative, Differentiability implies continuity.	**15**

Self-Learning topics (Unit wise)

Unit	Topics
1	**1.1** Vectors in plane and space, norm of a vector, vector addition and scalar multiplication, unit vectors. **1.2** Dot product of two vectors, Properties of dot product, geometric interpretation of dot product, Cauchy-Schwarz inequality, projection and component direction angles, direction cosines. **1.3** Cross product of two vectors, Properties of cross product, Scalar triple product, components of cross product.

Online Resources

NPTEL Course: Calculus OF Several Real Variables by Prof. Joydeep Dutta Department of Mathematics IIT Kanpur
(Lectures 1 to 5) NPTEL :: Mathematics - NOC:Calculus of Several Real Variables
Subject to change if any new relevant course is available.

Reference Books

1. Thomas' Calculus by Weir, Hass, Giordano, *Eleventh Edition*, Pearson (Chapter 12, Sections 13.1,13.2,13.3,13.4,14.1,14.2,14.3)
2. Calculus: One and Several Variables by Salas, Hille, Etgen, *Tenth Edition*, John Willey and Sons
3. Calculus by Tom M Apostol, Volume II, John Wiley.

Course II: Course Code: US-SMA-402
Title of course: Linear Algebra-II Total credits: 02

Objective:
The objective of the course is to provide a systematic account of the various topics in Linear Algebra which follow the topics learnt by the students in Semester III and also familiarize the students with certain applications of the same.

Unit	Content	No. of Lectures
1	**I. Matrix and Matrix Algebra (continued from Semester III).** 1.1 Solution set and matrices: Relation between an invertible matrix and its solution, Nontrivial solution of a homogeneous system, non-homogenous system and the associated homogeneous system of linear equations, Relation between the solution set of the linear system and that of the associated homogeneous linear system, Invertible Matrix Theorem. 1.2 Special matrices: Diagonal matrix, Identity matrix, Scalar matrix, Upper triangular matrix, Lower triangular matrix, Property of a triangular matrix.	**15**
2	**II. Determinant.** 2.1 Definition of Determinant and its Properties: Definition of Permutation, Even permutation and odd permutation, Signature function, Leibniz formula, Properties of the determinant (Statements Only). 2.2 Cofactor Expansion, Cramer's Rule and finding Inverse using Adjoint: Minor and cofactor, Adjugate (classical adjoint or adjunct), Cofactor expansion, Finding inverse matrix with adjoint matrix. 2.3 Applications of the Determinants: Using a determinant to find areas, volumes, equations of lines, equations of elliptic curves, or equations of plane, Vandermonde matrix and the determinants.	**15**
3	**III. Linear Transformations**. 3.1 Matrix as a Function (Transformation): Transformation, Linear Transformation, Special Linear Transformations, Properties of Linear Transformation, Standard Matrix. 3.2 Geometric Meaning of Linear Transformations: Linear Transformation from $\mathbb{R}^2$ to $\mathbb{R}^2$: rotation, symmetry, orthogonal projection, Isometry. Properties of a orthogonal matrix. 3.3 Kernel and Range: Kernel and Range, one-to-one (injective) and onto, (surjective) linear transformations, Properties of Kernel and Range of a linear transformation from $\mathbb{R}^n$ to $\mathbb{R}^m$. Composition of linear transformations, Inverse of a linear transformation.	15

Self-Learning topics (Unit wise)

Unit	Topics
1	1.2 Special matrices: Diagonal matrix, Identity matrix, Scalar matrix, Upper triangular matrix, Lower triangular matrix, Property of a triangular matrix.
2.	2.1 Properties of the determinant. 2.3 Applications of the Determinants: Using a determinant to find areas, volumes, equations of lines, equations of elliptic curves, or equations of plane

Online Resources

1. Online book on "Linear Algebra with Sage" with Sang-Gu Lee and others.
2. Basic Linear Algebra By Prof. I. K. Rana, IIT Bombay available on NPTEL portal at https://onlinecourses.nptel.ac.in/noc20_ma08/preview
3. Linear Algebra Co-ordinated by IIT Kanpur, available on NPTEL portal at https://nptel.ac.in/courses/111/104/111104137/
Subject to change if any new relevant course is available.

Reference Books:

1. Big-Book-LinearAlgebra-Eng-2015, by Kyobobook (ISBN-978-89-24-03105-8)
2. A First Course in Linear Algebra, by Robert A. Beezer, Version 3.50 (Created: 2015-12-30T15:06:58-08:00; Technical Refresh: 2017-04-14)
3. Elementary Linear Algebra, by Howard Anton, WileyPlus, 11th Edition 2019 (ISBN-978-1-119-62569-8)
4. Linear Algebra: A Geometric Approach by S. Kumaresan, Prentice Hall of India, 2000.
5. Linear Algebra and its Applications, by Gilbert Strang, Thomson Learning Inc., 1988.

Course III: Course Code: US-SMA-403
Title of course: Ordinary Differential Equations and Interpolation Total credits: 02
Objectives:

1. **Ordinary Differential Equations is** a natural goal of elementary calculus and the most important part of mathematics for understanding the physical sciences.
2. The topics of **Ordinary Differential Equations and Interpolation** have applications in data Science, economics, physics, chemistry, biological sciences and sociology to name a few.

Unit	Content	No. of Lectures
I	**1. Second order Linear Differential Equations:** 2.1 Existence and Uniqueness Theorem for the solution of a second order initial value problem (statement only), Definition of Lipschitz function, Examples based on verifying the conditions of existence and uniqueness theorem. 2.2 Homogeneous and non-homogeneous second order linear differentiable equations: The space of solutions of the homogeneous equation as a vector space. Wronskian and linear independence of the solutions. The general solution of homogeneous differential equations. The general solution of a non-homogeneous second order equation. Complementary functions and particular integrals. 2.3 The homogeneous equation with constant coefficients. auxiliary equation. The general solution corresponding to real and distinct roots, real and equal roots and complex roots of the auxiliary equation. 2.4 Non-homogeneous equations: The method of undetermined coefficients. The method of variation of parameter	**15**
2	**Linear System of ODEs** : 2.1 Existence and uniqueness theorems of solution of homogeneous linear system of ODEs in two variables(Statement) 2.2 The Wronskian W(t) of two solutions of a homogeneous linear system of ODEs in two variables, result: W (t) is identically zero or nowhere zero on [a, b]. 2.3 Two linearly independent solutions and the general solution of a homogeneous linear system of ODEs in two variables.	**15**

	2.4 Explicit solutions of Homogeneous linear systems with constant coefficients in two variables, examples.	
3	**Interpolation:** 3.1 Introduction. 3.2 Finite differences Forward Differences, Backward Differences, Central differences. Newton's Formulae for forward and backward interpolation. 3.3 Lagrange's Interpolation formula. Lagrange's Interpolation using PYTHON. 3.4 Regression/Curve fitting: Fitting straight line, fitting Quadratic function. 3.5 Finite difference Method to solve the boundary value problem. $\frac{d^2y}{dx^2}$ =f (x ,y ,y'), in the interval (a , b) , given y(a)=c , y(b)= d	**15**

Self-Learning topics (Unit wise)

Unit	Topics
2	2.4 Explicit solutions of Homogeneous linear systems with constant coefficients in two variables, examples.
3	3.3 Lagrange's Interpolation using PYTHON. 3.5 Finite difference Method to solve the boundary value problem $\frac{d^2y}{dx^2}$ =f (x ,y ,y'), in the interval (a , b) , given y(a)=c , y(b)= d

Online Resources

1. 1.Ordinary Differential equation and applications byK. Nandakumaran ,Raju K. George,P. S.Datti IISC Banglore https://nptel.ac.in/courses/111/108/111108081/Week3 lec 3,4,5
2. Ordinary Differential equation and applications by Pandey ,Agarwal **https://nptel.ac.in/courses/111/107/111107111/ (for unit 1,2)**
3. Numerical Methods by Prof. Usha IIT Madras https://nptel.ac.in/courses/111/106/111106101/ **(for unit3)**
4. 4.Prof. Ameeya Kumar Nayak IIT Roorkee**,** **https://nptel.ac.in/courses/111/107/111107107/Unit1 Lectures 3,4,5 (for unit3)**

Subject to change if any new relevant course is available.

Reference Books:

1. G.F. Simmons, Differential Equations with Applications and Historical Notes, Taylor's and Francis.(unit 1,2)
2. M.D. Raisinghania, Ordinary and Partial Differential Equations, S. Chand.(unit 1,2)
3. Numerical methods by E Balaguruswamy. (unit3)
4. S. S. Sastry, Introductory Methods of Numerical Analysis, PHI(unit3)

Part -13 Detailed Scheme Practicals
Code: US-SMA- 4P-4

Course -I- Practical **Total Credit: 01**

Title of Paper: Calculus– IV

Course Code:US-SMA-P401			
Unit	**Content**	**No. of Lectures**	**Reference Books**
I	1. Dot and Cross Products of vectors, Properties and Applications. 2. Lines and Planes (Parametrizations and distances), Sketching cylinders, ellipsoids, paraboloids, elliptical cones, hyperboloids using ***Computer Algebra System***.	03 Lectures per Practical per Batch	Reference No. 1, 2,3
II	3. Limits, Continuity and Derivatives of functions $f: \mathbb{R} \rightarrow \mathbb{R}^n$ 4. Tangent and normal to the smooth curve, Curvature of a curve. Visualizing tangent and normal to the smooth curve, Curvature of a plane curve using ***Computer Algebra System.***		
III	5. Limits, Iterated limits, Non-existence of limits and continuity of functions of 2 variables. 6. Partial Derivatives, Mixed partial derivatives, Directional derivatives. Visualizing level curves, level surfaces, partial derivatives using ***Computer Algebra System.***		

Course -II-Practical **Total Credit: 01**

Title of Paper: Linear Algebra-II

Course Code:US-FMA-P402			
Unit	**Content**	**No. of Lectures**	**Reference Books**
I	1. Solution set and matrices. 2. Special matrices.	03 Lectures per Practical per Batch	Reference No. 1, 2,3
II	3. Definition of Determinant and its Properties, Cofactor Expansion and Cramer's Rule. 4. Finding Inverse using Adjoint**,** Applications of Determinants		
III	5. Matrix as a Function (Transformation), Geometric Meaning of Linear Transformations. 6. Kernel and Range of a Linear Transformation**.**		

Course -III-Practical **Total Credit: 01**

Title of Paper: Ordinary Differential Equations and Interpolation

Course Code:US-SMA-P403			
Unit	**Content**	**No. of Lectures**	**Reference Books**
I	1. Finding the general solution of homogeneous and non-homogeneous higher order linear differential equations. 2. Solving second order linear differential equations using method of undetermined coefficients and method of variation of parameters 3. Solving second order linear ODEs with constant coefficients.	03 Lectures per Practical per Batch	Reference No. 1, 2,3
II	4. Solving a system of first order linear ODES -I 5. Solving a system of first order linear ODES -II		

III	6. Interpolating polynomial by Lagrange's Interpolation, Newton forward and backward difference Interpolation. Curve fitting 7. Finding the numerical solution of two-point linear boundary value problem using Finite difference method. 8. Interpolation using PYTHON programming.		

Online Reference (For Practical) https://ajitmathsoft.wordpress.com/sagemath/