॥ सा विद्या या विमुक्तये ॥

स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

'ज्ञानतीर्थ', विष्णुपुरी, नांदेड – ४३१ ६०६ (महाराष्ट्र राज्य) भारत

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED

'Dnyanteerth', Vishnupuri, Nanded - 431 606 (Maharashtra State) INDIA

Established on 17th September, 1994, Recognized By the UGC U/s 2(f) and 12(B), NAAC Re-accredited with'B++' grade

स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

Fax : (02462) 215572

Phone: (02462)215542

Academic-1 (BOS) Section

website: srtmun

E-mail: bos@srtmun

विज्ञान व तंत्रज्ञान विद्याशाखे अंतर्गत राष्ट्रीय शैक्षणिक धोरण २०२० च्या अनुषंगाने शैक्षणिक वर्ष २०२३–२४ पासून संलग्न महाविद्यालये व विद्यापीठ संकुलांत पदव्युत्तर पदवी प्रथम वर्ष आणि विद्यापीठ संकुले व न्यू मॉडेल डिग्री कॉलेज मध्ये पदवी प्रथमवर्ष अभ्यासक्रम लागू करण्याबाबत.

प रि प त्र क

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, शासन निर्णय क्र. एनईपी २०२०/प. क्र. ०९/विशि–३/शिकाना, दिनांक २० एप्रिल २०२३ व शासन पत्र. क्र एनईपी २०२०/प. क्र. ०९/विशि–३, दिनांक १६ जून २०२३ अन्वये सूचित केल्यानुसार राष्ट्रीय शैक्षणिक धोरण २०२०च्या अनुषंगाने दिलेल्या आराखडया नुसार दिनांक १६ जून २०२३ रोजी संपन्न झालेल्या मा. विद्यापरिषदेच्या बैठकीत ऐनवेळचा विषय क्र. ०५/५६–२०२३ अन्वये मान्यता दिल्यानुसार प्रस्तुत विद्यापीठाच्या विज्ञान व तंत्रज्ञान विद्याशाखा अंतर्गत खालील पदव्युत्तर पदवी अभ्यासक्रम (AICTE, PCI, BCI, CoA, NCTE) इ. सारख्या नियमक संस्थाची मान्यता आवश्यक असलेले अभ्यासक्रम वगळून) संलग्न महाविद्यालये, विद्यापीठ परिसर व उपपरिसर संकुलांमध्ये आणि पदवी प्रथम वर्ष अभ्यासक्रम विद्यापीठ परिसर व उपपरिसर संकुले व विद्यापीठ संचलित न्यू मॉडेल डिग्री कॉलेज, हिंगोली येथे शैक्षणिक वर्ष २०२३–२४ पासून लागू करण्यात येत आहे.

1) M.Sc. Bioinformatics (1st Year) – Sub-Campus School Latur
2) M.Sc. Mathematics (1st Year) – Campus School
3) M.Sc. Zoology (1st Year) - Campus School
4) M.Sc. Environmental Science (1st Year) –Campus School
5) M.Sc. Environmental Science (1st Year) - Affiliated colleges
6) M.Sc. Information Technology (1st Year) - Affiliated colleges
7) M.Sc. Software Engineering (1st Year) - Affiliated colleges

सदरील परिपत्रक व अभ्यासक्रम प्रस्तुत विद्यापीठाच्या **www.srtmun.ac.in** या संकेतस्थळावर उपलब्ध आहेत. तरी सदरील बाब ही सर्व संबंधितांच्या निदर्शनास आणून द्यावी, ही विनंती.

'ज्ञानतीर्थ' परिसर,
विष्णुपुरी, नांदेड – ४३१ ६०६.
जा.क्र.:शै–१/एनइपी२०२०/S&T/अक/२०२३–२४/133

दिनांक : ०७.०७.२०२३.

सहा.कुलसचिव
शैक्षणिक (१–अभ्यासमंडळ) विभाग

प्रत : १) मा. कुलगुरू महोदयांचे कार्यालय, प्रस्तुत विद्यापीठ.
३) मा. आधिष्ठाता, विज्ञान व तंत्रज्ञान विद्याशाखा, प्रस्तुत विद्यापीठ.
४) मा. संचालक, परीक्षा व मुंल्यमापन मंडळ, प्रस्तुत विद्यापीठ.
१) मा. प्राचार्य, सर्व संबधित संलग्नित महाविद्यालये, प्रस्तुत विद्यापीठ.
२) मा. संचालक, सर्व संकुले परिसर व उपपरिसर, प्रस्तुत विद्यापीठ
५) सिस्टीम एक्सपर्ट, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ. याना देवून कळविण्यात येते की, सदर परिपत्रक संकेतस्थळावर प्रसिध्द करण्यात यावे.

SWAMI RAMANAND TEERTH

MARATHWADA UNIVERSITY, NANDED - 431 606

TWO YEARS MASTER DEGREE PROGRAMME IN SCIENCE (M. Sc.)

Subject: MATHEMATICS

(Campus School)

Under the Faculty of
Science and Technology

Effective from Academic Year 2023 – 2024
(As per NEP-2020)

From the Desk of the Dean, Faculty of Science and Technology

Swami Ramanand Teerth Marathwada University, Nanded, enduring to its vision statement "*Enlightened Student: A Source of Immense Power",* is trying hard consistently to enrich the quality of science education in its jurisdiction by implementing several quality initiatives. Revision and updating curriculum to meet the standard of the courses at national and international level, implementing innovative methods of teaching-learning, improvisation in the examination and evaluation processes are some of the important measures that enabled the University to achieve the 3Es, the *equity, the efficiency and the excellence* in higher education of this region. To overcome the difficulty of comparing the performances of the graduating students and also to provide mobility to them to join other institutions the University has adopted the *cumulative grade point average* (CGPA) system in the year 2014-2015. Further, following the suggestions by the UGC and looking at the better employability, entrepreneurship possibilities and to enhance the latent skills of the stakeholders the University has adopted the *Choice Based Credit System* (CBCS) in the year 2018-2019 at graduate and post-graduate level. This provided flexibility to the students to choose courses of their own interests. To encourage the students to opt the world-class courses offered on the online platforms like, NPTEL, SWAYM, and other MOOCS platforms the University has implemented the credit transfer policy approved by its Academic Council and also has made a provision of reimbursing registration fees of the successful students completing such courses.

SRTM University has been producing a good number of high caliber graduates; however, it is necessary to ensure that our aspiring students are able to pursue the right education. Like the engineering students, the youngsters pursuing science education need to be equipped and trained as per the requirements of the R&D institutes and industries. This would become possible only when the students undergo studies with an updated and evolving curriculum to match global scenario.

Higher education is a dynamic process and in the present era the stakeholders need to be educated and trained in view of the self-employment and self-sustaining skills like start-ups. Revision of the curriculum alone is not the measure for bringing reforms in the higher education, but invite several other initiatives. Establishing industry-institute linkages and initiating internship, on job training for the graduates in reputed industries are some of the important steps that the University would like to take in the coming time. As a result, revision of the curriculum was the need of the hour and such an opportunity was provided by the New Education Policy 2020. National Education Policy 2020 (NEP 2020) aims at equipping students with knowledge, skills, values, leadership qualities and initiates them for lifelong learning. As a result the students will acquire expertise in specialized areas of interest, kindle their intellectual curiosity and scientific temper, and create imaginative individuals.

The curriculum given in this document has been developed following the guidelines of NEP-2020 and is crucial as well as challenging due to the reason that it is a transition from general science-based to the discipline-specific-based curriculum. All the recommendations of the *Sukanu Samiti* given in the NEP

Curriculum Framework-2023 have been followed, keeping the disciplinary approach with rigor and depth, appropriate to the comprehension level of learners. All the Board of Studies (BoS) under the Faculty of Science and Technology of this university have put in their tremendous efforts in making this curriculum of international standard. They have taken care of maintaining logical sequencing of the subject matter with proper placement of concepts with their linkages for better understanding of the students. We take this opportunity to congratulate the Chairman(s) and all the members of various Boards of Studies for their immense contributions in preparing the revised curriculum for the benefits of the stakeholders in line with the guidelines of the Government of Maharashtra regarding NEP-2020. We also acknowledge the suggestions and contributions of the academic and industry experts of various disciplines.

We are sure that the adoption of the revised curriculum will be advantageous for the students to enhance their skills and employability. Introduction of the mandatory *On Job Training, Internship* program for science background students is praise worthy and certainly help the students to imbibe first-hand work experience, team work management. These initiatives will also help the students to inculcate the workmanship spirit and explore the possibilities of setting up of their own enterprises.

Dr. L. M. Waghmare
Dean
Faculty of Science and Technology

Dr. M. K. Patil
Associate Dean
Faculty of Science and Technology

From Desk of Chairman, Board of Studies of the Subject MATHEMATICS

Preamble:

M. A. / M. Sc. Mathematics programme is of minimum 88 credits spread over four semesters. The programme emphasizes both theory and applications of Mathematics and is structured to provide knowledge and skills in depth necessary for the employability of students in industry, other organizations, as well as in academics. The program has some unique features such as independent projects, a large number of elective courses, extensive computer training including standard software packages such as LaTeX, SciLab, SageMath, R-software. The department has the academic autonomy and it has been utilized to add the new and need based elective courses. The independent project work is one of the important components of this program. The syllabus of the first year (two semesters) covers most of the core courses. In the third semester syllabus there are two core courses and eight elective courses. In the fourth semester syllabus there are two core courses and fourteen elective courses. The syllabus has been framed to have a good balance of theory, methods and applications of Mathematics.
It is possible for the students to study basic courses from other disciplines such as economics, life sciences, computer science and mathematics in place of electives.

Taking into consideration the rapid changes in science and technology and new approaches in different areas of Mathematics and related subjects, Board of studies in Mathematics after a thorough discussion with the teachers of Mathematics from Swami Ramanand Marathwada University Nanded and experts from industry as well as other Academic institutions has prepared the syllabus of M.A./M.Sc. I (w.e.f. 2023-24) Mathematics course under the NEP2020.
The Program Educational Objectives finalized for Postgraduate program in Mathematics are listed below:

Program Educational Objectives:

PEO1: To provide students Mathematical knowledge so that they are able to work as professionals in the subject.
PEO2: To prepare them to go for higher studies and pursue research
PEO3: To train students to handle the problems faced by industry through Mathematical knowledge and scientific computational techniques.
PEO4: To introduce the fundamentals of Mathematics to strengthen the students' logical and analytical ability.

PROGRAMME OUTCOMES (PO):

After the completion of the program, students will able to:

PO1: Pursue research in reputed institutions and solve the existing mathematical problems using the knowledge of pure and applied mathematics.

PO2: Acquire the **s**trong foundation of basic concepts which will benefit them to become good academicians.

PO3: Apply the concept of mathematical tools to address real life problems

PO4: Gain the knowledge of software which will be useful in Industry

PO5: Qualify various competitive exams like CSIR-UGC NET, SET, GATE, MPSC, UPSC, etc

PROGRAM SPECIFIC OUTCOMES (PSO):

PSO 1: To imbibe problem-solving and computational skills

PSO 2: To understand the motivation behind the statements and proofs

PSO 3: To enhance self learning and improve own performance.

PSO 4: To inculcate abstract mathematical thinking.

Course Outcomes (for all courses):

The course outcomes are the statement that describes the knowledge & abilities developed in the student by the end of course (subject) teaching. The focus is on development of abilities rather than mere content. There are 4 course outcomes of all courses defined here. These are to be written in the specific terms and not in general.

In addition to Program Educational Objectives, for each course of postgraduate program, objectives and expected outcomes from learner's point of view are also included in the curriculum to support the philosophy of outcome based education. I believe strongly that small step taken inright direction will definitely help in providing quality education to the stake holders.

Dr. Mahesh Sahebrao Wavare

Chairman, Board of Studies of the Mathematics

Swami Ramanand Teerth Marathwada University, Nanded

Details of the Board of Studies Members in the subject MATHEMATICS under the faculty of Science & Technology of S.R.T.M. University, Nanded

Sr No	Name of the Member	Designation	Address	Contact Number and EmailID
1	Prof. Dr. Mahesh Sahebrao Wavare	BoS Chairman (Ad hoc)under Section26(18) and BoS Member under section *40(2)(c)*	Rajarshi Shahu Mahavidyalaya (Autonomous), Latur,Tq. & Dist. Latur.	9890620620 maheshwavare@gmail.com
2	Prof. Dr. Dnyaneshwar Dadaji Pawar	*VC Nominated BoS Member Under Section 40(2)(a)*	Director School of Mathematical Sciences,SRTM University, Nanded	*9423124662 dypawar@yahoo.com*
3	Dr. B. Surendranath Reddy,	*VC Nominated BoS Member Under Section 40(2)(b)(i)*	School of Mathematical Sciences, SRTM University, Nanded	9096077789 surendra.phd@gmail.com bsreddy@srtmun.ac.in
4	Dr. Arun Babarao Jadhav,	*VC Nominated BoS Member Under Section 40(2)(b)(ii)*	DSM's College of Arts, Commerce and Science, Parbhani.	7875118707 arunbjadhav@gmail.com
5	Dr. S. S. Handibag,	*BoS Member Under Section 40(2)(b)(ii)*	Mahatma Basweshwar Mahavidylaya, Latur	9011491162 9604177 48 sujitmaths@gmail.com
6	Prof. Dr. Vandeo Chimnaji Borkar,	*BoS Member Under Section 40(2)(b)(iii)*	Yeshwant Mahavidyalaya, Nanded	9421769217 borkarvc@gmail.com
7	Dr. Kishor Ramrao Gaikwad,	*BoS Member Under Section 40(2)(b)(iii)*	Science College, Nanded	9923295556 drkr.gaikwad@yahoo.in
8	Dr. Hemant Kishor Undegaonkar,	*BoS Member Under Section 40(2)(b)(iii)*	Bahairji Smarak College, Basmat, Dist.Hingoli	9822546874 hkundegaonkar@gmail.com
9	Dr. S. S. Bellale	*BoS Member Under Section 40(2)(c)*	Dayanand Science College, Latur, Tq. & Dist. Latur - 413512	9405417417 sidhesh.bellale@gmail.com
10	Dr. Ram Govindrao Metkar	*BoS Member Under Section 40(2)(c)*	Indira Gandhi Sr. College, Cidco, NewNanded, Tq. & Dist.Nanded.:	9822312176 rammetkarmath@gmail.com

Swami Ramanand Teerth Marathwada University, Nanded

Faculty of Science & Technology

Credit Framework for Two Year PG Program (MA/M.Sc. Mathematics)

Subject: Mathematics (MAT)

Year & Level 1	Sem. 2	Major Subject (DSC) 3		Major Subject (DSE) 4	RM 5	OJT / FP 6	Research Project 7	Practicals 8	Credits 9	Total Credits 10
1	1	SMATC401	Algebra	**SMATE401** (Any one of the following)	SVECR 401 *Research Methodology* (3 Cr)	--		SMATP401 (3Cr) Latex Typesetting	22	44
		SMATC402	Real Analysis	A. Elementary Number Theory						
		SMATC403	Complex Analysis	B. Introduction to Probability						
				C. Multivariate Calculus						
				D.Advanced Discrete Mathematics						
				E.NPTEL/SWAYAM MOOCs						
	2	SMATC451	Linear Algebra	SMATE451 (Any one of the following)	---	SDSCOJ 451(3 Cr)	--	SMATP451 (3 Cr) Introduction to Scilab	22	
		SMATC452	Measure & Integration	A. Graph Theory						
		SMATC453	Differential Equations	B. Topology						
				C. Numerical Analysis						
				D. Algorithms and their Analysis						
				E. NPTEL/SWAYAM MOOCs						
Exit option: Exit Option with PG Diploma *(after 2024-25)*										
2	3	SMATC501	Integral Equations & Transforms	*SMATE501 (Any one of the following)*	--		Research Project SDSCR551 (4Cr)	SMATP501 (2Cr) Scientific programming with Python	22	44
		SMATC502	Functional Analysis	A. Coding Theory						
		SMATC503	Riemannian Geometry	B. Difference Equations						
				C. Analytic Number Theory						
				D.Lattice Theory						
				E. NPTEL/SWAYAM MOOCs						
	4	SMATC551	Galois Theory	SMATE551 *(Any one of the following)*	SVECP 551 Publication Ethics (2 Cr)		Research Project SDSCR552 (6 Cr)	SMATP551 (2Cr) R-programming	22	
		SMATC552	Fractional Calculus	A. Classical Mechanics						
				B. Theory of Relativity						
				C. Cryptography						
				D. Commutative Algebra						
				E. Operations Research						
Total Credits		44		16	05	03	10	10	88	

M.A/M. Sc. First Year Semester I *(Level 6.0)*

Teaching Scheme

	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs/ week)	
			Theory	Practical	Total	Theory	Practical
Major	**SMATC401**	Algebra	04	--	**04**	04	--
	SMATC402	Real Analysis	04	--	**04**	04	--
	SMATC403	Complex Analysis	04	--	**04**	04	--
Practical	**SMATP401**	Latex Typesetting	--	03	**03**	--	06
Elective (DSE)	**SMATE401**	(Choose any one) A.**Elementary Number Theory** **B. Introduction to Probability** **C. Multivariate Calculus** **D.Advanced Discrete Mathematics** **E.NPTEL/SWAYAM MOOCs**	04	--	**04**	04	--
Research Methodology	**SVECR401**	Research Methodology	03	--	**03**	03	
Total Credits			**19**	**03**	**22**	**19**	**06**

M.A/M. Sc. First Year Semester I *(Level 6.0)*

Examination Scheme

[20% Continuous Assessment (CA) and 80% End Semester Assessment (ESA)]

Subject (1)	Course Code (2)	Course Name (3)	Theory				Practical		Total Col (6+7) / Col (8+9) (10)
			Continuous Assessment (CA) Avg of			ESA			
			Test I (4)	Test II (5)	T1+T2)/2 (6)	Total (7)	CA (8)	ESA (9)	
Major	**SMATC401**	Algebra	20	20	20	80	--	--	100
	SMATC402	Real Analysis	20	20	20	80	--	--	100
	SMATC403	Complex Analysis	20	20	20	80	--	--	100
Practical	**SMATP401**	Latex Typesetting	--	-	--	--	15	60	75
Elective (DSE)	**SMATE401**	(Choose any one) A.**Elementary Number Theory** **B. Introduction to Probability** **C. Multivariate Calculus** **D.Advanced Discrete Mathematics** **E.NPTEL/SWAYAM MOOCs**	20	20	20	80	--	--	100
Research Methodology	**SVECR401**	Research Methodology	15	15	15	60	--	--	75

M.A/M. Sc. First Year Semester II *(Level 6.0)*

Teaching Scheme

	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs/ week)	
			Theory	Practical	Total	Theory	Practical
Major	**SMATC451**	Linear Algebra	04	--	**04**	04	--
	SMATC452	Measure & Integration	04	--	**04**	04	--
	SMATC453	Differential Equations	04	--	**04**	04	--
Practical	**SMATP451**	Introduction to Scilab	--	03	**03**	--	06
Elective (DSE)	**SMATE451**	(Choose any one) **A. Graph Theory** **B. Topology** **C. Numerical Analysis** **D. Algorithms and their Analysis** E. **NPTEL/SWAYAM MOOCs**	04	--	**04**	04	--
On Job Training	**SMATO451**	On Job Training	--	03	**03**	--	03
Total Credits			**16**	**06**	**22**	**16**	**09**

M.A/M. Sc. First Year Semester II *(Level 6.0)*

Examination Scheme

[20% Continuous Assessment (CA) and 80% End Semester Assessment (ESA)]

Subject (1)	Course Code (2)	Course Name (3)	Theory				Practical		Total Col (6+7) / Col (8+9) (10)
			Continuous Assessment (CA) Avg of			ESA			
			Test I (4)	Test II (5)	(T1+T2)/ 2 (6)	Total (7)	CA (8)	ESA (9)	
Major	**SMATC451**	Linear Algebra	20	20	20	80	--	--	100
	SMATC452	Measure & Integration	20	20	20	80	--	--	100
	SMATC453	Differential Equations	20	20	20	80	--	--	100
Practical	**SMATP451**	Introduction to Scilab	--	--	--	--	15	60	75
Elective (DSE)	**SMATE451**	(Choose any one) **A. Graph Theory** **B. Topology** **C. Numerical Analysis** **D. Algorithms and their Analysis** **E. NPTEL/SWAYAM MOOCs**	15	15	15	60	--	--	75
On Job Training	**SMATO451**	On Job Training	--	--	--	--	15	60	75

Course Structure: *DSC/DSE - Teaching Scheme*

Course Code	Course Name (Paper Title)	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
DSC/DSE	DSC/DSE per Course	04	--	04	--	04
DSC	DSC per course	--	--	--	06	06

DSC/DSE - Assessment Scheme

Course Code (2	Course Name (3)	Theory				Practical		Total [Col (6+7) / Col (8+9)] (10)
		CA			ESA (7)			
		Test I (4)	Test II (5)	Avg of (T1+T2)/2 (6)		CA (8)	ESA (9)	
DSC/DSI	DSC/DSE per Course	20	20	20	80	--	--	100
DSC	DSC per Cours	--	--	--	--	15	60	75

M.A/M. Sc. First Year Semester-I *(Level 6.0)*

SMATC401: Algebra

Course objectives: To introduce the concepts and to develop working knowledge on Groups and Rings, so that strong foundation for subsequent algebra courses can be developed.

Course outcomes:

After completing this course, the student will be able to:

- **CO1**: Understand automporphisms , Lagrange's theorem.
- **CO2:** Understand Sylow theorems.
- **CO3:** Study rings, ideals and their properties.
- **CO4:** Grasp Euclidean Domains , Unique Factorisation Domains.

Curriculum Details:

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0			**15**
	1.1	Cayley's Theorem, Properties of Isomorphisms.	
	1.2	Automorphisms, Cosets and Lagrange's Theorem.	
	1.3	An Application of Cosets to Permutation Groups, Normal Subgroups.	
	1.4	Factor Groups, Application of Factor Groups, Internal Direct Product.	
2.0			**15**
	2.1	Group Homomorphisms and their properties.	
	2.2	The First Isomorphism Theorem. The Fundamental Theorem of finite abelian groups (Statement Only).	
	2.3	Isomorphism Classes of Abelian Groups, The Class Equation, The Sylow's Theorems.	
3.0			

	3.1	Introduction to Rings, Examples and Properties.	**15**
	3.2	Integral Domains, Fields, Characteristic of a Ring.	
	3.3	Ideals and Factor Rings, Ring Homomorphisms.	
4.0			
	4.1	Polynomial Rings, Factorization of Polynomials.	**15**
	4.2	Divisibility in Integral Domains.	
	4.3	Unique Factorization Domains.	
	4.4	Euclidean Domains.	
		Total	**60**

Text Book:

J. A. Gallian, Contemporary Abstract Algebra, Fourth edition, Narosa Publishing House.

Scope-

Unit-I Chapter 6,7,8,9
Unit-II Chapter 10,11,24
Unit-III Chapter 12,13,14,15
Unit-IV Chapter 16,17,18

Reference Books:

1. **D. S. Dummit and R. M. Foote**, Abstract Algebra, 2nd Ed., John Wiley, 2002.
2. **I. N. Herstein**, Topics in Algebra, Macmillan, Indian Edition.
3. **J. B. Fraleigh**, Abstract Algebra, 5th Edition, Narosa Publications.
4. **I. S. Luthar**, I. B. S. Passi, Algebra, Vol. 1, Groups, Narosa Publishing House.
5. **P. B. Bhattacharyya, S. K. Jain and S. R. Nagpaul,** Basic Abstract Algebra (2e), Cambridge Univ. Press, Indian Edition, 1997.

SMATC402: Real Analysis

Course Objective(s):

To learn the concepts of basic topological objects such as open sets, closed sets, compact sets and the concept of sequence of functions, Arzela - Ascoli Theorem

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Attain mastery in Archimedean property, LUB axioms, and Sequence of real numbers

CO2: Acquire the knowledge of Open, closed, and connected sets and continuous functions

CO3: Study Compact metric space , Uniform Continuity, Continuous functions on Compact domains

CO4: Study in detail sequence of functions, Arzela - Ascoli Theorem

Curriculum Details:

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0			**15**
	1.1	Real Number System, LUB axiom, Archemedian property,Equivalent Sets	
	1.2	countable and uncountable sets, Sequences of real numbers,	
	1.3	convergent sequence, subsequence, monotonic sequence, Cauchy sequence	
	1.4	limsup, liminf, Metric spaces, Limits in Metric spaces.	
2.0			
	2.1	Open sets, closed sets,	

	2.2	The Relative Metric, Continuous Functions	**15**
	2.3	Homeomorphisms, The Space of Continuous Functions	
	2.4	Connected sets, Totally Bounded Sets	
3.0			
	3.1	Complete Metric Spaces, Fixed Points	**15**
	3.2	Compact Metric Spaces	
	3.3	Uniform Continuity,	
	3.4	Continuous functions on Compact domains	
4.0			
	4.1	Sequence of functions, point wise and uniform convergence	
	4.2	Interchanging limits, The space of Bounded Functions	**15**
	4.3	The Weierstrass theorem, equicontinuous family of functions	
	4.4	The Weierstrass theorem, equicontinuous family of functions	
		Total	**60**

Text Book:

N.L. Carothers, Real Analysis, Cambridge University Press.

Scope: Chapters 1 to 11.

Reference Books:

1. **Ajit Kumar and S. Kumaresan**, Basics of Real Analysis, CRC Press.
2. **W. Rudin**, Principles of Mathematical Analysis.
3. **C. C. Pugh**, Real Mathematical Analysis.
4. **S. Kumaresan**, Topology of Metric Spaces, Narosa Publishing House.
5. **T. M. Apostol**, Mathematical Analysis, Narosa Publishing House.
6. **Sudhir R. Ghorpade and Balmohan V. Limaye**, A Course in Calculus and Real Analysis, Springer Publications.

SMATC403: Complex Analysis

Prerequisites: Basic knowledge of the real number system is needed.

Course objectives:

This course is aimed to provide an introduction to the theories for functions of a complex Variable. Some of the objectives of the course is to study and understand the topics like Cauchy– Riemann Equations, Cauchy Integral Formula and its applications, Poles and residues, Mobius Transformation.

Course outcomes:

After completing this course, the student will be able to:

- **CO1:** Explain the concepts of C-R Equations, Analytic Functions, and Elementary Functions.
- **CO2:** Construct the proofs of Cauchy Integral Formula, Liouville's Theorem, and solve problems related to the Taylor and Laurent series.
- **CO3:** Identify different types of singularities, zeros of analytic function, Evaluate improper integrals and apply the Rouche's Theorem to solve the problems.
- **CO4:** Understand Mobius Transformation and mappings of regions under some special transformations.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0			**15**
	1.1	Derivatives, Cauchy–Riemann Equations, Sufficient Conditions for Differentiability	
	1.2	Polar Coordinates, Analytic Functions, Harmonic Functions, Uniquely Determined Analytic Functions	
	1.3	Reflection Principle, The Exponential Function, The Logarithmic Function	
	1.4	Branches and Derivatives of Logarithms, Complex Exponents, Trigonometric Functions, Hyperbolic Functions	
2.0			

	2.1	Derivatives of Functions, Definite Integrals of Functions, Contour Integrals, Branch Cuts	**15**
	2.2	Upper Bounds for Moduli of Contour Integrals, Antiderivatives	
	2.3	Cauchy–Goursat Theorem, Simply Connected Domains, Cauchy Integral Formula, Liouville's Theorem and the Fundamental Theorem of Algebra	
	2.4	Maximum Modulus Principle, Convergence of Sequences and series, Taylor Series, Laurent Series	
3.0			**15**
	3.1	Isolated Singular Points, Residues,Cauchy's Residue Theorem	
	3.2	Residue at Infinity, The Three Types of Isolated Singular Points, Residues at Poles	
	3.3	Zeros of Analytic Functions, Zeros and Poles	
	3.4	Behaviour of functions near isolated singular points	
4.0			**15**
	4.1	Evaluation of Improper Integrals, Jordan's Lemma	
	4.2	Definite Integrals Involving Sines and Cosines, Argument Principle	
	4.3	Rouche's Theorem. Linear Transformations, The Transformation w = 1/z, Mappings by 1/z	
	4.4	Linear Fractional Transformations, An Implicit Form.	
		Total	60

Text Book:

R.V.Churchill and J.W.Brown, Complex Variables and Applications (eighth edition), McGraw Hill Publication

Scope: Unit 1 – Chapter 2 and 3
Unit 2 - Chapter 4(excluding multiply connected domains) and Chapter 5(excluding continuity of sums of power series, integration and differentiation of power series, multiplication and division of power series)
Unit 3 - Chapter 6 and Chapter 7(excluding improper integral from Fourier Analysis, indented paths, integration along branch cuts, inverse Laplace transforms)
Unit 4 – Chapter 8 (excluding square roots of polynomials, Riemann surfaces)

Reference Books:

1. **John B. Convey**, "Function of one complex variable", Narosa Publication, House, 1980.
2. **S. Ponnusamy**, "Foundations of Complex Analysis", Narosa Publishing House.
3. **Lars V. Ahlofors**, "Complex Analysis", McGraw Hill Company.
4. **Silverman Herb**, "Complex Analysis".

SMATE401 (A): Elementary Number Theory

Course objectives: Introduce students with the basic concepts of number theory like divisibility, congruences, Diophantine equations, number theoretic functions, quadratic residues etc. ,Develop their skills in problem solving , Prepare students for advanced topics in number theory,Make students understand the art of proving theorems.

Course outcomes:

After completing this course, the student will be able to:

- **CO1:** Tackle Division Algorithm ,
- **CO2:**Handle Theory of Congruences.
- **CO3:**Understand Mobius inversion formula, Euler's theorem.
- **CO4:** Understand Legendre symbol and can solve problems.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0			**15**
	1.1	Divisibility Theory in the Integers: Division Algorithm.	
	1.2	The Greatest Common Divisor , Least Common Multiple.	
	1.3	The Euclidean Algorithm, The Diophantine Equations ax+by = c.	
	1.4	Fundamental Theorem of Arithmetic.	
2.0			**15**
	2.1	Theory of Congruences: Basic Properties of Congruences.	
	2.2	Binary and Decimal Representations of Integers, Linear congruence and the Chinese Remainder Theorem.	

	2.3	Fermat Theorem: Fermat Little theorem and Pseudo primes, Wilson's Theorem, The Fermat's theorem. –Kraitchik Factorization Method , The Equation x2+y2= z2 , Fermat's last Theorem.	
3.0			**15**
	3.1	Euler's Generalization of Fermat's Theorem: Sum and Number of divisors.	
	3.2	The Mobius Inversion Formula.	
	3.3	The greatest Integer function, Euler's Phi- Function, Euler's theorem, Properties of Phi function.	
4.0			**15**
	4.1	Roots, Indices and the Quadratic Reciprocity Law: The Order of an Integer Modulo n.	
	4.2	Primitive Roots for Primes , Composite Numbers having primitive Roots, Theory of Indices, Euler's Criterion.	
	4.3	The Legendre Symbol and its Properties , Quadratic Congruences with Composite Moduli.	
		Total	**60**

Text Book: David M. Burton ,Elementary Number Theory, Tata McGRAW-HILL,2006.

Scope- Unit-I Chapter 2,3
Unit-I Chapter 4,5,6
Unit-III Chapter 6,7
Unit-IV Chapter 8,9

Reference Books:

1. **A Baker**, A concise Introduction to the Theory of Numbers, Cambridge University Press 1984

2. **J.P. Serre**, A course in arithmetic-. GTM Vol.7, Springer Verlag 1973

3. **Tom M. Apostol.** ,Introduction to Analytic number theory Narosa Publishing house 1980.

SMATE401 (B): Introduction to Probability

Course objectives:

The focus of this course is to study the concepts like Axioms of Probability, Conditional probability, Random Variables, Distribution functions, types of random variables with examples and their properties, inequalities, modes of convergences, Law of Large Numbers.

Course outcomes:

After completing this course, the student will be able to:

- **CO1**: Solve the problems using Baye's formula and identify independent events.
- **CO2**: Able to identify the correct distribution to the real life problem
- **CO3**: Explain joint distributions and derive the marginal distributions. Find the expectation, variance, MGF of random variables.
- **CO4**: Apply inequalities and law of large numbers to solve real life problems

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0			**15**
	1.1	Sets and classes, limit of a sequence of sets, fields, sigma-fields, monotone classes.	
	1.2	Sample Space and Events, Axioms of Probability, Sample Spaces Having Equally Likely Outcomes.	
	1.3	Conditional Probabilities, Bayes Formula, Independent Events.	
2.0			**15**
	2.1	Random Variables, Distribution Functions, Discrete Random Variables, Expected Value, Expectation of a Function of a Random Variable, Variance.	
	2.2	Discrete distributions: uniform, binomial, geometric, negative binomial, hyper geometric, Poisson.	
	2.3	Continuous distributions: uniform, exponential, gamma, Weibull, beta, normal, Cauchy.	

3.0			
	3.1	Joint Distribution Functions, Independent Random Variables, Sums of Independent Random Variables.	**15**
	3.2	Conditional Distributions: Discrete Case and Continuous Case, Joint Probability Distribution of Functions of Random Variables. Expectation of Sums of Random Variables, Covariance, Variance of Sums, and Correlations, Conditional Expectation.	
	3.3	Moment Generating Functions, Joint Moment Generating Functions.	
4.0			
	4.1	Problems on Chebyshev's and other inequalities	**15**
	4.2	Modes of Convergence of random variables	
	4.3	Weak Law of Large Numbers, Strong Law of Large Numbers Central Limit Theorem.	
		Total	**60**

Text Book:

1. **Sheldon Ross**, A First Course in Probability, PRENTICE HALL India.
2. **VIJAY K. ROHATGI, A. K. MD. EHSANES SALEH**, An Introduction to Probability and Statistics, second edition, Wiley series.

Reference Books:

1. **Murray R. Speigel**, Schaum's Outline of Probability and Statistics.
2. **J.S. Milton & J.C. Arnold**, Introduction to Probability and Statistics.
3. **H.J. Larson** , Introduction to Probability Theory and Statistical Inference.
4. **S.M. Ross** , Introduction to Probability and Statistics for Engineers and Scientists.
5. **P. Halmos** , Measure Theory (for algebra of sets)
6. **Feller, W.**, Introduction to Probability Theory and its Applications, 3rd Ed., Wiley Eastern, 1978.
7. **PrakashRao, B.L.S.**, A First Course in Probability and Statistics, World Scientific, 2009.

SMATE401 (C): Multivariate Calculus

Course objectives:

The aim of this course is to introduce basic concepts such as tangent spaces, double integral, triple integral etc.

Course outcomes:

After completing this course, the student will be able to:

- **CO1:** Find the tangent space, maxima and minima.
- **CO2:** Solve problems related to surface integral.
- **CO3:** Use Stokes theorem , divergence theorem to solve triple integral.
- **CO4:** Study Geometry of surfaces in three dimensions.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0			**15**
	1.1	Introduction to differentiable functions, directional and partial derivatives, graphs and level sets of functions of several variables.	
	1.2	Implicit function theorem, Level sets and Tangent spaces.	
	1.3	Lagrange's multipliers, maximum and minimum of a function with constraints.	
	1.4	Critical points , Hessian, Maxima & Minima on open sets.	
2.0			**15**
	2.1	Directed curve in R^n, length of a curve, unit speed parametrization, piecewise smooth curves.	
	2.2	Line integral, Frenet-Serret equations.	
	2.3	Double Integration, fundamental theorem of calculus in R^2, Green's theorem.	
3.0			**15**
	3.1	Parameterized surfaces in R^3, Surface Area	
	3.2	Surface Integrals: Integral of a vector field over an oriented surface, Geometrical interpretations of Integral of a vector field.	
	3.3	Stoke's theorem for oriented surfaces in R^3	

4.0			**15**
	4.1	Triple integral, coordinate systems in R^3, change of variable formula.	
	4.2	The divergence theorem, examples of the divergence theorem.	
		Total	**60**

Text Book: Sean Dineen, Multivariate Calculus and Geometry, Springer Verlag.

Scope: Chapters 1 to 15.

Reference Books:

1. **Sudhir R. Ghorpade and Balmohan V. Limaye,** "A course in Multivariate Calculus and Analysis", Springer Verlag.
2. **T. M. Apostol,** "Calculus", Vol. 2, Second Edition, John Wiley and Sons, Inc.
3. **J. A. Thorpe,** "Elementary Topics in Differential Geometry", Springer Verlag.
4. **Devinatz,** "Advanced Calculus".
5. **B. Oneill,** Elementary Differential Geometry.

SMATE401 (D): Advanced Discrete Mathematics

Course Objectives:

The mission of the course is to study objects that are of discrete nature. Understand the application in real life communication models, computer sciences, and electronic circuits.

Course Outcomes:

On successful completion of this course, the student will be able to:

- **CO1:** Understand Formal Logic, Propositional Logic, Semi groups and Monoids, Congruence relation.
- **CO2:**.Study Complemented and Distributive Lattices.
- **CO3:** Analyze Boolean Algebras.
- **CO4:** Apply Boolean algebra to switching theory.

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Formal Logic:**	**15**
	1.1	Statements, Symbolic Representation and Tautologies, Quantifiers, Predicates and Validity, Propositional Logic.	
	1.2	Semi groups and Monoids: Definitions and examples of Semigroups and Monoids (including those pertaining to concatenation operations) Homomorphism of semigroups and monoids.	
	1.3	Congruence Relation and Quotient emigroups, Subsemigroup and Submonoids. Direct Product, Basic Homomorphism Theorem.	
2.0		**Lattices:**	**15**
	2.1	Lattices as partially ordered sets, their properties. Lattices as algebraic systems.	
	2.2	Sublattices, Direct Products and Homomorphisms.	
	2.3	Some Special lattices e. g. complete,Complemented and Distributive Lattices.	
3.0		**Boolean Algebras:**	

	3.1	Boolean Algebras as Lattices, Various Boolean Identities, The Switching Algebra.	**15**
	3.2	Example, Subalgebras, Direct Products and Homomorphisms, Joint- Irreducible Elements.	
	3.3	Atoms and Minterms, Boolean forms and their equivalence, Minterm Boolean forms, Sum of Products, Canonical forms.	
4.0		**Boolean Function:**	**15**
	4.1	Minimization of Boolean Functions.	
	4.2	Applications of Boolean Algebra to Switching Theory (using AND, OR and NOT gates).	
	4.3	The Karnaugh Map Method.	
		Total	**60**

Text Book: ***J. P. Trembley and Manohar,*** *Discrete Mathematical Structures with applications to Computer Science, McGraw-HillBookCo.1997.*

Reference Books:

1. Seymour Lipschutz, Finite Mathematics(International edition1983), McGraw-Hill Book
2. S.Wiitala, Discrete Mathematics-A Unified Approach, McGraw-Hill Book Co. New York.
3. J. L. Gersting, Mathematical Structures for Computer Science, (3rdedition).

SMATE401 (E): NPTEL/SWAYAM MOOCs

SMATP401: Latex Typesetting

Course objectives:

To prepare a Latex document, to make scientific article and project report, book, include figures and tables in a Latex document, make conference proceedings and presentations, the preamble of LaTeX file to define document class and layout options, Use BibTeX to maintain bibliographic information and to generate a bibliography for a particular document and beamer for beautiful presentations

Course outcomes:

After completing this course, the student will be able to:

- **CO1:** Typesetting of complex mathematical formulae using LaTeX.
- **CO2:** Use various methods to either create or import graphics into a LaTeX document.
- **CO3:** Typesetting of journal articles, technical reports, thesis, books, and slide presentations.
- **CO4:** Automatic generation of table of contents, bibliographies and indexes.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Latex Environment**	**5L+10P**
	1.1	Introduction to LaTeX, Installation of LaTeX, Layout Design,	
	1.2	LaTeX input files, Input file structure, document classes,	
	1.3	Packages, environments, page styles, Typesetting texts,	
	1.4	Fancy Header, tables.	
2.0		**Mathematical Expressions in Latex**	**5L+10P**
	2.1	Inline math formulas and displayed equations, Math symbols and fonts,	
	2.2	Delimiters, matrices, arrays, Typesetting Mathematical formulae: fractions,	
	2.3	Integrals, sums, products, etc. Producing Mathematical Graphics.	
3.0		**Latex Class and formatting**	**5L+10P**
	3.1	Document classes for paper writing, thesis, books, etc.	
	3.2	Table of contents, index, hypertext, pdf pages, geometry, fancy header and footer, Verbatim, itemize, and enumerate, boxes, equation number.	

	3.3	Creating Tables, Inserting figures, enumeration list, itemized list, font effects, and inserting equations.	
4.0		**Presentation in Latex**	**5L+10P**
	4.1	Beamer class, beamer theme, frames, slides, pause,	
	4.2	Overlay transparent, handouts and presentation mode.	
	4.3	Inserting references, Manual reference,	
	4.4	Reference using BibTex, citing reference.	
		Total	**60**

Reference Books:

1 LATEX Tutorials A Primer, Indian TEX Users Group, Trivandrum, India, 2003 September.

2 Learning LATEX by Doing, Andre Heck, 2002.

3 The Latex companion, M. Carter, B.vanBrunt, second edition, Addison wisely, Pearson Education.

M. Sc. First Year Semester-II *(Level 6.0)*

SMATC451: Linear Algebra

Prerequisites: Basic knowledge of Group Theory is needed.

Course objectives:

This course is aimed to provide an introduction to the theories, concepts and to develop working knowledge of vector spaces, linear transformations and canonical forms.

Course outcomes:

Upon successful completion of this course, students will able to

CO1: Assimilate the concept of linear dependence, basis etc.

CO2: Study eigen value, eigen vectors of linear transformation.

CO3: Study inner product spaces.

CO4: Develop knowledge of canonical forms.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0			**15**
	1.1	Vector spaces, subspaces, Linear combinations and system of linear equations	
	1.2	linear dependence and independence	
	1.3	Bases and dimension, Maximal Linear Independent Subsets	
	1.4	Linear Transformations, Null spaces, and range spaces	
2.0			**15**
	2.1	The matrix representation of a linear transformation, Composition of linear transformations	
	2.2	Invertibility and Isomorphisms	
	2.3	Eigen values and eigen vectors	
	2.4	Diagonalizabity	
3.0			

	3.1	Invariant Subspaces and the Cayley-Hamilton Theorem	**15**
	3.2	Inner products and Norms	
	3.3	The Gram-Schmidt orthogonalization process	
	3.4	Orthogonal complements.	
4.0			
	4.1	The adjoint of a linear operator, Normal and self-adjoint operators	**15**
	4.2	Unitary and orthogonal operators and their matrices	
	4.3	Orthogonal projections and the Spectral Theorem(Statement only), Quadratic forms	
	4.4	Jordan Canonical forms, The minimal polynomial.	
		Total	**60**

Text Book:

S.H. Friedberg, A.J. Insel, L.E. Spence, "Linear Algebra", Prentice-Hall, International, Inc., 3rd Edition.

Scope: Unit I - Chapter 1- Art 1.1 to 1.7, Chapter 2- Art 2.1

Unit II - Chapter 2 - Art 2.2 to 2.4, Chapter 5- Art 5.1, 5.2

Unit III - Chapter 5 - Art 5.4, Chapter 6 - Art 6.1, 6.2.

Unit IV - Chapter 6 - Art 6.3 to Art 6.6, 6.8, Chapter 7 - Art 7.1, Art 7.3

Reference Books:

1. **Vivek Sahai and Vikas Bist**, "Linear Algebra", Narosa Publishing House, 2nd Edition.
2. **S.Lang**, "Introduction to Linear algebra", Springer International Edition, 2nd Edition.
3. **K.Hoffman, R.Kunze**, "Linear Algebra", Prentice Hall of India.
4. **S.Kumaresan**, "Geometrical approach to Linear Algebra", Prentice Hall India Learning Private Limited; New title edition (2000).

SMATC452: Measure & Integration

- **Pre-requisites:** Algebra of sets, The axiom of choice and infinite direct products, Open and closed sets of real numbers, continuous functions, Borel sets.
- **Course Objectives:**

  This course will help to learn basic elements of measure theory such as measurable sets, functions, Lebesgue integration and differentiation. Also understand the concepts of abstract measure theory with the help of classical Banach spaces .

- **Course Outcome(s):**

  After completing this course, the student will be able to:

  CO1: Gain knowledge of measurable sets and measurable functions

  CO2: Acquire mastery on Lebesgue Integral

  CO3: Study Differentiation and integration concepts

  CO4: Learn Classical Banach spaces and approximation in Lp Spaces

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0			**15**
	1.1	Outer measure, measurable sets	
	1.2	Lebesgue measure	
	1.3	Non measurable sets	
	1.4	Measurable functions, Littlewood's three principles	
2.0			**15**
	2.1	The Riemann integral	
	2.2	Lebesgue integral of a bounded function over a set of finite measure,	
	2.3	The integral of a nonnegative function,	

	2.4	The general Lebesgue integral, convergence in measure	
3.0			**15**
	3.1	Differentiation of monotone functions	
	3.2	functions of bounded variation	
	3.3	differentiation of an integral	
	3.4	absolute continuity, convex functions	
4.0			**15**
	4.1	The Lp spaces	
	4.2	The Minkowski and Holder inequalities	
	4.3	Convergence and completeness	
	4.4	Approximations in Lp Spaces	
		Total	**60**

Text Book:

H. L. Royden Real Analysis, 3rd Edition, PHI Learning Private Ltd.

Reference Books:

1 **N.L. Carothers**, "Real Analysis", Cambridge university press.

2 **P.R. Halmos**: Measure theory, Narosa Publishing House.

3 **Inder K. Rana** : An Introduction to measure and Integration. Norosa publishing House, Delhi : 1997.

4 **G. de. Barra**; Measure theory and Integration, Woodhead Publishing, July 2003.

5 **P.K. Jain and V.P Gupta** : Lebesgue measure and Integrtion , New age international (P) ltd publishing, New Delhi (Reprint 2000.)

SMATC453: Differential Equations

Course objectives: This course aims to introduce various methods , techniques , tools to solve first order differential equations, study qualitative properties such as existence and uniqueness of their solutions , to introduce classification of partial differential equations and to learn various methods to solve them.

Course outcomes:

After completing this course, the student will be able to:

- **CO1:** Capable with various methods of finding solutions of ordinary differential equations , equipped with study the existence and uniqueness of solutions , and analyse systems of differential equations.
- **CO2:** Classify partial differential equations , will be able to apply a wide range of techniques and tools to solve them.
- **CO3:** Identify and solve homogeneous and non homogeneous differential equations with variable coefficients.
- **CO4:** Study the existence and uniqueness of solutions.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0			**15**
	1.1	Initial value problem, solution of the homogeneous equation.	
	1.2	Wronskian and linear independence.	
	1.3	Non-homogeneous equation.	
	1.4	The Euler equation, second order equation with regular singular points.	
2.0			**15**
	2.1	Equations with variables separated, exact equation.	
	2.2	The method of successive approximations.	
	2.3	The Lipschitz condition, approximations to and uniqueness of the solutions.	

3.0			**15**
	3.1	First order PDE, Linear equations of first order	
	3.2	Charpit's method	
	3.3	Jacobi method, Quasi-linear equations.	
4.0			**15**
	4.1	Classification of second order PDE, one dimensional wave equation	
	4.2	Laplace equation	
	4.3	Theory of Green's function for Laplace equation	
	4.4	Heat condensation problem	
		Total	**60**

Textbooks:-

1. **E. A. Coddington**: An Introduction to Ordinary Differential Equation, Prentice-Hall of India Pvt. Ltd. New Delhi.

Scope:
Unit I Chapter 3 , 4
Unit II Chapter 4 , 5

2. **T. Amarnath**: An elementary course in PDE(2^{nd} edition), Narosa Publishing House.

Scope:
Unit I Chapter 1
Unit II Chapter 2

Reference Books:-

1. **G. F. Simmons**: Differential Equations with Applications and Historical Notes, (2^{nd} edition)McGraw Hill Book Co.
2. **W. E. Williams:** Partial Differential Equations, Clarendon Press Oxford.
3. **G. Birkhoff and G. C. Rota**: Ordinary Differential Equations, John Wiley and Sons.
4. **E. T. Copson**: Partial Differential Equations, Cambridge University Press.
5. **I. N. Sneddon**: Elements of Partial Differential Equation , McGraw Hill Book Co.

SMATE451 (A): Graph Theory

Prerequisites: The elementary knowledge of set theory is required.

Course objectives:

The objectives of the course are to discuss the concepts of graph, tree and cut set. Discuss the Chinese Postman Problem and Travelling salesman problem. Use an algorithm to produce a plane drawing of a planar graph, know whether some special graphs are planar.

Course outcomes:

After completion of the course students will able to:

- **CO1:** solve problems involving vertex and edge connectivity
- **CO2:** Use algorithms for finding an Euler trail in a graph for solving the Chinese Postman Problem.
- **CO3:** Model and solve real world problems using graphs and trees, both quantitatively and qualitatively.
- **CO4:** Apply Ford and Fulkerson Algorithm to real life problems

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0			**15**
	1.1	Graphs, subgraphs, paths, cycles	
	1.2	Matrix representation of a graph, fusion	
	1.3	Trees and connectivity, bridges, spanning trees	
	1.4	cut vertices and connectivity.	
2.0			**15**
	2.1	Euler tour, Euler Graph	

	2.2	The Chinese postman problem	
	2.3	Hamiltonian graphs	
	2.4	Travelling salesman Problem	
3.0			
	3.1	Planar graphs, Euler's formula	**15**
	3.2	Kuratowski's theorem	
	3.3	Non- Hamiltonian plane graphs	
	3.4	The dual of a plane graph	
4.0			
	4.1	Directed graphs and Networks	**15**
	4.2	Tournaments, Traffic flow	
	4.3	The Ford and Fulkerson Algorithm	
	4.4	Separating sets	
		Total	**60**

Text Book:

John Clark and Derek Allan Holton, A First Look at Graph Theory, Allied Publishers Ltd.

Scope: Chapters:-1, 2, 3,5,7,8

Reference Books:

1. **Narsing Deo**, Graph Theory With Applications to Engineering and Computer Science, Prentice Hall of India.
2. **F. Harare**, Graph Theory, Addison Wesley.
3. **Douglas B. West**, Introduction to Graph Theory, Prentice- Hall, New Delhi
4. **K. R. Parthasarthy**, Basic Graph Theory, Tata McGraw- Hill Pub Comp Limited, Delhi.

SMATE451 (B): Topology

- **Course Objectives:**

  The goal of the course is to provide in depth knowledge of this fundamental core course in mathematics to show various techniques from analysis , set theory , logic that are used in topological spaces to obtain their properties , to demonstrate application in physics.

Course Outcomes:

After completing this course, the student will be able to:

- **CO1:** Understand basics of Topological Spaces
- **CO2:** Study Connected Spaces, Compact Spaces.
- **CO3:** Achieve the zenith in treating Countable Axioms, Separable, and Regular and Normal spaces.
- **CO4:** Apply The Urysohn's Lemma, Urysohn's Metrization Theorem to other results.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0			**15**
	1.1	Topological Spaces, Basis for Topology	
	1.2	The Order Topology, The product Topology, The Subspace Topology	
	1.3	Closed Sets and Limit Points	
	1.4	Continuous functions	
2.0			**15**
	2.1	Connected Spaces, Connected Subspace on Real Line.	
	2.2	Compact Spaces, Compact Subspace on the Real Line	
	2.3	Components and Local Connectedness	
3.0			**15**
	3.1	Limit Point Compactness, Local Compactness	
	3.2	Countable Axioms, First countable, Second Countable,	
	3.3	Separable, Lindelof space.	

4.0			
	4.1	Separation Axioms,	**15**
	4.2	Regular and Normal spaces	
	4.3	The Urysohn's Lemma and The Urysohan Metrization Theorem (Statements Only)	
	4.4	The Tychonoff Theorem	
		Total	**60**

Text Book:

James R. Munkres: Topology, A first course, Prentice Hall of India. Pvt. Ltd. New Delhi-2000.

Scope:-

1. Chapter 2: Articles 12 to 18
2. Chapter 3: Articles 23, 24, 25, 26, 27, 28, 29
3. Chapter 4: Articles 30 to 34.
4. Chapter 5:Article37

Reference Books:

1. **J. Dugundji Allya and Bacon**, Topology, (1966) reprinted: Prentice Hall of India.
2. **W. J. Pervin**: Foundations of general topology, academic press Inc.
3. **Stephen Willard**, General Topology, Addison-Wesley Publishing Company, 1970
4. **Sheldon W. Davis**, Topology (The Walter Rudin Student Series in Advanced Mathematics), TATA McGraw-Hill.2006.
5. **Sidney A Morris**, Topology without Tears, 2011 Version.
6. **S. Kumaresan**, Topology of metric spaces, 2nd edition, Narosa, 2011.

SMATE451 (C): Numerical Analysis

Course Objective(s):

Numerical Analysis deals with numerical solutions of certain problems of Mathematics. This course aims to study iterative methods to solve nonlinear equations in one variable, methods to solve system of equations, interpolation problems and Numerical solutions of differential equations.

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Obtain the solutions of Transcendental and Polynomial Equations.

CO2: Find solutions of system of equations using direct methods and Iteration methods

CO3: Attain mastery to solve problems using interpolation.

CO4: Acquire knowledge of Numerical methods to find solution of Ordinary Differential Equations

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		Transcendental and Polynomial equations	**15**
	1.1	Introduction, Bisection method	
	1.2	Iteration methods based on first degree equations and second degree equations	
	1.3	Rate of convergence	

	1.4	Polynomial Equations, Model problems	
2.0		System of Linear algebraic equations and Eigen value problems	**15**
	2.1	Introduction, direct methods,	
	2.2	Iteration methods	
	2.3	Eigen value and Eigen vectors	
	2.4	Model problems	
3.0		Interpolations and approximations:	**15**
	3.1	Introduction, Lagrange's, Newtonian Interpolation	
	3.2	finite difference operators	
	3.3	Interpolating polynomials using finite differences,	
	3.4	Approximations, Least Square approximations	
4.0		Ordinary Differential Equation, Initial Value Problems:	**15**
	4.1	Difference Equations, Numerical methods,	
	4.2	Stability Analysis of single step Method,	
	4.3	Multistep Method, Stability Analysis of multistep Method,	
	4.4	Initial Value Problem Method , Finite difference Method , Finite Element Methods.	
		Total	**60**

Text Book

M.K. Jain, SRK Iyengar, R.K. Jain, "Numerical methods for Scientific and Engineering computations." New Age International Limited Pub.(Chap2: Art. 2.1 to 2.5, 2.8, 2.9 Chap3: Art 3.1, 3.2 3.4 3.5 3.6 Chap4 Art 4.1 to 4.4, 4.8, 4.9 Chap 6: Art 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.8.

Chap 7: Art 7.1, 7.2, 7.3, 7.4.)

Reference Books

1. **S.S. Sastry**, "Introductory methods of Numerical Analysis" Prentice-Hall of India Private Ltd. (Second Edition) 1997.
2. **E.V. Krishnamurthi& Sen.** "Numerical Algorithm," Affiliate East. West press. Private Limited 1986.
3.**John H. Mathews**, Numerical Methods for Mathematics, Science and Engineering, Pearson Education (US); 2nd Revised edition edition (30 January 1992)

SMATE451 (D): Algorithms and Their Analysis

Course objectives:

This course aims to introduce students to the design of algorithms as a means of problem solving and to analyze the efficiency of algorithms.

Course Outcomes:

After completing this course, the student will be able to:

- **CO1:** To learn basic concepts of algorithms.
- **CO2:**. Attain mastery to design various algorithms.
- **CO3:** To learn the complexity of algorithms.
- **CO4:** Design and compare different algorithms.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Introduction to algorithms**	**15**
	1.1	Assignment, Arithmetic, Relational, Logical Operators.	
	1.2	Truth tables; Input/Output Statements,	
	1.3	Conditional Statements; Iterative Statements.	
	1.4	Functions; Recursion.	
2.0		**Algorithms to be Discussed:**	**15**
	2.1	Min, Max, Average, Prime Numbers, Standard Deviation.	
	2.2	Linear and Binary Search(Iterative and Recursive)	
	2.3	Simple Sorts: Selection and Bubble.	
3.0		**Trees**	

	3.1	Worst-Case, Best-Case, Average-Time Requirements,Trees, Binary Trees.	**15**
	3.2	Recurrence Relations, Lower Bound of time Requirements.	
	3.3	Problems Merging Sorted Lists, NlogN Sorts: Merge Sort and Heap Sort.	
4.0		**Algorithms to be Discussed:**	**15**
	4.1	P, NP, NP-Completeness, NP-Hard.	
	4.2	Tower of Hanoi(Iterative and Recursive).	
	4.3	Matrix Multiplication: Iterative O (n^3) versus Strassen's Recursive Algorithm O (n^2.807).	
	4.4	A brief look at Coppersmith–Winograd Algorithm O(n^2.376).	
		Total	**60**

Reference Books:

(1) **S. Lipschutz**, ”Data Structures”, Schaum’s Outline series.

(2) **Dino Mandrioli, Carlo Ghezzi** “Theoretical Foundations of Computing Science”, Wiley, 1987

MATP451: Introduction to Scilab

Course objectives:

Scilab, an alternate to MATLAB, is a scientific software package providing a powerful open computing environment for engineering and scientific applications. In this course, different tool boxes like related to plotting, matrices, polynomials, system of equations, etc. will be discussed.

Course outcomes:

After completing this course, the student will be able to:

- **CO1:** Install Scilab and execute looping and branching commands.
- **CO2:** Able to understand the basic concepts of programming.
- **CO3:** Handle matrices and their operations in scilab; Plot and visualize 2D and 3D graphs of various functions.
- **CO4:** Understand the main features of the Scilab program development environment to enable it's usage in the higher learning. Interpret and visualize simple mathematical functions and operations by using plots.

Curriculum Details:

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Introduction to Scilab**	**5L+10P**
	1.1	Introduction to Scilab, Installation of Scilab,	
	1.2	Basic elements of the language, Looping and Branching:	
	1.3	If, select, for, break, continue, Functions, return,	
	1.4	Contour plots, tiles, axes, legends.	
2.0		**Linear Algebra using Scilab**	**5L+10P**
	2.1	Creating matrices, sum, product of matrices, inverse, rank determinant,	
	2.2	Comparing matrices, system of equations, High level linear algebra features, working with polynomials,	
	2.3	Matrix inversions, Solving system of equations.	
3.0		**Scilab Demonstrations:**	**5L+10P**
	3.1	Polynomials, discrete and continuous Random variables,	
	3.2	Basic functions, animation, Bezier curves and surfaces, matplot,	
	3.3	complex elementary functions. Scilab	
4.0		**Calculus Using Scilab**	

	4.1	Plotting 2D and 3D graphs, defining a function and output arguments.	**5L+10P**
	4.2	Parametric plots, Polar plots	
	4.3	Evaluation of definite integrals, Generating prime numbers	
	4.4	Illustration of Rolle's and Mean value theorems.	
		Total	**60**

Reference Books:

1. **Michael Baudin** , Introduction to scilab, , Scilab Consortium, digiteo, Nov 2010.
2. **Satish Annigeri** , An introduction to scilab, , free online version.
3. **Graeme Chandler**, Stephen Roberts , Introduction to Scilab, free online version, 2002.
4. **Gilberto E. Urroz** , Introduction to Scilab, distributed by infoclearinghouse.com

Guidelines for Course Assessment:

A. Continuous Assessment (CA) (20% of the Maximum Marks):

This will form 20% of the Maximum Marks and will be carried out throughout the semester. It may be done by conducting **Two Tests** (Test I on 40% curriculum) and **Test II** (remaining 40% syllabus). Average of the marks scored by a student in these two tests of the theory paper will make his **CA** score (col. 6).

B. End Semester Assessment (80% of the Maximum Marks):

(For illustration we have considered a paper of 04 credits, 100 marks and need to be modified depending upon credits of an individual paper)

1. **ESA Question paper will consists of 6 questions, each of 20 marks.**
2. **Students are required to solve a total of 4 Questions.**
3. **Question No.1 will be compulsory and shall be based on entire syllabus.**
4. Students need to solve **ANY THREE** of the remaining Five Questions (Q.2 to Q.6) and shall be based on entire syllabus.

Note: **Number of lectures required to cover syllabus of a course depends on the number of credits assigned to a particular course. One credit of theory corresponds to 15 Hours lecturing and for practical course one credit corresponds to 30 Hours. For example, for a course of two credits 30 lectures of one hour duration are assigned, while that for a three credit course 45 lectures.**