Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Structure and Curriculum of

Under Graduate Programme (II Year) of Science and Technology

B.Sc. in Mathematics

Approved by

Board of Studies

in

Mathematics

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

w.e.f. June, 2024

(In Accordance with NEP-2020)

Review Statement

The NEP Cell reviewed the Curriculum of **B.Sc-II. Mathematics in UG** Programme to be effective from the **Academic Year 2024-25.** It was found that, the structure is as per the NEP-2020 guidelines of Govt. of Maharashtra.

Date: 20/03/2024

Place: Latur

NEP Cell
Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)

CERTIFICATE

I hereby certify that the documents attached are the Bonafide copies of the Curriculum of **B.Sc.-II Mathematics** course to be effective from the **Academic Year 2024-25.**

Date: 13/03/2024

Place: Latur

Dr. M S Wavare
Chairperson
Board of Studies in Mathematics
Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)

Shiv Chhatrapati Shikshan Santha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Members of Board of Studies in the Subject Mathematics

Under the Faculty of Science and Technology

Sr. No.	Name	Designation	In position
1	**Dr. Mahesh S Wavare** Professor and Head, Department of Mathematics, Rajarshi Shahu Mahavidyalaya, Latur (Autonomous)	Chairperson	HoD
2	Dr. Bhalchandra D. Karande Head and Associate Professor, Department of Mathematics, Maharashtra Udaygiri Mahavidyalaya, Udaygiri Dist. Latur.	Member	V.C. Nominee
3	Dr. S. D. Kendre, Associate Professor, Department of Mathematics, Savitribai Phule Pune University, Pune.	Member	Academic Council Nominee
4	Dr. M. T. Gophane Associate Professor, Department of Mathematics Shivaji University, Kolhapur.	Member	Academic Council Nominee
5	Dr. N. S. Darkunde School of Mathematical Sciences, S. R. T. M. U Nanded.	Member	Expert from outside for Special Course
6	Mr. S. S. Ranmal Sungrace Computers Pvt Ltd, Pune.	Member	Expert from Industry
7	Prof. S. M. Shinde Department of Mathematics, Government College of Engineering, Amravati, Dist. Amaravati.	Member	P.G. Alumni
8	Dr. N. S. Pimple	Member	Faculty Member
9	Miss. S. D. Shinde	Member	Faculty Member
10	Mr. P. D. Bombalge	Member	Faculty Member
11	Mr. N. D. Kapale	Member	Faculty Member
12	Dr. A. A. Yadav	Member	Member from the same faculty

From the Desk of the Chairperson…

When Shiv Chhatrapati Shikshan Sanstha started the Science Faculty in Rajarshi Shahu Mahavidyalaya, Latur in 1971, the Department of Mathematics was founded. In the beginning, there was just one instructor for the PUC class and the first year of the B.Sc. B.Sc.-II and B.Sc. III year courses began in 1973 and 1974, respectively, in response to the natural expansion. During the 2017–2018 academic year, the department launched its M.Sc. Mathematics programme with a 30-student entry limit.

The undergraduate degree course in mathematics is a six- or eight-semester course spanned across three- or four-academic years, in accordance with the guidelines of the Undergraduate Curriculum Framework 2022 (UGCF 2022). The teaching and learning process is centered on the learner and includes both theoretical and practical elements. While guaranteeing that the student has a solid foundation in the topic and obtains in-depth knowledge, it provides flexibility in program structure. A student may choose courses from the syllabus that includes Discipline Specific Electives (DSEs), Generic Electives (GEs), Skill Enhancement Courses (SECs), Ability Enhancement Courses (AECs), and Value Addition Courses (VACs) in addition to the Discipline Specific Core (DSC) courses. As a result, the interdisciplinary approach and commitment to creative approaches within the curricular framework are highlighted.

The new National Education Policy (NEP), 2020, which includes significant elements, offers a platform to develop, nurture, grow, encourage, and multiply mathematical thinking. To achieve a balance between the requirement for employment in the twenty-first century and entrepreneurship, which is characterized by lateral, critical, and numerical thinking, the essential changes have been put in place. The NEP acknowledged the importance of mathematical thinking and how necessary it is for the country to become a Vishwa guru. The NEP provides children with the nutrition they require by making mathematics enjoyable and engaging from the very beginning. Because it encourages the development of computer skills and intuitive reasoning, the NEP also requires the adoption of a coding curriculum, which should start in middle school.

The courses for the UG Programme are framed using time tested and internationally popular text books so that the courses are at par with the courses offered by any other reputed universities around the world.

Only those concepts that can be introduced at the UG level are selected and instead of cramming the course with too many ideas the stress is given in doing the selected concepts rigorously. The idea is to make learning mathematics meaningful and an enjoyable activity rather than acquiring manipulative skills and reducing the whole thing an exercise in using thumb rules.

As learning Mathematics is doing Mathematics, to this end, some activities are prescribed to increase student's participation in learning. Duration of the degree Programme shall be six- or-eight semesters distributed in a period of three/four academic years.

Dr. Mahesh S Wavare
Chairperson
Board of Studies in Mathematics

Shiv Chhatrapati Shikshan Santha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Index

Sr. No.	Content	Page No.
1	Structure for Four Year Multidisciplinary UG Programme	1
2	Abbreviations	2
3	Courses and Credits	3
4	UG Program Outcomes	4
5	Programme Specific Outcomes	5
6	**Curriculum:**	6
6.1	**Major Courses**	7
	Semester-III	8
	a) DSC V : Real Analysis	9
	b) DSC VI : Group Theory	15
	c) DSM I : Applied Mathematics	20
	Semester-IV	24
	c) DSC-VII : Ordinary Differential Equations	25
	d) DSC-VIII : Ring Theory	31
	f) DSM II : Fundamentals of Statistics	36
6.2	**Open Elective Courses offered by the Department (Basket I Semester I & II**	40
	GE : Business Mathematics	41
6.3	**Skill Enhancement Courses offered by the Department (Basket II) Semester I&II**	43
	SEC: Introduction to R Programming	44
7	**Common Baskets**	
	Basket I: Generic/Open Elective (GE/OE)	46
	Basket II: Skill Enhancement Courses (SEC)	47
	Basket III: Ability Enhancement Courses (AEC)	48
8	**Extra Credit Activities**	49
9	**Examination Framework**	51

Shiv Chhatrapati Shikshan Santha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Faculty of Science and Technology

Structure for Four Year Multidisciplinary Undergraduate Degree Programme in Mathematics Multiple Entry and Exit (In accordance with NEP-2020)

Year & Level	Sem	Major		Minor	GE/OE	VSC/ SEC (VSEC)	AEC/ VEC	OJT,FP,CEP, RP	Credit per Sem.	Cum./ Cr. per exit
		DSC	DSE							
1	**2**	**3**		**4**	**5**	**6**	**7**	**8**	**9**	**10**
I 4.5	I	DSC V: 04 Cr. DSC VI: 04 Cr.	NA	DSM- I 04 Cr	GE-III: 02 Cr.	SEC-III: 02 Cr.	AEC-III: Eng 02 Cr.	CC-I: 02 Cr.(SSC) Field Project: 02 Cr.	22	44 Cr. UG Certificate
	II	DSC VII: 04 Cr. DSC VIII: 04 Cr.	NA	DSM-II 04 Cr	GE-IV: 02 Cr.	SEC-IV: 02 Cr.	AEC-IV Eng: 02 Cr.	CC-II: 02 Cr.(SSC) Field Project: 02 Cr.	22	
	Cum. Cr.	16	-	08	04	02+02= 04	02+02= 04	08	44	
Exit Option: Award of UG Certificate in Major with 44 Credits and Additional 04 Credits Core NSQF Course/Internship or continue with Major and Minor										

Abbreviations:

1.	DSC	: Discipline Specific Core (Major)
2.	DSE	: Discipline Specific Elective (Major)
3.	DSM	: Discipline Specific Minor
4.	GE/OE	: Generic/Open Elective
5.	VSEC	: Vocational Skill and Skill Enhancement Course
6.	VSC	: Vocational Skill Courses
7.	SEC	: Skill Enhancement Course
8.	AEC	: Ability Enhancement Course
9.	MIL	: Modern Indian Languages
10.	IKS	: Indian Knowledge System
11.	FSRCE	: Fostering Social Responsibility & Community Engagement
12.	VEC	: Value Education Courses
13.	OJT	: On Job Training
14.	FP	: Field Projects
15.	CEP	: Community Engagement and Service
16.	CC	: Co-Curricular Courses
17.	RP	: Research Project/Dissertation
18.	SES	: Shahu Extension Services

Shiv Chhatrapati Shikshan Santha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Mathematics

B.Sc. -II Mathematics(Major and Minor)

Year & Level	Semester	Course Code	Course Title	Credits	No. of Hrs.
II 5.0	III	201MAT3101 (DSC-V)	Real Analysis	03	45
		201MAT3103	Lab Course-V	01	30
		201MAT3102 (DSC-VI)	Group Theory	03	45
		201MAT3104	Lab Course-VI	01	30
		201MAT (DSM-I)	Applied Mathematics	03	45
		201MAT	Lab Course-I(Minor)	01	30
		GE-III	From Basket	02	30
		(SEC-III)	From Basket	02	30
		(AEC-III)	From Basket	02	30
		CC-I	SSC	02	30
		FP-I	Field Project-I	02	60
	Total Credits			**22**	
	IV	301MAT4101 (DSC-VII)	Ordinary Differential Equations	03	45
		301MAT4103	Lab Course-VII	01	30
		301MAT4102 (DSC-VIII)	Ring Theory	03	45
		301MAT4104	Lab Course-VIII	01	30
		201MAT (DSM-II)	Fundamentals of Statistics	03	45
		201MAT	Lab Course-II (Minor)	01	30
		GE-IV	From Basket	02	30
		(SEC-IV)	From Basket	02	30
		(AEC-IV)	From Basket	02	30
		CC-II	SSC	02	30
		FP-II	Field Project-II	02	30
	Total Credits			**22**	
Total Credits (Semester III & IV)				**44**	

Programme Outcomes (POs) for B.Sc. Programme	
PO 1	**Mathematical foundations:** Students will have a deep understanding of mathematical concepts, including algebra, analysis, geometry, and number theory.
PO 2	**Analytical and problem-solving skills:** Students will be able to apply mathematical techniques to analyze and solve problems in a logical and methodical way.
PO 3	**Computational skills:** Students will be proficient in using mathematical software and programming languages, such as MATLAB, Python, or R.
PO 4	**Critical thinking and problem-solving:** Students will be able to think critically and approach problems in a logical and analytical way.
PO 5	**Communication and presentation:** Students will be able to communicate complex mathematical ideas effectively, both orally and in writing.
PO 6	**Collaboration and teamwork:** Students will be able to work effectively in teams to solve mathematical problems and complete projects.
PO 7	**Lifelong learning:** Students will be committed to ongoing learning and professional development in mathematics.
PO 8	**Time management and organization:** Students will be able to manage their time effectively and prioritize tasks to meet deadlines.
PO 9	**Data science and analytics:** Students will be prepared for careers in data science and analytics, including roles in business, government, and healthcare.
PO 10	**Contribution to society:** Students will be prepared to make positive contributions to society, using their mathematical skills to solve real-world problems.

Programme Specific Outcomes (PSOs) for B.Sc. in Mathematics (Honors)	
PSO No.	Upon completion of this Programme the students will be able to
PSO 1	To Develop their mathematical knowledge, oral, written, and practical skills in a way to enhance confidence and provide satisfaction.
PSO 2	To inculcate the confidence by developing a feel for numbers, patterns, and relationships.
PSO 3	To advance an ability to consider, solve problems, present and interpret results.
PSO 4	To improve Communication and reason using mathematical concepts.
PSO 5	To understand mathematical principles and their applications.
PSO 6	To foster the abilities to reason logically, to classify, to generalize and to prove.
PSO 7	To acquire the foundation, appropriate to their further studies of mathematics and of other disciplines.
PSO 8	To qualify IIT-JAM a higher education entrance in the subject of Mathematics.
PSO 9	To do minor research project in the field of Mathematics.
PSO 10	To nurture the basic information of Indian Knowledge System.

Curriculum

Major and VSC Courses

Semester - III

Course Type: DSC-V
Course Title: Real Analysis
Course Code: 201MAT3101
Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO 1. Understand Definition of Sequence and its properties

LO 2. study Bolzano-Weierstrass theorem and Cauchy's criterion for convergence

LO 3. Define Sequence of functions and study convergence of sequence of functions

LO 4. Infinite Series convergence and Absolute Convergence

Course outcomes

After completion of course the student will be able to-

CO 1. Know the definition of the limit of a sequence, evaluate the limits of a wide class of real sequences

CO 2. Do point wise and Uniform convergence

CO 3. Decide on convergence or divergence of a wide class of series

CO 4. Determine whether or not real series are convergent by comparison with standard series or using the Ratio Test

CO 5. Understand the concept of Absolute convergence and be familiar with the statements and some proofs of the standard results about Absolute convergence

Unit No.	Title of Unit & Contents	Hrs.
I	**Sequences**	**10**
	1.Introduction: Sequences and their limits 2. Limit theorems and Monotone Sequences 3. Subsequences and Bolzano Weierstrass theorem 4. The Cauchy's criterion, Properly divergent sequences	
	Unit Outcome: UO 1. To acquire knowledge about convergent and divergent sequence..	
II	**Sequence of functions**	**12**
	1. Pointwise and uniform convergence 2. Interchange of limits 3.The exponential and Logarithmic functions, The trigonometric functions	
	Unit Outcomes: UO 1. To study some special type of function	

Unit No.	Title of Unit & Contents	Hrs.
	UO 2. To check uniform convergence and pointwise convergence	
III	**Infinite Series**	**13**
	1. Introduction to series, infinite series, its convergence and sum 2. Cauchy general principle of convergence for series 3.General test for the convergence of positive term series 4.Comparison tests convergence of positive term series 5.D'alembert's ratio test, Cauchy nth root test , Raabe's test , Logarithmic test ,Cauchy Integral test , Cauchy condensation test, Abel's test	
	Unit Outcomes: UO 1. To study series of function. UO 2. To check convergent series and divergent series	
IV	**Infinite Series with positive and negative terms**	**10**
	1.Absolute convergence Test for Absolute convergence, Test for Non- absolute convergence 2.Conditional Convergence 3.Alternating series, Leibnitz's Theorem 4. Radius of Convergence	
	Unit Outcomes: 1.To calculate the radius of convergence	

Learning Resources:

1. Robert G.Bartle & Donald R Sherbert , "Introduction to real Analysis" (Third Edition) (Wiley Student Edition)
2. George B. Thomas, Ross L. Finney, "Calculus and Analytical Geometry" (Sixth Edition) (Narosa Publishing House)
3. Robert Wrede & Murray R, "Advanced Calculus" (Third Edition) Spiegel
4. S.C.Malik & Savita Arora, "Mathematical Analysis" New age International Ltd.
5. Shanti Narayan M. D. Raisinghaniya ,"Elements of Real Analysis", (S.Chand & Comp. Ltd.)
6. S.K.Mapa ,"Introduction to real Analysis" (Sixth Edition)
7. Richard Goldberg , " Methods of Real Analysis", John Wiley & Sons, Inc. New york

Course Type: DSC-V
Course Title: Lab Course – V (Based on DSC-V)
Course Code: 201MAT3103
Credits: 01 **Max. Marks: 50** **Hours: 30**

Learning Objectives

LO 1. Understand Definition of Sequence and its properties

LO 2. study Bolzano-Weierstrass theorem and Cauchy's criterion for convergence

LO 3. Define Sequence of functions and study convergence of sequence of functions

LO 4. Infinite Series convergence and Absolute Convergence

Course outcomes

After completion of course the student will be able to-

CO 1. Know the definition of the limit of a sequence, evaluate the limits of a wide class of real sequences;

CO 2. Do point wise and Uniform convergence

CO 3. Decide on convergence or divergence of a wide class of series;

CO 4. Determine whether or not real series are convergent by comparison with standard series or using the Ratio Test;

CO 5. Understand the concept of Absolute convergence and be familiar with the statements and some proofs of the standard results about Absolute convergence

Practical No.	Unit
1	Using the definition of the limit of a sequence to establish the following limits. a) $\lim\left(\frac{n}{n^2+1}\right)=0$ c) $\lim\left(\frac{2n}{n+1}\right)=2$ b) $\lim\left(\frac{3n+1}{2n+5}\right)=\frac{3}{2}$ d) $\lim\left(\frac{n^2-1}{2n^2+3}\right)=\frac{1}{2}$
2	Show that:

	a) $\lim\left(\frac{1}{\sqrt{n+7}}\right)=0$ b) $\lim\left(\frac{\sqrt{n}}{n+1}\right)=0$ c) $\lim\left(\frac{2n}{n+2}\right)=2$
3	Show that : a) $\lim\left(\frac{1}{n}-\frac{1}{n+1}\right)=0$ b) $\lim\left(\frac{1}{3^n}\right)=0$ c) $\lim\left((2n)^{1/n}\right)=1$
4	Show that if X and Y are sequences such that X and X+Y are convergent, then prove that Y is convergent.
5	If 0<a<b, determine $\lim\left(\frac{a^{n+1}+b^{n+1}}{a^n+b^n}\right)$
6	If a>0,b>0 show that $\lim\left(\sqrt{(n+a)(n+b)}-n\right)=(a+b)/2$
7	Let $x_1=8 \text{ and } x_{n+1}=\frac{1}{2}x_n+2 \text{ for } n\in N$ .Show that (x_n) is bounded and monotone. Find the limit.
8	Let $x_1=1 \text{ and } x_{n+1}=\sqrt{2+x_n} \text{ for } n\in N$ .Show that (x_n) converges and find the limit.
9	Investigate the convergence or divergence of the following sequences: a) $\sqrt{n^2+2}$ b) $\left(\sqrt{n}/(n^2+1)\right)$

	c) $\left(\sqrt{n^2+1}/\sqrt{n}\right)$ d) $\left(\sin\sqrt{n}\right)$.
10	Show that $\lim\left(\frac{x}{x+n}\right)=0,\ for\ all\ x\ in\ R,\ x\geq 0.$
11	Show that $\lim\left(\frac{nx}{1+nx}\right)=0,\ for\ all\ x\ in\ R,\ x\geq 0.$
12	Let $f:\Re\to\Re$ be uniformly continuous on $\Re$ and let $f_n(x)=f(x+1/n)\ for\ x\in\Re$ .Show that (f_n) converges uniformly on $\Re$ to f .
13	The exponential function satisfies the following properties: i) $E(x)\neq 0\ for\ all\ x\in R$ ii) $E(x+y)=E(x)E(y)\ \ for\ all\ x,y\in R;$ iii) $E(r)=e^r\quad for\ \ all\ r\in Q$
14	Calculate cos(.2),sin(.2) and cos 1,sin 1 correct to four decimal places.
15	Show that $\lvert\sin x\rvert\leq 1 and \lvert\cos x\rvert\leq 1\ for\ all\ \ x\in R$.
16	Show that if $0\leq x\leq a\ and\ n\in N$, then $1+\frac{x}{1!}+\ldots+\frac{x^n}{n!}\leq e^x\leq 1+\frac{x}{1!}+\ldots+\frac{x^{n-1}}{(n-1)!}+\frac{e^a x^n}{n!}$
17	Does the series $\sum_{n=1}^{\infty}\left(\frac{\sqrt{n+1}-\sqrt{n}}{\sqrt{n}}\right) convegre?$
18	Does the series $\sum_{n=1}^{\infty}\left(\frac{\sqrt{n+1}-\sqrt{n}}{n}\right) convegre?$
19	Show that the series $\frac{1}{1^2}+\frac{1}{2^3}+\frac{1}{3^2}+\frac{1}{4^3}+\ldots$ is convergent, but both the ratio and the Root Tests fail to apply

20	If a and b are positive numbers, then $\sum(an+b)^{-p}$ *converges if* $p>1$ and diverges if $p\le 1$.
21	Show that the series $1+\frac{1}{2}-\frac{1}{3}+\frac{1}{4}+\frac{1}{5}-\frac{1}{6}++-\ldots$ is divergent
22	Test the following series for convergence and for absolute convergence. i) $\sum_{n=1}^{\infty}\frac{(-1)^{n+1}}{n^2+1}$ ii) $\sum_{n=1}^{\infty}\frac{(-1)^{n+1}}{n+1}$ iii) $\sum_{n=1}^{\infty}\frac{(-1)^{n+1}n}{n+2}$
23	Discuss the series whose nth term is: i) $(-1)^n\frac{(n)^n}{(n+1)^{n+1}}$ ii) $\frac{(n)^n}{(n+1)^{n+1}}$
24	Determine the radius of convergence of the series $\sum a_n x^n$,where a_n is given by : i) $1/n^n$ ii) $\frac{n^\alpha}{n!}$

Learning Resources:

1. Robert G.Bartle & Donald R Sherbert , "Introduction to real Analysis" (Third Edition) (Wiley Student Edition)
2. George B. Thomas, Ross L. Finney, "Calculus and Analytical Geometry" (Sixth Edition) (Narosa Publishing House)
3. Robert Wrede & Murray R, "Advanced Calculus" (Third Edition) Spiegel
4. S.C.Malik & Savita Arora, "Mathematical Analysis" New age International Ltd.
5. Shanti Narayan M. D. Raisinghaniya ,"Elements of Real Analysis", (S.Chand & Comp. Ltd.)
6. S.K.Mapa ,"Introduction to real Analysis" (Sixth Edition)
7. Richard Goldberg , " Methods of Real Analysis", John Wiley & Sons, Inc. New york

Course Type: DSC-VI
Course Title: Group Theory
Course Code: 201MAT3102
Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO 1. Understand the definition of Group and be able to provide examples of groups.

LO 2. Define Subgroups, Normal Subgroup, Quotient Group, Homomorphism, Isomorphism.

LO 3. Application of Cayley and Lagrange theorem

LO 4. Discuss about external direct product and normal subgroup

Course Outcomes:

After completion of course the student will be able to-

CO 1. Categorize group structures

CO 2. Find quotient group, subgroups of a given group.

CO 3. Analyze group structure from its order.

CO 4. Study isomorphic group and compute new group of order n.

Unit No.	Title of Unit & Contents	Hrs.
I	**Groups and Subgroup**	**11**
	1. Definition of group, subgroups. 2. Elementary properties of groups, finite groups. 3. Cyclic groups and its properties.	
	Unit Outcomes: UO 1. Acquaint with the basic concepts of group and its examples. UO 2. Able to find structures of different groups.	
II	**Permutation groups and Isomorphism**	**11**
	1. Symmetric groups, Permutations 2. Group isomorphism 3. Automorphism and their properties, Cayley's theorem	
	Unit Outcome: UO 1. Can relate isomorphism of groups.	
III	**Coset and Lagrange's theorem**	**11**
	1. Definition of coset and properties **2.** Lagrange's theorem and its consequences **3.** An application of cosets to permutation groups.	

Unit No.	Title of Unit & Contents	Hrs.
	Unit Outcomes: UO 1. Can find different cosets of a group.	
IV	**Direct Product**	**12**
	1. External direct product 2. Definition and examples of normal subgroups and factor groups.	
	Unit Outcomes: UO 1. One can Apply external direct product to obtain new groups.	

Learning Resources:

1. Joseph A. Gallian, "Contemporary Abstract Algebra", (Fourth Ed.), Narosa Publication, 1999.
2. J.B. Fraleigh, "A first Course in Abstract Algebra", Narosa Publication.
3. I. N. Herstein, "Topics in Algebra", Second Edition.
4. V.K. Khanna, S.K. Bhambri, "A Course in Abstract Algebra", Vikas Publishing House. (Second Edition)
5. David Dummit and Richard Foote, "Abstract Algebra", John Wiley and Sons
6. P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul, "Basic Abstract Algebra", (Second Ed.), Cambridge Univ. Press (Indian Ed.1995)

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Department of Mathematics

Course Type: DSC-VI
Course Title: Lab Course –VI (Based on DSC-VI)
Course Code: 201MAT3104
Credits: 01 **Max. Marks: 50** **Hours: 30**

Learning Objectives:

LO 1. Understand the definition of Group and be able to provide examples of groups.

LO 2. Define Subgroups, Normal Subgroup, Quotient Group, Homomorphism, Isomorphism.

LO 3. Application of Cayley and Lagrange theorem

LO 4. Discuss about external direct product and normal subgroup

Course Outcomes:

After completion of course the student will be able to-

CO 1. Categorize group structures

CO 2. Find quotient group, subgroups of a given group.

CO 3. Analyze group structure from its order.

CO 4. Study isomorphic group and compute new group of order n.

Practical No.	Practical
1	Prove that the set GL(2,R) = $\left\{\frac{[a\ b\ c\ d\ ]}{a,b,c,d\in R\ ,ad-bc\neq 0}\right\}$ of 2×2 matices with real entries and non-zero determinant is non abelian group under the operation of matrix multiplication?
2	Show that the set {5,15,25,35} is a group under multiplication modulo 40. What is identity of this group? Can you see any relation between?
3	Find the inverse of the element$[2\ 6\ 3\ 5\ ]$ in GL(2, $\mathbb{Z}_{11}$)
4	Prove that a group G is abelian if and only if $(ab)^{-1}=a^{-1}b^{-1}$ for all a,b in G
5	Construct Cayley table for U(12)
6	Find all subgroups of D_3 and find how many subgroups of order does D_3?
7	In the group $\mathbb{Z}$ find i. <{8,4}>

	ii. <{8,15}> ii. <{6,15}> v. <{m,,n}> v. <{12,18,45}>
8	Let R^* be the group of nonzero real numbers under multiplication and let H=$\left\{\frac{x \in R^*}{x^2 \text{ is rational}}\right\}$ prove that H is subgroup of R^*. Can the exponent 2 be replaced by any positive integer and still have H be a group?
9	Find all generators of $\mathbb{Z}_6$, $\mathbb{Z}_8$, $\mathbb{Z}_{30}$.
10	Determine the number of cyclic groups of order 4 in D_n
11	How many elements of order 5 are their in A_6
12	Determine all possible order of elements of S_7.
13	Show that number of cyclic group of order n upto isomorphism is 1. Hence find number of groups of order p upto isomorphism for any prime p.
14	Let G be a group. Prove that the mapping $a(g)=g^{-1}$ $\forall$ $g \epsilon G$ is automorphism iff G is abelian.
15	Show that $\mathbb{Z}$ has infinitely many subgroup isomorphic to $\mathbb{Z}$
16	Show that the mapping from U(16) to itself given by $x \rightarrow x^3$ is an automorphism. What about $x \rightarrow x^5$ and $x \rightarrow x^7$? Generalixe
17	Discuss the group of symmetries of an equilateral triangle
18	Discuss the group of symmetries of a square
19	Comment on converse of Lagrange's Theorem.
20	Show that order of proper subgroup of a group of order 75 can be at most 75
21	Let $\|G\| = 15$. If G has only one subgroup of order 3 and only one subgroup of order 5 then prove that G is cyclic group. Generalize to $\|G\| = pq$. Where p and q are prime
22	Find the number of elements of order 5 in $\mathbb{Z}_{25} \oplus \mathbb{Z}_5$.
23	Prove or disprove that

	a. $\mathbb{Z} \oplus \mathbb{Z}$ is cyclic b. $\mathbb{Z}_2 \oplus \mathbb{Z}_3$ is cyclic c. $\mathbb{Z}_4 \oplus \mathbb{Z}_6$ is cyclic
24	Prove that every subgroup H of a Group G such that $[G:H] = 2$ is normal. hence $\frac{G}{H}$.

Learning Resources:

1. Joseph A. Gallian, "Contemporary Abstract Algebra", (Fourth Ed.), Narosa Publication, 1999.
2. J.B. Fraleigh, "A first Course in Abstract Algebra", Narosa Publication.
3. I. N. Herstein, "Topics in Algebra", Second Edition.
4. V.K. Khanna, S.K. Bhambri, "A Course in Abstract Algebra", Vikas Publishing House. (Second Edition)
5. David Dummit and Richard Foote, "Abstract Algebra", John Wiley and Sons
6. P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul, "Basic Abstract Algebra", (Second Ed.), Cambridge Univ. Press (Indian Ed.1995)

Shiv Chhatrapati Shikshan Santha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Mathematics

Course Type: DSM-I
Course Title: Applied Mathematics
Course Code:
Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO 1. Study set theory and Functions

LO 2. Understand basic trigonometry

LO 3. Learn basics of calculus

LO 4. Familiarize with derivative and integration

Course Outcomes:

After completion of course the student will be able to-

CO 1. Solve real-life problems requiring interpretation and comparison of complex numeric summaries which extend beyond simple measures of center.

CO 2. Solve a system of equations containing one first-degree polynomial and one second-degree Polynomial

CO 3. Apply various concepts of right triangle trigonometry

CO 4. Relate the tangent and area problems to differential and integral calculus.

Unit No.	Title of Unit & Contents	Hrs.
I	**Elementary Algebra**	**12**
	1. Sets; Relations and Functions 2. Mathematical Induction; Logarithms 3. Complex numbers 4. Linear and Quadratic equations	
	Unit Outcome: UO 1 To solve problems using logarithm tool UO 2. To know various types of methods to solve linear and quadratic equations.	
II	**Trigonometry and Geometry**	**12**
	1. Trigonometry 2. Cartesian System of Rectangular Coordinates 3. Straight lines and Family 4. Three Dimensional Geometry	
	Unit Outcome:	

Unit No.	Title of Unit & Contents	Hrs.
	UO 1. To understand basic trigonometric functions. UO 2. To familiarize with the three dimensional geometry	
III	**Elementary Calculus**	**08**
	1. Sequences and Series 2. Matrices and Determinants 3. Boolean Algebra 4. Limits and Continuity	
	Unit Outcome: UO 1. To find inverse of matrices UO 2. To understand the concept of Limit and continuity	
IV	**Derivative and Integration**	**13**
	1. Differentiation; Ordinary Differential Equations Application of Derivatives 2. Integration as inverse process of differentiation 3. Definite and indefinite integrals 4. Methods of Integration 5. Integration by parts.	
	Unit Outcome: UO 1. To study derivative and integration formulae	

Learning Resources:

1. S. K. Goyal, "Objective Mathematics", Arihant Prakashan, Meerut
2. V. Venkateshwara Rao, N. Krishnamurthy, B.V.S.S. Sarma, "Intermediate Mathematics", Vol-I, S. Chand &Company, New Delhi.
3. Dorai Raj, " Business Mathematics", Sahitya Bhawan, Agra.
4. S. Saha, "Basic Business Mathematics and Statistics", New Central Book Agency(P), Ltd, Calcutta.

Course Type: DSM-I
Course Title: Lab Course –I (Based on DSM-I)
Course Code:
Credits: 01 **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning Objectives:

LO 1. Study set theory and Functions
LO 2. Understand basic trigonometry
LO 3. Learn basics of calculus
LO 4. Familiarize with derivative and integration

Course Outcomes:

After completion of course the student will be able to-

CO 1. Solve real-life problems requiring interpretation and comparison of complex numeric summaries which extend beyond simple measures of center.
CO 2. Solve a system of equations containing one first-degree polynomial and one second-degree Polynomial
CO 3. Apply various concepts of right triangle trigonometry
CO 4. Relate the tangent and area problems to differential and integral calculus

Practical No.	Practical's
1	Problems on Sets; Relations and Functions
2	Problems on Mathematical Induction
3	Problems on Logarithms
4	Problems on Complex numbers
5	Problems on Linear and Quadratic equations
6	Problems on Trigonometry
7	Problems on Cartesian System of Rectangular Coordinates
8	Problems on Straight lines and Family
9	Problems on Three Dimensional Geometry
10	Problems on Sequences and Series
11	Problems on Matrices and Determinants
12	Problems on Boolean Algebra
13	Problems on Limits and Continuity
14	Problems on Differentiation

15	Problems on Ordinary Differential Equations
16	Problems on Application of Derivatives
17	Problems on Integration as inverse process of differentiation
18	Problems on Definite and indefinite integrals
19	Problems on Methods of Integration
20	Problems on Integration by parts

Learning Resources:

1. S. K. Goyal, "Objective Mathematics", Arihant Prakashan, Meerut
2. V. Venkateshwara Rao, N. Krishnamurthy, B.V.S.S. Sarma, "Intermediate Mathematics", Vol-I, S. Chand &Company, New Delhi.
3. Dorai Raj, " Business Mathematics", Sahitya Bhawan, Agra.
4. S. Saha, "Basic Business Mathematics and Statistics", New Central Book Agency(P), Ltd, Calcutta.

Semester - IV

Course Type: DSC-VII
Course Title: Ordinary Differential Equation
Course Code: 201MAT4101
Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO 1. Learn to solve ODEs.
LO 2. Learn to solve first-order linear ODEs using various methods (separation of variables, integrating factor, etc.).
LO 3. Learn to solve systems of first-order linear ODEs
LO 4. Learn to solve a second-order differential equation with constant coefficients and variable coefficients.

Course Outcomes:

After completion of course the student will be able to-

CO 1. Obtain general solutions to first-order, second-order, and higher-order homogeneous and non-homogeneous differential equations by manual and technology-based methods.
CO 2. Identify and apply initial and boundary values to find particular solutions to first-order, second-order, and higher order homogeneous and non-homogeneous differential equations by manual and technology-based methods, and analyze and interpret the results.
CO 3. Select and apply appropriate methods to solve differential equations; these methods will include, but are not limited to, undetermined coefficients, variation of parameters.
CO 4. Solve ordinary differential equation more than two variable.

Unit No.	Title of Unit & Contents	Hrs.
I	**Definitions and Formation of Differential Equation**	**06**
	1. Preliminaries: Ordinary and partial differential equations order and degree. 2. Solutions and constants of integration. 3. The derivation of differential equation. Solutions, general, particular, singular. 4. Geometrical meaning of differential equation of the first order and degree.	
	Unit Outcomes: UO 1. Identify the order and degree of a differential equation.	

Unit No.	Title of Unit & Contents	Hrs.
	UO 2. Differentiate between general, particular, singular. solutions of differential equations.	
II	**Equations of the First order and of the First Degree**	**12**
	1. Equation of the form $f_1(x)dx+f_2(y)dy=0$. 2. Equations homogeneous in x and y. 3. Non-homogeneous equation of the first degree in x and y. 4. Exact differential equations: condition that an equation of the first order be exact. 5. Rules for finding the solution of an exact differential equation, integrating factors-rules for finding integrating factors-I, II, III, IV and V. 6. Linear equations, equations reducible to the linear form.	
	Unit Outcomes: UO 1. Develop critical thinking skills to analyze and choose appropriate methods for solving different types of first-order and first-degree equations. UO 2.Differentiate between linear and nonlinear equations.	
III	**Linear Differential equations with constant coefficient**	**12**
	1. Linear equations, The complementary function, the particular Integral, the complete integral. 2. The linear equation with constant coefficient and second member zero. Case of the auxiliary equation having equal roots, imaginary roots, the symbol D, theorem concerning D. 3. The linear equation with constant coefficient and second member is a function of x, the symbolic function $1/f(D)$, Method of finding the Particular integral. 4. Trajectories, determination of orthogonal trajectories in Cartesian and polar coordinates, working rule, self-orthogonal trajectories.	
	Unit Outcomes: UO 1. Define linear differential equations with variable coefficients. UO 2. Differentiate between linear and nonlinear differential equations.	
IV	**Linear Differential equations with variable coefficients**	**15**
	1. The Homogeneous linear equation. First method of solution 2. Second method of Solution: To find the a) complementary function, b) particular integral. 3. The symbolic functions $f(\theta)$ and $1/f(\theta)$, method for finding particular integral. 4. Integral corresponding to a term of form x^m in the second member, equations reducible to the homogeneous linear form.	

Unit No.	Title of Unit & Contents	Hrs.
	5. Equation of the second order, the complete solution in terms of a known integral, relation between the integrals, solution by inspection, by means of first two integrals, by variation of parameters. 6. Ordinary differential equation with more than two variables: Simultaneous linear differential equation and their solutions. Geometrical meaning, single differential equation that are integrable, method of finding the solution of the single integrable equation.	
	Unit Outcome: UO 1. To provide a comprehensive understanding of linear differential equations with variable coefficients	

Learning Resources:

1. Daniel A. Murray, "Introductory Course in Differential Equations", Universities Press
2. G. F. Simmons "Differential Equations with Applications and Historical Notes", Second Edition, Mc Graw Hill.
3. M.D. Raisinghania, "Ordinary and Partial Differential Equations", S Chand and Company Ltd
4. T M Karade, "Differential Equation", Sonu –Nilu Publication

Shiv Chhatrapati Shikshan Santha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Mathematics

Course Type: DSC-VII
Course Title: Lab Course – VII (Based on DSC-VII)
Course Code: 201MAT4103
Credits: 01 **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning Objectives:

LO 1. Learn to solve ODEs.

LO 2. Learn to solve first-order linear ODEs using various methods (separation of variables, integrating factor, etc.).

LO 3. Learn to solve systems of first-order linear ODEs

LO 4. Learn to solve a second-order differential equation with constant coefficients and variable coefficients.

Course Outcomes:

After completion of course the student will be able to-

CO 1. Obtain general solutions to first-order, second-order, and higher-order homogeneous and non-homogeneous differential equations by manual and technology-based methods.

CO 2. Identify and apply initial and boundary values to find particular solutions to first-order, second-order, and higher order homogeneous and non-homogeneous differential equations by manual and technology-based methods, and analyze and interpret the results.

CO 3. Select and apply appropriate methods to solve differential equations; these methods will include, but are not limited to, undetermined coefficients, variation of parameters.

CO 4. Solve ordinary differential equation more than two variable.

Practical No.	Unit
1	1. Derive the differential equation $(x-a)^2+(y-b)^2=r^3$
2	Find the differential equation of all circles which pass through the origin and whose centre are on x-axis.
3	Solve $3ex \tan y\, dx + (1-e^x) \sec^2 y\, dy=0$.
4	Solve $(4x+3x)\frac{dy}{dx} +y -2x=0$
5	Solve $(2ax+by+g)dx+(2cy+bx+e)dy=0$.
6	Solve $(x^2y+2xy^2)dx-(x^3-3x^2y)dy=0$.

Practical No.	Unit
7	Solve $\cos^2 x \frac{dy}{dx} + y = \tan x$.
8	Solve $\frac{dy}{dx} + \frac{2}{x} y = 3x^2 y^{3/4}$.
9	Solve $\frac{d^3y}{dx^3} - 3\frac{d^2y}{dx^2} + 4y = 0$
10	$\frac{d^3y}{dx^3} + 2\frac{d^2y}{dx^2} + \frac{dy}{dx} = e^{2x} + x^2 + x$.
11	Solve $\frac{d^2y}{dx^2} - \frac{dy}{dx} + 4y = e^x \cos x + \sin 2x$.
12	Find the orthogonal trajectories of the system of curves $r^n \sin n\theta = a^n$
13	Using method of variation of parameter solve i) $6y'' + 5y' - 6y = x$. ii) $y'' + y = 2\sec x \cdot \sin 2x$.
14	Solve $x^2\frac{d^2y}{dx^2} - x\frac{dy}{dx} + y = 2\log x$
15	**Solve** $x^2\frac{d^2y}{dx^2} + 2x\frac{dy}{dx} - 20y = (x+1)^2$.
16	Solve $(5+2x)^2 \frac{d^2y}{dx^2} - 6(5+2x)\frac{dy}{dx} + 8y = 0$
17	Show that the system of parabolas $y^2 = 4a(x+a)$ is self-orthogonal .
18	Solve $(2x-1)^3 \frac{d^3y}{dx^3} + (2x-1)\frac{dy}{dx} - 2y = 0$
19	Solve $x \frac{d^2y}{dx^2} + (1-x)\frac{dy}{dx} - y = e^x$
20	Solve $3x^2 \frac{d^2y}{dx^2} + (2x - 6x^2)\frac{dy}{dx} - 4y = 0$
21	i) solve $\frac{dx}{dt} - 7x + y = 0, \quad \frac{dy}{dt} - 2x - 5y = 0$ ii) Solve $\frac{dx}{x^2 - y^2 - z^2} = \frac{dy}{2xy} = \frac{dz}{2xz}$
22	i) Solve $(y+z)dz + dy + dz = 0$ ii) Solve $\frac{adx}{(b-c)xy} = \frac{bdy}{(c-a)zx} = \frac{cdz}{(a-b)xy}$
23	i) Solve $(y+z)dx + (2+x)dy + (x+y)dz = 0$ ii) solve $\frac{dx}{dt} + 4x + 3y = t, \quad \frac{dy}{dt} + 2x + 5y = e^t$

Practical No.	Unit
24	Verify that the function φ_1 satisfies the equation, and find a second independent solu $x^2y'' - 7xy' + 15y = 0, \varphi_1(x)=x^3$.

Learning Resources:

1. Daniel A. Murray, "Introductory Course in Differential Equations", Universities Press
2. G. F. Simmons "Differential Equations with Applications and Historical Notes", Second Edition, Mc Graw Hill.
3. M.D. Raisinghania, "Ordinary and Partial Differential Equations", S Chand and Company Ltd
4. T M Karade, "Differential Equation", Sonu –Nilu Publication

Shiv Chhatrapati Shikshan Santha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Mathematics

Course Type: DSC-VIII
Course Title: Ring Theory
Course Code: 201MAT4102
Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives

LO 1. Definition and some classes of Rings

LO 2. Ideals, Quotient ring.

LO 3. Euclidean rings and their properties.

LO 4. Polynomial Ring

LO 5. Reducibility and irreducibility of polynomial

Course outcomes

After completion of course the student will be able to-

CO 1. Analyze classes of rings

CO 2. Find quotient structure of quotient ring

CO 3. Learn Euclidean ring and examples.

CO 4. Evaluate reducibility and irreducibility of polynomials

Unit No.	Title of Unit & Contents	Hrs.
I	**Rings**	**10**
	Definition and examples of rings Some special classes of rings Subring and Characteristic of ring	
	Unit Outcome: UO1.Classify the various rings with terminology UO2.Identify Characteristic of Rings	
II	**Ideals and quotients rings**	**12**
	Ideals and quotients rings More ideals and quotients rings The field of quotients of an integral domains .	
	Unit Outcome: UO1. Get knowledge of ideals and quotient ring UO2. Find quotient structure of quotient ring .	
III	**Homomorphism**	**10**

Unit No.	Title of Unit & Contents	Hrs.
	Homomorphism of rings Isomorphism Fundamental theorem of homomorphism Kernels of Homomorphism	
	Unit Outcomes UO1. Get concept of homomorphism UO2. Find Kernel of homomorphism	
IV	**Euclidean ring and Polynomial ring**	**13**
	Euclidean rings A particular Euclidean ring (Ring of Gaussian Integers) Unique Factorization theorem Polynomial rings Polynomial oven the rational fields. Reducibility Test ,Irreducibility Test Eisenstein's Criteria	
	Unit Outcome: UO1. Learn Euclidean ring and examples . UO2. Learn Properties of polynomials UO3. Evaluate reducibility and irreducibility of polynomials.	

Learning Resources:

1. Topics in Algebra, I.N. Herstein, John Wiley and Sons (New York)
2. A first course in abstract algebra, by J.B. Fraleigh, Narosa Publications.
3. Contemparary Abstract Algebra, by Joseph Gallion,Narosa Publications.
4. Modern Algebra, by A.R. Vasishtha, Krishna Prakashan Media
5. Modern Algebra, by R.P. Rohtatgi, Dominant Publishers and Distributors, New Delhi.
6. Modern Algebra, By Goyal and Gupta, Pragato Prakashan Meerut
7. College Mathematics, by N.R. Jayaram and R.V. Prabhakara, Himalaya Publishing House.
8. Elements of Logic and Modern Algebra, by M.V. Bhat and M.L. Bhave, S. Chand and Company Ltd. Ramnagar, New Delhi 110055
9. Lectures on Abstract Agebra By T M Karade J N Salunke ,K S Adhav, Maya Bendre, SonuNilu Publication

Shiv Chhatrapati Shikshan Santha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Mathematics

Course Type: DSC-VIII
Course Title: Lab-Course –VIII (Based on DSC-VIII)
Course Code: 201MAT4104
Credits: 01 **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning Objectives

LO 1. Definition and some classes of Rings

LO 2. Ideals, Quotient ring.

LO 3. Euclidean rings and their properties.

LO 4. Polynomial Ring

LO 5. Reducibility and irreducibility of polynomial

Course outcomes

After completion of course the student will be able to-

CO1. Analyze classes of rings

CO2. Find quotient structure of quotient ring

CO3. Learn Euclidean ring and examples.

CO4. Evaluate reducibility and irreducibility of polynomials

Practical No.	Unit
1	Prove that if R is Ring and $a, b \in R$, then $(a+b)^2 = a^2 + ab + ba + b^2$, where by x^2 we mean xx
2	If every if$x \in R$, satisfies x^2=x, prove that R must be commutative (A ring in which x^2 = x for all elements is called a Boolean Ring.)
3	If D is an integral domain and D is of finite Characteristics, prove that the characteristics of D is a prime number.
4	If D is an integral Domain and if na=0 for some $a \neq 0$ in D and some integer $n \neq 0$, prove that D is of finite characteristics
5	If R is system satisfying all the conditions for a ring with unit element with the possible exception of $a + b = b + a$, prove that the axiom $a + b = b + a$ must hold in R is thus a Ring.
6	Show that the commutative ring D is an integral domain iff for $a, b, c, \in Da \neq 0$ the relation $ab = ac$ implies that $b = c$.
7	If U is an ideal of R and $1 \in U$, prove that U=R.

Practical No.	Unit
8	If F is a field, prove that's its only ideal is (0) and f itself
9	If R is Commutative ring and $a, \epsilon R$, a. Show that $aR = \{ar \mid r \in R\}$ is a two sided ideal of R b. Show by an example that this may be false if R is not Commutative
10	If U, V are ideals of R, let $U + V = \{u + v \mid u \in U, v \in V\}$. Prove that $U + V$ is also an ideal.
11	If U is an ideal of R, let $r(U) = \{x \in R \mid xu = 0 \; for \; all \; u \in U\}$ prove that r(U) is an ideal of R.
12	Let R be a Ring with unit element, R not necessarily commutative, such that the only right- ideals of R are (0) and R. prove that R is a Division Ring.
13	Let J be a ring of integers, p a prime number, and (p) the ideal of J consisting of all multiples of p. prove a. J|(p) is isomorphic to J_p, the ring of integer modulo p b. J_p is an field.
14	Let R be the ring of all real-valued continuous functions on the closed unit interval. If M is a Maximal ideal of R, prove that there exists a real number γ, $0 \leq \gamma \leq 1$, such that $M = M_\gamma = \{f(x) \in R \mid f(\gamma) = 0\}$.
15	Let $J(\sqrt{2})$ be all real number of the form $m + n\sqrt{2}$, where m, n are integers; Prove that $J(\sqrt{2})$ forms a ring under the usual addition and multiplication of real numbers. Define $\emptyset: J(\sqrt{2}) \to J(\sqrt{2})$ by $\emptyset(m + n\sqrt{2}) = m - n\sqrt{2}$.Verify that $\emptyset$ is Homomorphism of $J(\sqrt{2})$onto $J(\sqrt{2})$and its kernel $I(\emptyset)$, consists only of 0.
16	Prove that the mapping $\emptyset: D \to F$ defined by $\emptyset(a) = [a, 1]$ is an isomorphism of D into F.
17	Find all the units in $J[i]$,F[X]
18	If $a + bi$ is not a unit of $J[i]$ prove that $a^2 + b^2 > 1$.
19	Find the Greatest common divisor of the following polynomials over F, the field of rational numbers: a. $x^3 - 6x^2 + x + 4$ and $x^5 - 6x + 1$

Practical No.	Unit
	b. x^2+1 and x^6+x^3+x+1
20	Prove that: a. x^2+x+1 is irreducible over F, the field of integers mod 2. b. x^2+1 is irreducible over F, the integers mod 7. c. x^3-9 is irreducible over F, the integers mod 91. d. x^3-9 is irreducible over the integers mod 11.
21	Prove that x^2+1 is irreducible over the field F of integers mod 11 and prove directly that $F[x]/(x^2+1)$ is a field having 121 elements.
22	Let F be the field of real numbers. Prove that $F[x]/(x^2+1)$ is a field isomorphic to the field of complex numbers.
23	If p is prime number, prove that the polynomial x^n-p is irreducible over the rationals.
24	If a is rational and $x-a$ divides an integers monic polynomial, prove that the a must be an integer.

Learning Resources:

1. Topics in Algebra, I.N. Herstein, John Wiley and Sons (New York)
2. A first course in abstract algebra, by J.B. Fraleigh, Narosa Publications.
3. Contemparary Abstract Algebra, by Joseph Gallion,Narosa Publications.
4. Modern Algebra, by A.R. Vasishtha, Krishna Prakashan Media
5. Modern Algebra, by R.P. Rohtatgi, Dominant Publishers and Distributors, New Delhi.
6. Modern Algebra, By Goyal and Gupta, Pragato Prakashan Meerut
7. College Mathematics, by N.R. Jayaram and R.V. Prabhakara, Himalaya Publishing House.
8. Elements of Logic and Modern Algebra, by M.V. Bhat and M.L. Bhave, S. Chand and Company Ltd. Ramnagar, New Delhi 110055
9. Lectures on Abstract Algebra by T M Karade J N Salunke, K S Adhav, Maya Bendre, SonuNilu Publication

Course Type: DSM-II
Course Title: Fundamentals of Statistics
Course Code:
Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO 1. Identify the various approaches to inferential statistics and their strengths and weaknesses

LO 2. Display data graphically and interpret graphs: stem plots, histograms, and box plots

LO 3. Recognize, describe, and calculate the measures of the spread of data: variance, standard deviation, and range

LO 4. Understand and use the terminology of probability

Course Outcomes:

After completion of course the student will be able to-

CO 1. Create and interpret frequency tables

CO 2. Calculate the measures of the center of data: mean, median, and mode

CO 3. Calculate the measures of location of data: quartiles and percentiles

CO 4. Calculate probabilities using the Addition Rules and Multiplication Rules

Unit No.	Title of Unit & Contents	Hrs.
I	**Frequency Distribution**	**10**
	1. Frequency Distribution, Continuous Frequency Distribution, Graphic Representation of a Frequency Distribution 2. Histogram 3. Frequency Polygon	
	Unit Outcome: UO 1 To understand frequency distribution and its types UO 2. To draw Histogram and frequency polygon	
II	**Measures of Central Tendency**	**12**
	1. Arithmetic Mean, Properties of Arithmetic Mean, Geometric Mean, Harmonic Mean 2. Weighted Mean 3. Median 4. Mode	

Unit No.	Title of Unit & Contents	Hrs.
	Unit Outcome: UO 1. Calculate Mean, Median and Mode for the grouped and ungrouped data	
III	**Measures of Dispersion**	**13**
	1. Measures of dispersion –range, quartile deviation 2. Mean Deviation for grouped and ungrouped data 3. Variance and Standard Deviation 4. Analysis of Frequency Distribution	
	Unit Outcome: UO 1. Calculate range,QD,MD,SD for the frequency distribution	
IV	**Probability**	**10**
	1. Random Experiments; Event 2. Axiomatic Approach to Probability 3. Conditional Probability and its properties 4. Multiplication Theorem on Probability; Independent Events; Bayes' Theorem	
	Unit Outcome: UO 1. Understand Sample space, Events, probability of a random experiment.	

Learning Resources:

1. S.C. Gupta and V.K. Kapoor, "Fundamentals of Mathematical Statistics (A Modern Approach), Tenth Revised Edition, Sultan Chand & Sons Educational Publishers New Delhi.
2. S. Saha, "Basic Business Mathematics and Statistics", New Central Book Agency, (P), Ltd, Calcutta.

Course Type: DSM-II
Course Title: Lab-Course II (Based on DSM-II)
Course Code:
Credits: 01 **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning Objectives:

LO 1. Identify the various approaches to inferential statistics and their strengths and weaknesses
LO 2. Display data graphically and interpret graphs: stem plots, histograms, and box plots
LO 3. Recognize, describe, and calculate the measures of the spread of data: variance, standard deviation, and range
LO 4. Understand and use the terminology of probability

Course Outcomes:

After completion of course the student will be able to-

CO 1. Create and interpret frequency tables
CO 2. Calculate the measures of the center of data: mean, median, and mode
CO 3. Calculate the measures of location of data: quartiles and percentiles
CO 4. Calculate probabilities using the Addition Rules and Multiplication Rules

Practical No.	Practical's
1	Problems on frequency distribution
2	Problems on continuous frequency distribution
3	Problems on graphic representation of a frequency distribution
4	Problems on Histogram
5	Problems on Frequency Polygon
6	Problems on Arithmetic Mean
7	Problems on Properties of Arithmetic Mean
8	Problems on Geometric Mean
9	Problems on Harmonic Mean
10	Problems on Weighted Mean
11	Problems on Median
12	Problems on Mode

Practical No.	Practical's
13	Problems on Measures of dispersion –range, quartile deviation
14	Problems on mean deviation for grouped and ungrouped data
15	Problems on variance and standard deviation
16	Problems on frequency distribution
17	Problems on Random Experiments and event
18	Problems on probability
19	Problems on conditional Probability
20	Problems on Independent events; Bayes' theorem

Learning Resources:

1. S.C. Gupta and V.K. Kapoor, "Fundamentals of Mathematical Statistics (A Modern Approach), Tenth Revised Edition, Sultan Chand & Sons Educational Publishers New Delhi.
2. S. Saha, "Basic Business Mathematics and Statistics", New Central Book Agency, (P), Ltd, Calcutta.

Open Elective Courses Offered by the Department

Course Type: GE-IV
Course Title: Business Mathematics
Course Code:
Credits: 02 **Max. Marks: 50** **Hours: 30**

Learning Objectives:

LO 1. Familiarize with the basic concepts of Business Mathematics and a hands on practice of the various mathematical tools and techniques

LO 2. Boost quantitative thinking and develop numerical abilities

LO 3. Acquainting students with the emerging issues in business, trade and commerce regarding analyzing business facts

Course Outcomes:

After completion of the course, students will be able to-

CO 1. Assess the applicability of matrices as mathematical tools in representing a system of equations.

CO 2. Apply differential calculus to solve simple business problems.

CO 3. Evaluate business problems involving complex linear relationships between decision variables and their determining factors.

CO 4. Explain mathematical formulation and solution of problems related to finance including different methods of interest calculation, future and present value of money.

Unit No.	Title of Unit & Contents	Hrs.
I	**Matrices and Determinants**	**07**
	1. Overview of Matrices. 2. Solution of a system of linear equations (having a unique solution and involving not more than three variables) using matrix inversion method 3. Cramer's Rule	
	Unit Outcome: UO 1: Find inverse of Matrix UO 2. Solve system of linear equations	
II	**Calculus-I**	**08**
	1. Concepts and rules of differentiation 2. Concept of Marginal Analysis: Marginal Revenue, Marginal Cost 3. Concept of Elasticity of demand and supply 4. Application of Maxima and Minima problems 5. Revenue, Cost, Profit, Economic Order Quantity, Optimal trade in time.	

Unit No.	Title of Unit & Contents	Hrs.
	Unit Outcome: UO 1. Understand the rules of differentiation. UO 2. Apply differentiation rule for finding marginal revenue and cost.	
III	**Calculus-II**	**08**
	1. Partial Differentiation: Partial derivatives up to second order. Homogeneity of a function and Euler's theorem. 2. Production Function: Returns to factor, Returns to scale. 3. Application of Maxima and Minima problems involving two independent variables.	
	Unit Outcome: UO 1. Familiarize with the concept of Partial derivatives and product function .	
IV	**Mathematics of Finance**	**07**
	1. Rates of interest: nominal, effective and their inter-relationships in different compounding situations. 2. Compounding a sum using different types of rates. 3. Applications relating to Depreciation of assets and average due date. 4. Types of annuities: ordinary, due, and deferred - Discrete and continuous	
	Unit Outcome: UO 1. Understand various types of rates of interest. UO 2. Evaluate compounding a sum using different types of rates.	

Learning Resources:

1. Anthony, M., & Biggs, N. (1996). Mathematics for Economics and Finance. Cambridge: Cambridge University Press.
2. Ayres, F. J. (1963). Theory and Problems of Mathematics of Finance. New York: McGraw Hill Publishing.
3. Budnick, P. (1986). Applied Mathematics for Business, Economics, & Social Sciences. New York: McGraw Hill Publishing.
4. Dowling, E. (2011). Introduction to Mathematical Economics. New York: McGraw Hill Publishing Kapoor.
5. Ghosh & Sinha (2018). Business Mathematics and Statistics. Oxford University Press.
6. S.K. Sharma and Kaur, G. (2019). Business Mathematics. New Delhi: Sultan Chand & Sons (P) Ltd.
7. Singh, J. K. (2017). Business Mathematics. New Delhi: Himalaya Publishing House.
8. Thukral, J. K. (2009). Mathematics For Business Studies. New Delhi: Mayur Paperbacks.
9. V. K., & Sancheti, D. C. (2014). Business Mathematics, Theory & Applications. Delhi: S. Chand Publishing.

Skill Enhancement Courses Offered by the Department

Course Type: SEC
Course Title: Introduction to R Programming
Course Code:
Credits: 02 **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning Objectives:

LO 1. Basics in R programming in terms of constructs, control statements, string functions.
LO 2. Learn to apply R programming.
LO 3. Understand the use of R Big Data analytics
LO 4. Plot graph using R programming.

Course Outcomes:

After completion of course the student will be able to-

CO 1. Do basic programming in R
CO 2. Handle matrix, array and list computations.
CO 3. Discus data frames in R programming.
CO 4. Plot two and three dimensional.

Unit No.	Title of Unit & Contents	Hrs.
I	**Introducing to R**	**08**
	R Data Structures, Help functions in R, Vectors, Scalars, Declarations, recycling, Common Vector operations, using all and any Vectorized operations, NA and NULL values, Filtering Vectorised if-then else, Vector Equality, Vector Element names	
	Unit Outcomes: **UO1:** To study R data Structures **UO2:** To use vectorized operations.	
II	**Matrices, Arrays and Lists**	**07**
	Matrices, Arrays and Lists Creating matrices, Matrix operations, Applying Functions to Matrix Rows and Columns, Adding and deleting rows and columns, Vector/Matrix Distinction, Avoiding Dimension Reduction, Higher Dimensional arrays, lists, creating lists, General list operations, accessing list components and values, applying functions to lists, recursive lists.	
	Unit Outcome: **UO1:** To study matrix array and list operations.	

Unit No.	Title of Unit & Contents	Hrs.
III	**Data Frames**	**08**
	Creating Data Frames, Matrix like operations in frames, Merging Data Frames, applying functions to Data frames, Factors and Tables, factors and levels, Common functions used with factors, Working with tables, other factors and table related functions.	
	Unit Outcomes: **UO1:** To create data frames. **UO2:** To work with table.	
IV	**Graphs Using R**	**07**
	Creating Graphs, Customizing Graphs, Saving graphs to files, Creating three-dimensional plots	
	Unit Outcomes : **UO1:** Plotting of 2D Graphs using R. **UO2:** Plotting of 3D Graphs using R	

Learning Resources:

1. Norman Mat off, "The Art of R Programming: A Tour of Statistical Software Design", No Starch Press, 2011.
2. Jared P. Lander, "R for Everyone: Advanced Analytics and Graphics", Addison-Wesley Data & Analytics Series, 2013.
3. Mark Gardener, " Beginning R – The Statistical Programming Language", Wiley, 2013.
4. Robert Knell, "Introductory R: A Beginner's Guide to Data Visualisation, Statistical Analysis and Programming in R", Amazon Digital South Asia Services Inc, 2013.'

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

UG Second Year (Semester III / IV)

Basket I: Open Elective (OE)

(GEs offered to the Science and Technology students in Sem.-III/IV)

Sr. No.	BoS Proposing OE	Course Title	Credits	Hrs.
1.	Commerce	Digital Marketing	2	30
2	Commerce	Introduction to Personal Taxation	2	30
3	Commerce	Fundamentals of Accounting	2	30
4	Hindi	Rojgar Abhimulak Hindi	2	30
5	English	English Proficiency Course	2	30
6	Geography	Fundamentals of GIS & RS	2	30

Note: Student can choose any one OE from the basket.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

UG Second Year (Semester III / IV)

Basket II: Skill Enhancement Courses (SEC)

(SEC offered to the Commerce and Management students in Sem.-III/IV)

Sr. No.	BoS Proposing SEC	Course Title	Credits	Hrs.
1	Commerce	Financial Management	2	30
2	Analytical Chemistry	Skills In Chemistry	2	30
3	Commerce	Wealth Management	2	30
4	Biotechnology	Good Laboratory Practices	2	30
5	Biotechnology	Dairy Technology	2	30
6	Botany	Herbal Technology	2	30
7	Information technology	Software Development Techniques	2	30
8	Information technology	Information Security	2	30
9	Computer Science	Web Development using WordPress	2	30
10	Electronics	Internet of Things	2	30
11	English	English for Careers	2	30
12	Geography	Disaster Management	2	30
13	Commerce	Business Law	2	30
14	Microbiology	Production of Bio fertilizers	2	30
15	Physics	Applied Optics	2	30
16	Political Science	Political Journalism	2	30
17	Chemistry	Chemistry of Biomolecules	2	30
18	Mathematics	Essential Statistics for Data Science	2	30
19	Information Technology	Android Aap Development	2	30
20	English	English for Competitive Examinations	2	30

Note: Student can choose any one SEC from the basket.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

UG Second Year

Basket III: Ability Enhancement Courses (AEC)

(AEC offered to the Science & Technology students in Sem.-III/IV)

Sr. No.	BoS Proposing AEC	Course Title	Credits	Hrs.
1.	English	English Communication	2	30
2.	English	English for Professionals	2	30

Note: Student can choose any one AEC from the basket.

Shiv Chhatrapati Shikshan Santha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

UG First Year

Extra Credit Activities

Sr. No.	Course Title	Credits	Hours T/P
1	MOOCs	Min. of 02 credits	Min. of 30 Hrs.
2	Certificate Courses	Min. of 02 credits	Min. of 30 Hrs.
3	IIT Spoken Tutorial Courses	Min. of 02 credits	Min. of 30 Hrs.

Guidelines:

Extra -academic activities

1. All extra credits claimed under this heading will require sufficient academic input/ contribution from the students concerned.
2. Maximum 04 extra credits in each academic year will be allotted.
3. These extra academic activity credits will not be considered for calculation of SGPA/CGPA but will be indicated on the grade card.

Additional Credits for Online Courses:

1. Courses only from SWAYAM and NPTEL platform are eligible for claiming credits.
2. Students should get the consent from the concerned subject Teacher/Mentor/Vice Principal and Principal prior to starting of the course.
3. Students who complete such online courses for additional credits will be examined/verified by the concerned mentor/internal faculty member before awarding credits.
4. Credit allotted to the course by SWAYAM and NPTEL platform will be considered as it is.

Additional Credits for Other Academic Activities:

1. One credit for presentation and publication of paper in International/National/State level seminars/workshops.
2. One credit for measurable research work undertaken and field trips amounting to 30 hours of recorded work.

3. One credit for creating models in sponsored exhibitions/other exhibits, which are approved by the concerned department.
4. One credit for any voluntary social service/Nation building exercise which is in collaboration with the outreach center, equivalent to 30 hours
5. All these credits must be approved by the College Committee.

Additional Credits for Certificate Courses:

1. Students can get additional credits (number of credits will depend on the course duration) from certificate courses offered by the college.
2. The student must successfully complete the course. These credits must be approved by the Course Coordinators.
3. Students who undertake summer projects/ internships/ training in institutions of repute through a national selection process, will get 2 credits for each such activity. This must be done under the supervision of the concerned faculty/mentor.

Note:

1. The respective documents should be submitted within 10 days after completion of Semester End Examination.
2. No credits can be granted for organizing or for serving as office bearers/ volunteers for Inter-Class / Associations / Sports / Social Service activities.
3. The office bearers and volunteers may be given a letter of appreciation by the respective staff coordinators. Besides, no credits can be claimed for any services/ activities conducted or attended within the college.
4. All claims for the credits by the students should be made and approved by the mentor in the same academic year of completing the activity.
5. Any grievances of denial/rejection of credits should be addressed to Additional Credits Coordinator in the same academic year.
6. Students having a shortage of additional credits at the end of the third year can meet the Additional Credits Coordinator, who will provide the right advice on the activities that can help them earn credits required for graduation.

Shiv Chhatrapati Shikshan Santha's

Rajarshi Shahu Mahavidyalaya, Latur

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Examination Framework

Theory:

40% Continuous Assessment Tests (CATs) and 60% Semester End Examination (SEE)

Practical:

50% Continuous Assessment Tests (CATs) and 50% Semester End Examination (SEE)

Course	Marks	CAT & Mid Term Theory				CAT Practical		Best Scored CAT & Mid Term	SEE	Total
1	2	3				4		5	6	5 + 6
		Att.	CAT I	Mid Term	CAT II	Att.	CAT			
DSC/DSE/OE/ Minor	100	10	10	20	10	-	-	40	60	100
DSC	75	05	10	15	10	-	-	30	45	75
Lab Course/AIPC/ OJT/FP	50	-	-	-	-	05	20	-	25	50
VSC/SEC/ AEC/VEC/CC	50	05	05	10	05	-	-	20	30	50

Note:

1. All Internal Exams are compulsory
2. Out of 02 CATs best score will be considered
3. Mid Term Exam will be conducted by the Exam Section
4. Mid Term Exam is of Objective nature (MCQ)
5. Semester End Exam is of descriptive in nature (Long & Short Answer)
6. CAT Practical (20 Marks): Lab Journal (Record Book) 10 Marks, Overall Performance 10 Marks.