

Shree Warana Vibhag Shikshan Mandal's

**WARANA UNIVERSITY,
WARANANAGAR**

(A State Public University established under Section 3 (6) of MPUA,
2016)

॥ विद्या सर्वस्य भूषणम् ॥



Warana University

Established: 2025

**Structure & Syllabus For
Bachelor of Science (B.Sc.) in
Mathematics**

UNDER

**Faculty of Science & Technology
B.Sc. Part – II (Semester- III and IV)**

(As Per National Education Policy – 2020)

With effect from Academic Year 2026-27 Onwards

Sr. No.	CONTENT	Page No
1.	PREAMBLE	1
2.	GENERAL OBJECTIVES	1
3.	PROGRAMME OUTCOMES (POS)	1
4.	PROGRAMME SPECIFIC OUTCOMES (PSOS)	2
5.	ELIGIBILITY	2
6.	DURATION	2
7.	MEDIUM OF INSTRUCTION	3
8.	MEME INSTRUCTION	3
9.	SCHEME OF TEACHING AND EXAMINATION	4
10.	COURSE STRUCTURE B.SC.-II	4
11.	COURSE STRUCTURE SUBJECT SPECIFIC	5
12.	NOTE ON COURSE	5
13.	STRUCTURE OF PROGRAMME	6-7
14.	SYLLABUS	8-38
15.	SCHEME OF EXAMINATION	39-46

Abbreviations:

POs	Program Outcomes
PSOs	Program Specific Outcomes
COs	Course Outcomes
DSC	Discipline Specific Core
DSE	Discipline Specific Elective
GE	Generic Elective
OE	Open Elective
VSC	Vocational Skill Course
SEC	Skill Enhancement Course
IKS	Indian Knowledge System
AEC	Ability Enhancement Course
VEC	Value Education Course
OJT	On Job Training (Internship)
FP	Field project
CEP	Community engagement project
CC	Co-curricular Courses
RM	Research Methodology
RP	Research Project
MJ	Major Course
MN	Minor Course

PREAMBLE:

The syllabus of B.Sc. Part-II (Mathematics) is designed to provide students with a solid foundation in basic branches of mathematics under Choice Based Credit System (CBCS). It aims to equip learners with essential theoretical knowledge and computational skills that are critical for higher studies in mathematics, allied sciences, technology and research. The curriculum emphasizes logical reasoning, rigorous proofs, , abstraction and problem solving ability. Through courses in differential equations, Numerical Methods, Differential and integral calculus, Computational Mathematics for Science, Improper Integrals & Special Functions, Laplace Transform students will develop the capability to model and analyze various phenomena and gain both procedural fluency and conceptual understanding. The syllabus also integrates practical components where applicable to enhance learning through hand on experience.

GENERAL OBJECTIVES OF THE COURSE

To prepare the learners, who will understand and apply the basic as well as advanced principles of mathematics for solving problems from science with an emphasis on applications.

To produce the learners who are well-grounded in the fundamentals of mathematics with the acquisition of the necessary skills, tools, and techniques required in many applications areas.

To develop an ability to study the conceptual problem and critically analyze and also promote the use of mathematics in industry and applied sciences.

To provide exposure and motivate students for research in current trends of mathematics.

PROGRAMME OUTCOMES (POs)-B.Sc. Mathematics

PO1. Enhance students logical thinking and apply advanced mathematical concepts to solve complex problems.

PO2. Formulate research questions, design experiments or investigations, collect and analyze data and present their findings in a clear and coherent manner.

PO3. Apply advanced mathematical techniques or tools to analyze and solve challenging problems encountered in mathematics and related fields.

PO4. Formulate mathematical models that represent real-world phenomena, analyze the models using mathematical methods and interpret the results to make informed decisions or predictions.

PO5. Develop proficiency in utilizing computational tools, software and programming languages to aid in mathematical analysis, numerical simulations and data visualization.

PO6.Analyzing the results critically and applying acquired knowledge to solve the problems.

PROGRAMME SPECIFIC OUTCOMES (PSOs)B.Sc.Mathematics

After successful completion of the B.Sc. Mathematics course, the student will

POS 1.have a strong foundation for being research in mathematics.

POS 2.be able to apply mathematical skills for solving problems.

POS 3.at least basic knowledge of programming and computational techniques as required for employment.

POS 4.capable to analyze the results critically and apply acquired knowledge to solve the problems.

POS 5.have at least four different skills and capable to think and communicate in three different languages.

POS 6. be able prepare the models for real life problems.

ELIGIBILITY FOR ADMISSION

As per guide lines obtained from Warana University, Warananagar by following rules and regarding reservations by Govt. of Maharashtra

DURATION

The course shall be a fulltime course. Second Year, Semester III and IV

MEDIUM OF INSTRUCTION

The Medium of instruction shall be English

MEME Instructions: In alignment with the National Education Policy (NEP) 2020, the Bachelor of Science (B.Sc.) program adopts the Multiple Entry and Multiple Exit (ME-ME) framework. This flexible structure is designed to provide students with academic mobility, skill development, and lifelong learning opportunities. Through ME-ME framework, the program enables students to enter and exit at different stages with appropriate certifications. Information regarding different entry and exit options available to students and respective mandatory number of credits to be earned by the students are provided in the table below.

Year	Stage of exit	Type of Award	Mandatory Credits to be earned	Minimum credits to be earned
1	After successful completion of One Year	Undergraduate Certificate in Science	44	40
2	After successful completion of Two Year	Undergraduate Diploma in Science	88	80
3	After successful completion of Two Year	Bachelor of Science Degree	132	120

Re-entry provision: Students leaving after a undergraduate certificate or undergraduate diploma may re-enter the program within 5 years by earning required credits through Academic Bank of Credits.

SCHEME OF TEACHING AND EXAMINATION:

[The scheme of teaching and examination should be given as applicable to the course/paper concerned.]

B.Sc. Program Structure for Level 5 of B.Sc.-II Semester III														
Teaching Scheme						Examination Scheme								
Sr. No.	Theory (TH) & Practical (P)					Semester-end Examination (SEE)			Internal Assessment (IA)			Practical		
	Course Type	No. of Lectures	Practical	Hours	Credits	Paper Hours	Max	Min	Internal	Max	Min	Paper Hours	Max	Min
1.	Major V	4		4	2	1	30	12	Assignment	20	8	-	-	-
2.	Major VI	4		4	2	1	30	12		20	8	-	-	-
3.	Major PIII		1	4	2	-	-	-		-	-	2	50	20
4.	Minor V	4		4	2	1	30	12		20	8	-	-	-
5.	Minor VI	4		4	2	1	30	12		20	8	-	-	-
6.	Minor PIII		1	4	2	-	-	-		-	-	2	50	20
7.	OE III	-	1	4	2	-	-	-		-	-	2	50	20
8.	VSC I	-	1	4	2	-	-	-		-	-	2	50	20
9.	SEC I	-	1	4	2	-	-	-		-	-	2	50	20
10.	AEC I	4	-	4	2	1	30	12		20	8	-	-	-
11.	CC-I	-	-	-	2	-	-	-		-	-	2	50	20
Total					22	Major, Minor, AEC 30 X 5 Total SEE = 150			Major, Minor, AEC 20 X 5 Total SEE = 100			Practical. = 50X6 Total Practical. = 300		
						Total Semester –III = 550								

B.Sc. Program Structure for Level 5 of B.Sc.-II Semester IV														
Teaching Scheme						Examination Scheme								
Sr. No.	Theory (TH) & Practical (P)					Semester-end Examination (SEE)			Internal Assessment (IA)			Practical		
	Course Type	No. of Lectures	Practical	Hours	Credits	Paper Hours	Max	Min	Internal	Max	Min	Paper Hours	Max	Min
1.	Major VII	4		4	2	1	30	12	Assignment	20	8	-	-	-
2.	Major VIII	4		4	2	1	30	12		20	8	-	-	-
3.	Major PIV		1	4	2	-	-	-		-	-	2	50	20
4.	Minor VII	4		4	2	1	30	12		20	8	-	-	-
5.	Minor VIII	4		4	2	1	30	12		20	8	-	-	-
6.	Minor PIV		1	4	2	-	-	-		-	-	2	50	20
7.	OE IV	-	1	4	2	-	-	-		-	-	2	50	20
8.	SEC II	-	1	4	2	-	-	-		-	-	2	50	20
9.	VEC II	-	1	4	2	-	-	-		-	-	2	50	20

10.	AEC II	4	-	4	2	1	30	12		20	8	-	-	-
11.	CEP-I	-	-	-	2	-	-	-		-	-	2	50	20
Total					22	Major, Minor, AEC 30 X 5 Total SEE = 150			Major, Minor, AEC 20 X 5 Total SEE = 100		Practical. = 50X6 Total Practical. = 300			
						Total Semester –III = 550								

General Guidelines for the selection of subjects

1. In first year, student has to choose three DSC subjects from the basket for faculty of Science. (The DSC Basket for faculty of Science includes Mathematics, Physics, Chemistry, Botany, Zoology, Biochemistry, Industrial Microbiology and Computer Science)
2. At the start of second year, out of these 3 DSC subjects, he/she must opt one subject as Major subject and one as Minor subject. The remaining DSC subject will be dropped.
3. Student cannot select a subject as major or minor other than the subjects taken in first year.
4. OE is to be chosen compulsorily from faculty other than that of the major. (B.Sc. students needs to select OE from faculty of Arts or Faculty of Commerce)
5. VSC is to be selected from the basket of Skill courses approved by the university.
6. IKS (Generic) will be provided by the university separately.

Credit Distribution Structure for B.Sc.-II in Mathematics with Multiple Entry and Multiple Exit Options:

COURSE CATEGORY	ABBREVIATION (Only 2 Letters)	DESCRIPTION	Sem.-III Credit	Sem.-IV Credit
MAJOR	Major (MJ)	Discipline Specific Course	2x3=6	2x3=6
MINOR	Minor (MN)	Discipline Specific Course	2x3=6	2x3=6
OE	OE(OE)	Open Elective	2x1=02	2x1=02
SEC	SEC (SE)	Skill Enhancement Course	2x1=02	2x1=02
AEC/IKS/VEC	AEC(AE)	Ability Enhancement Course	2x1=02	2x1=02
	VSC (VS)	Vocational Skill Course	2x1=02	-
	VEC(VE)	Value Education Course	-	2x1=02
	CC (CC)	Co-curricular Course	2x1=02	-

CC/CEP	CEP(CE)	Community Engagement Project	-	2x1=02
			22	22
			Total 44	

Bachelor of Science in MATHEMATICS

Credit Framework

Second Year (B. Sc. II- MATHEMATICS)

	WARANA UNIVERSITY, WARANANAGAR NEP-2020: Credit Framework for UG (B. Sc.) Programme under Faculty of Science and Technology							
SEM (Level)	COURSES		OE	VSC/ SEC	AEC /VEC / IKS	OJT/ FP/ CEP / CC/ RP	Total Credits	Degree / Cum. Cr
	MAJOR	MINOR						
SEM III (5.0)	Major V (2) Major VI (2) Major PIII (2)	Minor V (2) Minor VI (2) Minor PIII (2)	OE- 3(2) (T/P)	VSC I (2) (P) (Major specific) SEC I (2) (T/P)	AEC I (2) (English)	CC-I (2)	22	UG Diploma 88
SEM IV (5.0)	Major VII (2) Major VIII (2) Major P IV (2)	Minor VII (2) Minor VIII (2) Minor P IV (2)	OE- 4(2) (T/P)	SEC-II (2) (T/P)	AEC-II (2) (English) VEC-II (2) (Environ mental studies)	CEP-I (2)	22	
Credits	8(T)+4(P) = 12	8(T)+4(P) =12	2+2=4 (T/ P)	4(T/P) +2(P) = 6	2+4=6	2+2=4	44	Exit Option:4 credits NSQF/ Internship/ Skill courses

Course Code Table

B.Sc.-II: SEMESTER-III (TOTALCREDITS-22): (Note: Put '—' wherever 'Not Applicable')

COURSE CATEGORY		COURSE NAME	COURSE CODE	CREDITS
MAJOR	MJ-V	Numerical Methods	2602USMTMJ301	2
MAJOR	MJ-VI	Differential Equations - II	2602USMTMJ302	2
MAJOR	MJ-PIII	Major Practical-III	2602USMTMJ303	2
MINOR	MN-V	Improper Integrals	2602USMTMN301	2
MINOR	MN-VI	Computational Mathematics-I	2602USMTMN302	2
MINOR	MN-PIII	Minor Practical-III	2602USMTMN303	2
OE	OE-III	Vedic Mathematics Part- I [वैदकगणित भाग-१]	2602USMTOE301	2
SEC	SE-I	Mathematics Typesetting using Latex-I	2602USMTSE301	2
VSC	VS-I	Introduction to SciLab	2602USMTVS301	2
AEC	AE-I	English	-	2
CC	CC	Co-curricular Course	-	2
CREDITS FOR B.Sc.-II, SEM-III .				22

B.Sc.-II: SEMESTER-IV (TOTALCREDITS-22): (Note: Put '—' wherever 'Not Applicable')

COURSE CATEGORY		COURSE NAME	COURSE CODE	CREDITS
MAJOR	MJ-VII	Differential Calculus	2602USMTMJ401	2
MAJOR	MJ-VIII	Integral Calculus	2602USMTMJ402	2
MAJOR	MJ-PIV	Major Practical -IV	2602USMTMJ403	2
MINOR	MN-VII	Laplace Transform	2602USMTMN401	2
MINOR	MN-VIII	Computational Mathematics-II	2602USMTMN402	2
MINOR	MN-PIV	Minor Practical-IV	2602USMTMN403	2
OE	OE-IV	Vedic Mathematics Part- II [वैदकगणित भाग-2]	2602USMTOE401	2
SEC	SE-II	Mathematics Typesetting using Latex-II	2602USMTSE401	2
VEC	VE-I	Environmental Studies		2
AEC	AE-I	English	-	2
CEP	CE	Community Engagement Program	-	2
CREDITS FOR B.Sc.-II, SEM-IV .				22

NOTE REGARDING OPEN ELECTIVE: The OE courses offered by the Department of Botany are available for the second-year students of the faculty of Arts and Humanities or faculty of Commerce and Management. The students of science should select the open elective subject from the OE basket provided by the faculty of Arts and Humanities or the faculty of Commerce and Management. The details of OE courses available are provided in the prospectus and posted on Institutional Website.

SEMESTER - III
Mathematics MAJOR PAPER V: Numerical Methods (2602USMTMJ301)
CREDITS: 2, LECTURE HOURS: 2 PER WEEK, MARKS: 50

Course Outcomes:

After successful completion of this course, the students will be able to:

CO1	solve algebraic and transcendental equations using numerical techniques.
CO2	apply various interpolation methods to approximate and compute numerical solutions.
CO3	compute numerical solutions for definite integrals and ordinary differential equations using appropriate methods.
CO4	utilize numerical methods to solve practical problems in real-life.

SYLLABUS

Unit1: **(15Hrs.)**

1.1 SolutionsofAlgebraicandTranscendentalEquations:

- 1.1.1 Introduction
- 1.1.2 Basicpropertiesofequations
- 1.1.3 Synthetictdivisionofapolynomialbyalinearexpression
- 1.1.4 BisectionMethod
- 1.1.5 MethodofFalsePositionorRegula-FalsiMethod
- 1.1.6 Newton-Raphsonmethod
- 1.1.7 Examplesbasedonart.11.2to1.1.6

1.2 Interpolation

- 1.2.1 Introduction
- 1.2.2 Finitedifferences
 - 1.2.2.1 Forwardandinverseforwarddifferenceoperator
 - 1.2.2.2 Backwardandinversebackwarddifferenceoperator
- 1.2.3 Shiftandinverseshiftoperator
- 1.2.4 Relationsbetweenaboveoperators
- 1.2.5 Interpolationwithequalintervals
 - 1.2.5.1 Newton'sforwardinterpolationformula
 - 1.2.5.2 Newton'sbackwardinterpolationformula
- 1.2.6 Interpolationwithunequalintervals:Lagrange'sinterpolationformula
- 1.2.7 Examplesbasedonart.12.2to1.2.6

Unit2: **(15Hrs.)**

2.1 NumericalIntegration

- 2.1.1 Introduction
- 2.1.2 Newton-CotesQuadratureFormula
- 2.1.3 Trapezoidalrule
- 2.1.4 Simpson's $1/3^{\text{rd}}$ -rule
- 2.1.5 Simpson's $3/8^{\text{th}}$ -rule
- 2.1.6 Examplesbasedonart.21.3to2.1.5.

2.2 Numerical Solutions of ODE:

- 2.2.1 Introduction
- 2.2.2 Picard's method (upto three iterations)
- 2.2.3 Taylor's series method (upto three iterations)
- 2.2.4 Euler's method
- 2.2.5 Runge-Kutta method of second order
- 2.2.6 Examples based on art.2.2.2to2.2.5.

RecommendedBook:-

B. S. Grewal - Numerical Methods in Engineering and Science: C, C++, and MatLab, Mercury Learning And Information, New Delhi,

Scope:- Unit-1[Chapter-2:2.1,2.2,2.4,2.8,2.9,2.12;Chapter-6:6.1,6.2,6.6,6.8,6.9;
Chapter-7:7.1,7.2,7.3,7.11,7.6]
Unit-2[Chapter-:8.5;Chapter-:10.1,10.2,10.3,10.4,10.5,10.7]

ReferenceBooks:-

1. G.Haribaskaran,NumericalMethods,LaxmiPublicationsPvt.Ltd,NewDelhi,First Edition (2006).
2. H.C.Saxena-FiniteDifferencesandNumericalAnalysis,S.Chand&CompanyLtd.(2005).
3. M.K.Jain,S.R.K.Iyengar&R.K.Jain-NumericalMethods(ProblemsandSolutions): Revised Second Edition, New Age International Pvt Ltd Publishers, Mumbai.
4. S. S. Sastry - Introductory Methods of Numerical Analysis: Fifth Edition, Prentice Hall India Learning Private Limited, New Delhi (2012).

Mathematics MAJOR PAPER VI: Differential Equations-II (2602USMTMJ302)
CREDITS: 2, LECTURE HOURS: 2 PER WEEK, MARKS: 50

Course Outcomes:

After successful completion of this course, the students will be able to:

CO1	solve differential equations of the first order but not of the first degree.
CO2	identify types of higher order ordinary differential equations.
CO3	solve different types of higher order ordinary differential equations.
CO4	understand simultaneous differential equations.

SYLLABUS

Unit No. 1 Differential Equations of first order but not of first degree (15 Htrs)

1.1 Equations of the first order but not of the first degree

- 1.1.1 Introduction
- 1.1.2 Method I: Equations solvable for y
- 1.1.3 Method II: Equations solvable for x
- 1.1.4 Method III: Equations solvable for y'
- 1.1.5 Method IV: Equations in Clairaut's form
- 1.1.6 Method V: Equations reducible to Clairaut's form
- 1.1.7 Examples based on 1.1.2 to 1.1.6.

1.2 Homogeneous linear equations or Cauchy-Euler equations

- 1.2.1 Homogeneous linear equation (Cauchy-Euler equation)
- 1.2.2 Method of solution of homogeneous linear differential equations
- 1.2.3 Working rule for solving linear homogeneous differential equations
- 1.2.4 Equations reducible to homogeneous linear form (Legendre's linear equations)
- 1.2.5 Working rule for solving Legendre's linear equations
- 1.2.6 Examples based on 1.2.3 and 1.2.5.

Unit 2: Linear Differential Equations of Second Order (15 Hrs.)

2.1 Linear differential equations of second order

- 2.1.1 The general (standard) form of the linear differential equation of the second order.
- 2.1.2 Complete solution of $y'' + Py' + Qy = R$ in terms of one known integral belonging to the complementary function (C.F.).
- 2.1.3 Rules for getting an integral belonging to

C.F. of $y'' + Py' + Qy = R$

2.1.4 Working rule for finding complete primitive (solution) when an integral of C.F. is known or can be obtained.

2.1.5 Removal of first derivative (Reduction to normal form or changing the dependent variable).

2.1.6 Working rule for solving problems by changing the dependent variable.

2.1.7 Transformation of the equation by changing the independent variable.

2.1.8 Working rule for solving equations by changing the independent variable.

2.1.9 Examples based on 2.1.4, 2.1.6 and 2.1.8.

2.2 Simultaneous differential equations of the form $(dx)/P = (dy)/Q = (dz)/R$

2.2.1. Introduction

2.2.2 The nature of solution of $(dx)/P = (dy)/Q = (dz)/R$

2.2.3 Geometrical interpretation of $(dx)/P = (dy)/Q = (dz)/R$

2.2.4 Rule I for solving $(dx)/P = (dy)/Q = (dz)/R$

2.2.5 Rule II for solving $(dx)/P = (dy)/Q = (dz)/R$

2.2.6 Rule III for solving $(dx)/P = (dy)/Q = (dz)/R$

2.2.7 Rule IV for solving $(dx)/P = (dy)/Q = (dz)/R$

2.2.8 Examples based on 2.2.4 to 2.2.7

Recommended book:-

Ordinary and Partial Differential Equations, M. D. Raisinghania, Eighteenth revised edition 2016; S. Chand and Company Pvt. Ltd. New Delhi.

Scope:- Unit 1: Part-I Chapter 4: 4.1 to 4.11; Part-I Chapter 6: 6.1 to 6.4 and 6.9 to 6.11;
Unit 2: Part-I Chapter 10: 10.1 to 10.4 (excluding 10.4A and 10.4B),
10.5 (excluding 10.5A), 10.6 to 10.11; Part-II Chapter 2: 2.1 to 2.11.

Reference books:-

1. Introductory course in Differential Equations, D. A. Murray, Khosala Publishing House, Delhi.
2. Differential Equations, Shepley L. Ross, Third Edition 1984; John Wiley and Sons, New York.
3. Elements of Partial Differential Equations, Ian Sneddon, Seventeenth Edition, 1982; Mc-Graw-Hill International Book Company, Auckland.

SEMESTER – III
Major Mathematics Practical-III (2602USMTMJ303)
(based on Major Paper V and VI)

CREDIT: 2. PRACTICAL HOURS:60 MARKS:50

Course Outcomes:

After successful completion of this course, the students will be able to:

CO1	solve differential equations of the first order but not of the first degree.
CO2	identify types of higher order ordinary differential equations.
CO3	solve different types of higher order ordinary differential equations.
CO4	understand simultaneous differential equations.
CO5	solve algebraic and transcendental equations using numerical techniques.
CO6	apply various interpolation methods to approximate and compute numerical solutions.
CO7	compute numerical solutions for definite integrals and ordinary differential equations using appropriate methods.
CO8	utilize numerical methods to solve practical problems in real-life.

SYLLABUS

Sr. No	Title of the Practical	No. of Practical(s)
1	Equations solvable for p, x and y	01
2	Clairaut's equation & equations reducible to Clairaut's form	01
3	Homogeneous linear differential equations	01
4	Legendre's lineal equations	01
5	Solution of linear differential equation of second order when one integral is known	01
6	Solution of linear differential equation of second order by the change of dependent variable	01
7	Solution of linear differential equation of second order by the change of independent variable	01
8	Bisection method	01
9	Newton Raphson method	01
10	Newton's forward and backward interpolation formula	01
11	Lagrange's interpolation formula	01
12	Evaluation of Numerical integration by using Simpson's 1/3 rd rule	01
13	Evaluation of Numerical integration by using Simpson's 3/8 th rule	01
14	Numerical solutions of ordinary differential equations by Euler's method.	01
15	Numerical solutions of ordinary differential equations by Runge-Kutta method of second order	01
	TOTAL	15

Mathematics MINOR PAPER V: Improper Integrals (2602USMTMN301)

CREDITS: 2, LECTURE HOURS: 2 PER WEEK, MARKS: 50

Course Outcomes:

After successful completion of this course, the students will be able to:

CO1	analyze and evaluate improper integrals with infinite limits.
CO2	apply Beta and Gamma functions to solve integrals and demonstrate their properties and interrelationships.
CO3	evaluate parameter-dependent improper integrals and understand the conditions for interchanging limits, differentiation, and integration.
CO4	interpret and apply the Error function in solving integrals and problems arising in applied mathematics and engineering contexts.

SYLLABUS

Unit 1. Improper Integrals

(15Hrs.)

- 1.1 Introduction
- 1.2 Improper Integrals of the First Kind (Range of Integration is Infinite) (Definition)
- 1.3 Improper Integral of the Second Kind (Definition)
- 1.4 Gamma Function
- 1.5 Some Identities of Gamma Function
 - 1.5.1 $\Gamma(1) = 1$
 - 1.5.2 $\Gamma(x+1) = x\Gamma(x)$
 - 1.5.3 $\Gamma(x+1) = x!$, for any positive integer x .
 - 1.5.4 $\Gamma\left(\frac{1}{2}\right) = \sqrt{\pi}$
 - 1.5.5 $\Gamma(x) = 2 \int_0^{\infty} t^{x-1} e^{-t^2} dt$, $x > 0$
 - 1.5.6 $\Gamma(x) = \int_0^{\infty} t^{x-1} e^{-t} dt$, $x > 0$
- 1.6 Beta Function
- 1.7 Some Identities of Beta function
 - 1.7.1 $B(x, y) = B(y, x)$
 - 1.7.2 $B(x, y) = 2 \int_0^{\frac{\pi}{2}} \sin^{2x-1} \theta \cos^{2y-1} \theta d\theta$
 - 1.7.3 $B(x, y) = \frac{\Gamma(x)\Gamma(y)}{\Gamma(x+y)} = \int_0^{\infty} \frac{x^{y-1}}{(1+x)^{m+n}} dx$

$$1.7.4 \quad \Gamma(m, n) = \frac{\Gamma(m)\Gamma(n)}{\Gamma(m+n)}$$

$$1.7.5 \quad \Gamma(m, n) = \Gamma(m+1, n) + \Gamma(m, n+1)$$

1.7.6 Duplication formula of Gamma function (only statement)

1.8 Examples based on 1.4 to 1.7

Unit 2. Improper integrals involving a parameter and the Error functions

(15 Hrs.)

1.1. Definition of improper integral involving a parameter

1.2. Integral with its limits as constants (Statement only)

1.3. Integral with limits as functions of the parameter (Leibnitz's Rule) (Statement only)

1.4. Examples based on 2.2 and 2.3

1.5. Error Function Integral $\text{erf}(x)$

1.6. Complementary Error Function Integral $\text{erfc}(x)$

1.7. Expression for $\text{erf}(x)$ in series

1.8. Properties of error-integral functions

i) $\text{erf}(-x) = -\text{erf}(x)$

ii) $\text{erf}(-x) = 1 - \text{erf}(x) = 2 - \text{erfc}(x)$

iii) Derivative of error function: $\frac{d}{dx} [\text{erf}(x)] = \frac{2}{\sqrt{\pi}} e^{-x^2}$

iv) Integral of error function: $\int_0^x \text{erf}(t) dt = x \text{erf}(x) + \frac{e^{-x^2}}{\sqrt{\pi}}$

1.9. Examples based on 2.5 to 2.7

Recommended books:

1. **For Unit. 1 & Unit 2:** R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, 4th Edition, Narosa Publishing House, New Delhi, Chennai, Mumbai, Kolkata. [Scope: Chapter 1: 1.4.1, 1.4.2, 1.4.4 to 1.4.6.]

2. **For Unit. 2:** P. N. Wartikar and J. N. Wartikar, A text Book of Applied Mathematics, Pune Vidhyarthi Griha Prakashan, 1786, Sadashiv Peth, Pune-411030, Vol. I, 2011. [Scope: Chapter 19: 19.1 to 19.3 Chapter 21: 21.2 to 21.5.]

Reference books:

1. P. N. Wartikar and J. N. Wartikar, A text book of Applied Mathematics, Pune Vidhyarthi Griha Prakashan, Pune. Vol. I, 2011.

2. Shanti Narayan and Dr. P. K. Mittal, Integral Calculus, S. Chand and Company, New Delhi, 2015.

3. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, Delhi, 2012.

4. Gorakh Prasad, Integral Calculus, Pothishala Pvt. Ltd., Allahabad

5. Dass H. K., Advanced Engineering Mathematics, 22^e, S. Chand and Company, New Delhi, 2018.

Mathematics MINOR PAPER VI: Computational Mathematics –I
(2602USMTMN302)

CREDITS: 2, LECTURE HOURS: 2 PER WEEK, MARKS: 50

Course Outcomes:

After successful completion of this course, the students will be able to:

CO1	learn the partial differentiation and Euler's theorem on homogeneous functions.
CO2	learn the concept of Jacobian of a transformation.
CO3	understand the concepts of gradient, divergence and curl of point functions in terms of cartesian co-ordinate system.
CO4	evaluate the gradient, divergence and curl of point functions

SYLLABUS

Unit1: Partial differentiation and Jacobians

(15Hrs.)

1.1. Partial differentiation

1.1.1. Revision of Partial derivatives

1.1.2. Partial derivatives of composite Functions

1.1.3. Homogeneous functions :definition

1.1.4. Euler's theorems on homogeneous functions

1.1.4.1. If z is a homogeneous function of degree n in x and y , then

a) $x \frac{\partial z}{\partial x} + y \frac{\partial z}{\partial y} = n z.$

b) $x^2 \frac{\partial^2 z}{\partial x^2} + 2xy \frac{\partial^2 z}{\partial x \partial y} + y^2 \frac{\partial^2 z}{\partial y^2} = n(n-1)z$

1.1.4.2. If u is a homogeneous function of degree n in x and y and $z = f(u)$, then

a) $x \frac{\partial z}{\partial x} + y \frac{\partial z}{\partial y} = z f'(u)$

b) $x^2 \frac{\partial^2 z}{\partial x^2} + 2xy \frac{\partial^2 z}{\partial x \partial y} + y^2 \frac{\partial^2 z}{\partial y^2} = n(n-1)z$ where $f(u) = f'(u)$

1.1.5. Examples based on 1.1.2, 1.1.3, 1.1.4

1.2. Jacobian

1.2.1. Definition of Jacobian

1.2.2. Properties of Jacobians.

1.2.2.1. If ϕ is Jacobian of u, v with respect to x, y and ϕ' is Jacobian of x, y with respect to u, v then $JJ' = 1$.

1.2.2.2. If ϕ is Jacobian of u, v with respect to x, y and ϕ' is Jacobian of x, y with respect to u, v then $JJ' = 1$.

1.2.2.3. If ϕ, ψ are functions of x, y and ϕ, ψ are functions of u, v then prove that $\frac{\partial(\phi, \psi)}{\partial(u, v)} = \frac{\partial(\phi, \psi)}{\partial(x, y)} \frac{\partial(x, y)}{\partial(u, v)}$

1.2.2.4. If ϕ, ψ, χ are functions of x, y, z and ϕ, ψ, χ are functions of u, v, w then prove that $\frac{\partial(\phi, \psi, \chi)}{\partial(u, v, w)} = \frac{\partial(\phi, \psi, \chi)}{\partial(x, y, z)} \frac{\partial(x, y, z)}{\partial(u, v, w)}$

1.2.3. Jacobian of implicit functions (without proof)

1.2.4. Examples based on 1.2.1, 1.2.2, 1.2.3

Unit 2: Vector Calculus

(15 Hrs.)

2.1 Partial differentiation of vectors

2.1.1 The Scalar and Vector valued Point functions

2.1.2 The Operator ∇

2.1.3 Gradient of a Scalar Point Function: definition

2.1.4 Directional derivatives of scalar and vector point functions

2.1.5 Geometrical Interpretation of $\text{grad } \phi$, where ϕ is a scalar point function

2.1.6 Divergence of vector point function: definition

2.1.7 Curl of vector point function: definition

2.1.8 Gradient, Divergence and Curl of sums

$$\text{i. } \text{grad}(\phi \pm \psi) = \text{grad } \phi \pm \text{grad } \psi$$

$$\text{ii. } \text{div}(f\vec{g}) = \text{div } f\vec{g} + f \text{div } \vec{g}$$

$$\text{iii. } \text{curl}(f\vec{g}) = \text{curl } f\vec{g} + f \text{curl } \vec{g}$$

2.1.9 Gradient, Divergence and Curl of Products

$$\text{i. } \text{grad}(\phi \psi) = \phi \text{grad } \psi + \psi \text{grad } \phi$$

$$\text{ii. } \text{div}(\phi \vec{f}) = \phi \text{div } \vec{f} + (\text{grad } \phi) \cdot \vec{f}$$

$$\text{iii. } \text{div}(\vec{f} \times \vec{g}) = \vec{g} \cdot \text{curl } \vec{f} - \vec{f} \cdot \text{curl } \vec{g}$$

$$\text{iv. } \text{curl}(\phi \vec{f}) = \text{grad } \phi \times \vec{f} + \phi \text{curl } \vec{f}$$

2.1.10 Second order differential operators

$$\text{i. } \text{div grad } \phi = \nabla \cdot \nabla \phi = \frac{\partial^2 \phi}{\partial x^2} + \frac{\partial^2 \phi}{\partial y^2} + \frac{\partial^2 \phi}{\partial z^2}$$

$$\text{ii. } \text{curl grad } \phi = \nabla \times \nabla \phi = 0$$

$$\text{iii. } \text{div curl } \vec{f} = \nabla \cdot \nabla \times \vec{f} = 0$$

2.1.11 The Laplacian Operators ∇^2

2.1.12 Solenoidal and Irrotational vector fields

2.1.13 Examples based on 2.1.3, 2.1.4, 2.1.6, 2.1.7, 2.1.12

Recommended books:

2. Differential Calculus, Shanti Narayan and P.K. Mittal, S. Chand publishing, 15th edition (2016) – For Unit 1 of the syllabus.
[Scope: Chapter-11: 11.1, 11.6, 11.7, 11.8, Chapter-12: 12.1, 12.2, 12.3]
3. A text book of Vector Calculus, Shanti Narayan & P.K. Mittal, S. Chand & CO (Pvt) Ltd, Ram nagar, New Delhi-110055.- For Unit 2 of the syllabus.
[Scope: Chapter-6: 6.1 to 6.17]

Reference books:

1. Differential Calculus, Gorakh Prasad, Pothishala Pvt. Ltd., 19th edition (2016).
2. Mathematical Physics, B. D. Gupta, Vikas Publishing House Pvt. Ltd. Fourth edition (2022).
3. Higher Engineering Mathematics, B.S. Grewal, Khanna Publishers, New Delhi-110002.
4. Advanced Engineering Mathematics R.K. Jain & S.R.K. Iyengar, fourth edition, Narosa Publishing House New Delhi.

SEMESTER – III
Minor Mathematics Practical-IV (2602USMTMN303)
(based on Minor Paper V and VI)

CREDIT: 2. PRACTICAL HOURS:60 MARKS:50

Course Outcomes:

After successful completion of this course, the students will be able to:

CO1	Apply Beta and Gamma functions to solve integrals and demonstrate their properties and interrelationships.
CO2	evaluate parameter-dependent improper integrals and understand the conditions for interchanging limits, differentiation, and integration.
CO3	interpret and apply the Error function in solving integrals and problems arising in applied mathematics and engineering contexts.
CO4	learn the Euler's theorem on homogeneous functions.
CO5	learn the concept of Jacobian of a transformation
CO6	understand the concept of gradient, divergence and curl of point functions in terms of cartesian co-ordinate system.
CO7	evaluate the gradient, divergence and curl of point functions
CO8	analyze and evaluate improper integrals with infinite limits.

SYLLABUS

Sr. No	Title of the Practical	No. of Practical(s)
1	Gamma function-I	01
2	Gamma function-II	01
3	Definition of Beta function	01
4	Identities of Beta function-I	01
5	Identities of Beta function-II	01
6	Differentiation under integral sign (DUIS)-I	01
7	Differentiation under integral sign (DUIS)-II	01
8	Euler's theorems on homogeneous functions-I	01
9	Euler's theorems on homogeneous functions-II	01
10	Jacobians-I	01
11	Jacobians-II	01
12	Curl, Divergence and Gradient-I	01
13	Curl, Divergence and Gradient-II	01
14	Solenoidal and Irrotational vector field.	01
15	Directional Derivatives	01
	TOTAL	15

SEMESTER-III
OPEN ELECTIVE - III: VEDIC MATHEMATICS-I(2602USMTOE301)
CREDIT: 2 PRACTICAL HOURS:60 MARKS:50

Course Outcomes:

After successful completion of this course, the students will be able to do:

CO1	Multiplication (NIKHILAM) of Integers below and above the base 100
CO2	Multiplication (NIKHILAM) of decimal numbers
CO3	Multiplication (NIKHILAM) of numbers with bases of 1000 and 10000
CO4	Multiplication (NIKHILAM) of numbers of secondary base of 50, 250, 500, 40, 60 & 300
CO5	Multiplication (URDHVA TRIYAK) of two 2-digit numbers, 3-digit numbers and 4-digit numbers,
CO6	Multiplication (URDHVA TRIYAK) of 2-digit with 3-digit number, 2-digit with 4-digit number and 3-digit with 4-digit number

SYLLABUS

Sr. No	Title of the Practical	No. of Practical(s)
1	Multiplication (NIKHILAM) [गुणाकार (निखीलम)] Case 1: Integers less than the base (100) (पायाभूतसंकेपे १००) लहान असणारे पूर्णांक)	01
2	Multiplication (NIKHILAM) [गुणाकार (निखीलम)] Case 2: Integers above the base (100) (पायाभूतसंकेपे १००) मोठे असणारे पूर्णांक)	01
3	Multiplication (NIKHILAM) [गुणाकार (निखीलम)] Case 3: Integers below and above the base (100) (पायाभूतसंकेपे १००) मोठे किंवा लहान असणारे पूर्णांक)	01
4	Multiplication (NIKHILAM) [गुणाकार (निखीलम)] Case 4: Examples of decimal numbers (दशांश अपूर्णाकांची उदाहरणे)	01
5	Multiplication (NIKHILAM) [गुणाकार (निखीलम)] Case 5: Examples with bases of 1000 and 10000 (१००० आणि १०००० पाया असणारे उदाहरणे)	01
6	Multiplication (NIKHILAM) [गुणाकार (निखीलम)] Problem on secondary base of 50 [दुखमपायाभूतसंय ५०]	01
7	Multiplication (NIKHILAM) [गुणाकार (निखीलम)] Problem on secondary base of 250 [दुखमपायाभूतसंय २५०]	01
8	Multiplication (NIKHILAM) [गुणाकार (निखीलम)] Problem on secondary base of 500 [दुखमपायाभूतसंय ५००]	01
9	Multiplication (NIKHILAM) [गुणाकार (निखीलम)] Problem on secondary base of 40 and 60 [दुखमपायाभूतसंय ४० आणि ६०]	01
10	Multiplication (NIKHILAM) [गुणाकार (निखीलम)] Problem on secondary base of 300 [दुखमपायाभूतसंय ३००]	01
11	Multiplication (URDHVA TRIYAK) [गुणाकार (उर्ध्व त्रियक)] Multiplication of two 2-digit numbers (२ अंकासंयचा गुणाकार) Multiplication of two 3-digit numbers (३ अंकासंयचा गुणाकार)	01

12	Multiplication(URDHVATRIYAK)[गुणाकार(उर्ध्वतियक्)] Multiplicationoftwo4-digitnumbers(४अंकासंयांचागुणाकार)	01
13	Multiplication(URDHVATRIYAK)[गुणाकार(उर्ध्वतियक्)] Multiplicationof2-digitwith3-digitnumber[२-अंकीसं%ेसोबत३-अंकी सं%ेचा गुणाकार]	01
14	Multiplication(URDHVATRIYAK)[गुणाकार(उर्ध्वतियक्)] Multiplicationof2-digitwith4-digitnumber[२-अंकीसं%ेसोबत४-अंकी सं%ेचा गुणाकार]	01
15	Multiplication(URDHVATRIYAK)[गुणाकार(उर्ध्वतियक्)] Multiplicationof3-digitwith4-digitnumber[३-अंकीसं%ेसोबत४-अंकी सं%ेचा गुणाकार]	01
TOTAL		15

RecommendedBooks:

- 1) **The power of Vedic Maths with Trigonometry** (English 2nd Edition): By Atul Gupta, Jaico Publishing House Ahmedabad, Bangalore, Chennai, Delhi, Hyderabad, Kolkata, Mumbai.
Scope:[Chapter-4,Chapter-5]
- 2) **वैदिकगिणताचेसामांशिकोणिमतीसह**(मराठीररीआवृक्की):अतुलगुप्ता,जयकोपणीसंगहाउस अहमदाबाद , बँगलोर, चेन्नई , िदली, हैदराबाद , कोलकाता , मुंबई .
Scope:[पंकरण-४,पंकरण-५]

ReferenceBooks:

- 1) Vedic Mathematics (English Edition): The original Vedic Mathematics in Marathi by Jagadguru Swami Sri Bharati Krishna Tirthaji Maharaj (Author), S. N. Bhaavsar (Author), Publisher: Motilal Banarsidass.
- 2) वैदिक गिणत (मराठी आवृक्की) : अनुवादक: संदीप दकात्रे लेले, संपादक: डॉ. सं. ना. भावसार, मोतीलाल बनारसीदासपब्लिशिंगहाउस, िदली.
- 3) Vedic Mathematics Made Easy (English 2nd Edition): By Dhaval Bathia, Jaico Publishing House Ahmedabad, Bangalore, Chennai, Delhi, Hyderabad, Kolkata, Mumbai.
- 4) सरळवैदिकगिणत(मराठीररीआवृक्की) :धवलबिथया, जयकोपणीसंगहाउसअहमदाबाद,बँगलोर,चेन्नई, िदली,हैदराबाद,कोलकाता ,मुंबई

SEMESTER–III
SKILL ENHANCEMENT COURSE-I Mathematics Typesetting using Latex-I
(2602USMTSE301)
CREDIT: 2 PRACTICAL HOURS:60 MARKS:50

Course Outcomes:

After successful completion of this course, the students will be able to :

CO1	learn mathematics typing setting using Latex
CO2	learn Styling pages, formatting: bold, italic, underlining, and comments
CO3	learn adding math to LaTeX, fractions and binomials and Integral and limits
CO4	learn equations and its alignment, Math Accents and Delimiters
CO5	learn creating and using Theorems
CO6	learn drawing diagrams

SYLLABUS

Sr. No	Title of the Practical	No. of Practical(s)
1	Introduction to LaTeX	01
2	Styling pages	01
3	Formatting: bold, italic, underlining, and comments	01
4	Subscript and superscript	01
5	Adding math to LaTeX	01
6	Fractions and binomials	01
7	Integral and limits	01
8	Equations and its alignment	01
9	Math Accents	01
10	Delimiters	01
11	Matrix	01
12	Creating list	01
13	Math Functions	01
14	Creating and Using Theorems	01
15	Drawing Diagrams	01
	TOTAL	15

Reference books:-

1. "LaTeX Tutorials - A Primer" by Indian TeX Users Group, Trivandrum, India 2003 September.

Link:<https://www.tug.org/twg/mactex/tutorials/ltxprimer-1.0.pdf>

2. The Not So Short Introduction to LATEX, Tobias Oetiker, Marcin Serwin Hubert Partl, Irene Hyna and Elisabeth Schlegl.

Link:<https://tobi.oetiker.ch/lshort/lshort.pdf>

3. LaTeXWikibook

Link:<https://upload.wikimedia.org/wikipedia/commons/2/2d/LaTeX.pdf>

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SEMESTER – III
VOCATIONAL SKILL COURSE (Major Specific) Introduction to SciLab
(2602USMTVS301)

CREDIT: 2. PRACTICAL HOURS:60 MARKS:50

Course Outcomes:

After successful completion of this course, the students will be able to:

CO1	learn the Euler's theorem on homogeneous functions.
CO2	learn the concept of Jacobian of a transformation.
CO3	understand the concept of gradient, divergence and curl of point functions in terms of cartesian co-ordinate system.
CO4	evaluate the gradient, divergence and curl of point functions
CO5	analyze and evaluate improper integrals with infinite limits.
CO6	apply Beta and Gamma functions to solve integrals and demonstrate their properties and interrelationships.

SYLLABUS

Sr. No	Title of the Practical	No. of Practical(s)
1	Introduction to Scilab: Overview of Scilab and its applications in mathematics. Installing Scilab, Scilab environment: Console window, Command History window, Variable Browser window, File Browser window, SciNotes window, Graphics window. Getting Help in Scilab. Use of Scilab as a calculator.	02
2	Basics of Scilab: Introduction, Character Set. Data types: Integer data type, Real data type, Complex data type, Boolean data type, String data type. Constants and Variables in Scilab, Operators: Arithmetic, Relational, Logical. Hierarchy of Operations, Scilab Expressions, Built-in Functions	02
3	Polynomial: Polynomial creation, Polynomial evaluation, Roots of a Polynomial, Polynomial Arithmetic Operations, Polynomial Differentiation and Integration	01
4	Basic Elements of Scilab as a Programming Language: Scilab Editor, Scilab Keywords, Predefined Variables, Input and Output Statements, Assignment statements, Simple Programs based on elementary operators.	02
5	Conditional structure: if-else, if-elseif-else, select-case, Simple Programs based on conditional structure.	01
6	Looping structure: for loop, while loop, break and continue statement, Simple Programs based on Looping structure.	02
7	Vectors and Matrices: Row matrix, column matrix, general matrix, operation on matrix addition, subtraction, product. Advanced matrix operations: Matrix functions: eye(), zero(), ones(), empty matrix, element-wise operation, determinant, inverse, trace of matrix & eigen values and vectors of matrix	02
8	Functions: Defining custom functions and Programs based on it.	01
9	Recursive Functions: Defining Recursive functions and Programs based on it.	01
10	Plotting graph: Creating two dimensional graphs of simple functions.	01
	TOTAL	15

Reference Books:-

- 1) **Advanced Programming in SciLab**: Chetana Jain, Alpha Science International Ltd (2020).
 - 2) **Engineering and Scientific Computing with Scilab 1999th** Edition by Claude Gomez (Editor), C. Bunks (Contributor), J.-P. Chancelier (Contributor), F. Delebecque (Contributor), M. Goursat (Contributor), R. Nikoukhah (Contributor), S. Steer (Contributor)
 - 3) **Introduction to Scilab**: For Engineers and Scientists Book by Sandeep Nagar
 - 4) **Official Scilab Documentation**: www.scilab.org.
 - 5) **Scilab**: A Practical Introduction to Programming and Problem Solving Kindle Edition by Tejas Sheth (Author)
 - 6) **Scilab**: A Hands-on Introduction by Satish Annigeri.
 - 7) **Scilab**: From Theory to Practice - I. Fundamentals Book by Philippe Roux
- Sample problems:-**

- **Conditional structure (if...else)**

1. Write a program to check whether a given number is maximum/minimum.
2. Write a program to check whether a given number is odd or even.
3. Write a program to check whether a given year is a leap year or not.

- **Looping structure (for loop)**

4. Write a program to find the sum of n natural numbers.
5. Write a program to find factorial of n .
6. Write a program to generate STAR pattern.
7. Write a program to generate Pascal triangle.
8. Write a program to find $\exp(x)$, $\sin(x)$, $\cos(x)$ using series expansion.

- **Looping structure (while loop)**

9. Write a program to find the sum of n natural numbers.
10. Write a program to find factorial of n .
11. Write a program to check whether a given number is prime or not.
12. Write a program to find prime GCD of the given numbers.
13. Write a program to find the reverse of the given number.
14. Write a program to find prime factors of the given number.

- **Function and Recursive Function**

15. Write a function to find factorial of number and use it to find $(n)_k$.
16. Write a recursive function to find factorial of number and use it to find $(n)_k$.
17. Using recursive function write a program that convert given decimal number to binary number.

SEMESTER – IV

Mathematics MAJOR PAPER VII: Differential Calculus (2602USMTMJ401)

CREDITS: 2, LECTURE HOURS: 2 PER WEEK, MARKS: 50

Course Outcomes:

After successful completion of this course, the students will be able to:

CO1	evaluate the limit and examine the continuity of a function at a point.
CO2	understand conceptual variations while advancing from one variable to several variables in differential calculus.
CO3	set and solve optimization problems involving several variables.
CO4	learn the concept of Jacobian of a transformation.

SYLLABUS

Unit-1: Limit, Continuity and Differentiability

(12hrs.)

1.1 Left hand and Right hand limits (do not use ϵ - δ definition).

1.2 Properties of limits:

Theorem (without proof): If f and g are two functions defined on some neighborhood of c such

that $\lim_{x \rightarrow c} f(x) = L$, $\lim_{x \rightarrow c} g(x) = M$ then

$$(\square) \quad \lim_{x \rightarrow c} (f(x) + g(x)) = L + M$$

$$(\square\square) \quad \lim_{x \rightarrow c} (f(x) - g(x)) = L - M$$

$$(\square\square\square) \quad \lim_{x \rightarrow c} (f(x) \cdot g(x)) = L \cdot M$$

$$(\square\square\square) \quad \lim_{x \rightarrow c} (f(x)/g(x)) = L/M \text{ if } M \neq 0$$

1.3 Evaluation of limit: Examples (using techniques like factorization, rationalization, Left hand and Right hand limits).

1.4 Continuous functions: definition of Continuity at a point, definition of continuity in an interval.

1.5 Properties of continuous functions:

1.5.1 Theorem: Let f and g be two functions continuous at a point c , then the functions $f + g$

$f - g$, $f \cdot g$ are also continuous at c and if $f(c) \neq 0$, then f/g is also continuous at

c . Functions continuous on closed intervals:

1.5.2 Definition of bounded function

1.5.3 Theorem (Statement only): If a function f is continuous in a closed interval, then it is bounded therein.

1.5.4 Theorem: If a function f is continuous on a closed interval $[a, b]$, then it attains its bounds at least once in $[a, b]$.

1.5.5 Theorem(Statement only): If a function f is continuous at an interior point a of an interval $[a, b]$ and $f'(a) \neq 0$, then $\exists \delta > 0$ such that $f'(x)$ has the same sign as $f'(a)$, for every $x \in (a - \delta, a + \delta)$.

1.5.6 Corollary(Statement only): If f is continuous at the endpoint a of $[a, b]$ and $f'(a) \neq 0$, then there exists an interval $(a - \delta, a)$ such that $f'(x)$ has the sign of $f'(a)$ for all x in $(a - \delta, a)$.

1.5.7 Corollary(Statement only): If f is continuous at the endpoint a of $[a, b]$ and $f'(a) \neq 0$, then there exists an interval $[a, a + \delta)$ such that $f'(x)$ has the sign of $f'(a)$ for all x in $[a, a + \delta)$.

1.5.8 Theorem(Statement only): If a function f is continuous on a closed interval $[a, b]$ and $f(a)$ and $f(b)$ are of opposite signs ($f(a) \cdot f(b) < 0$), then there exists at least one point $c \in (a, b)$ such that $f(c) = 0$.

1.5.9 Intermediate Value Theorem.

1.5.10 Corollary(Statement only): A function f , which is continuous on a closed interval $[a, b]$, assumes every value between its bounds.

1.6 Discontinuous functions: Definition, Types of discontinuities – (i) removable discontinuity (ii) discontinuity of first kind (iii) discontinuity of second kind.

1.7 Examples on 1.4 and 1.6

1.8 Differentiability at a point and Differentiability in an interval: definitions.

1.9 Examples on 1.8.

1.10 (Differentiability and continuity) Theorem: A function which is derivable at a point is necessarily continuous at that point.

Unit–2: Partial derivatives, Jacobian and Extreme values

(18hrs.)

2.1 Partial derivatives:

2.1.1 Total Differentials.

2.1.2 Differentiation of composite functions.

2.1.3 Homogeneous functions: definition.

2.1.4 Euler's theorem on homogeneous functions (Case of two and three variables)

2.1.5 Examples on 2.1.2, 2.1.3, 2.1.4.

2.2 Jacobian

2.2.1 Definition of Jacobian and examples.

2.2.2 Jacobian of function of functions (proof of the corollary $\frac{\partial x}{\partial x} = 1$ is expected).

2.2.3 Jacobian of implicit functions (without proof)

2.2.4 Examples on 2.2.2 and 2.2.3.

2.3 Extreme values

2.3.1 Maxima and minima of functions of two variables: Sign of quadratic expression, Lagrange's condition for stationary value.

2.3.2 Lagrange's method of undetermined multipliers for three variables.

2.3.3 Examples on 2.3.1 and 2.3.2.

Recommended Books:

1. **Mathematical Analysis**, S.C. Malik and Savita Arora, New Age International Publishers, 4th Edition (2012) – For Unit 1 of the syllabus.
[Scope: Chapter 5 – section 1.1, 1.2, section 2.1, 2.2, 2.3, 2.4, section 3, Chapter 6 – section 1.1, 1.2, section 2 (Theorem 1), 2.1].
2. **Differential Calculus**, Shanti Narayan and P.K. Mittal, S. Chand publishing, 15th edition (2016) – For Unit 2 of the syllabus.
[Scope: Chapter 11 – 11.8, 11.8.1, 11.9.1, 11.9.2, 11.9.3, Chapter 12 – 12.1, 12.2, 12.3 Chapter 9 – 9.6, 9.6.1, 9.6.2, 9.6.3, 9.6.4, 9.7]

Reference Books:

1. **Differential Calculus**, Gorakh Prasad, Pothishala Pvt. Ltd., 19th edition (2016).
2. **Aspects of Calculus**, Gabriel Klambauer, Springer-Verlag. (1986)
3. **Basic Multivariable Calculus**, J.E. Marsden, A.J. Tromba & A. Weinstein; Springer Verlag, New York, 1993.

SEMESTER – IV

Mathematics MAJOR PAPER VIII: Integral Calculus (2602USMTMJ402)

CREDITS: 2, LECTURE HOURS: 2 PER WEEK, MARKS: 50

Course Outcomes:

After successful completion of this course, the students will be able to:

CO1	understand special functions.
CO2	understand types of multiple integrals.
CO3	apply special functions to evaluate multiple integrals.
CO4	solve integrals using differentiation under the integral sign

SYLLABUS

Unit I.

(15 Hrs.)

1.1 Gamma function.

1.1.1 Definition of Gamma function and examples.

1.1.2 Properties of Gamma function.

$$1.1.2.1 \Gamma(1) = 1$$

$$1.1.2.2 \Gamma(n+1) = n \Gamma(n) \text{ in general.}$$

$$1.1.2.3 \Gamma(n+1) = n! \text{ if } n \text{ is positive integer.}$$

$$1.1.2.4 \Gamma(0) = \infty, \Gamma(\infty) = \infty$$

$$1.1.2.5 \Gamma(x) = 2 \int_0^{\infty} x^{x^2} e^{-x^2} dx, x > 0$$

$$1.1.2.6 \Gamma(x) = \int_0^{\infty} e^{-kx} x^{n-1} dx, k > 0$$

1.1.2.7 Examples based on article 1.1.2.

1.2 Beta function.

1.2.1 Definition of Beta function and examples.

1.2.2 Properties of Beta function.

$$1.2.2.1 \Gamma(x) \Gamma(y) = \Gamma(x+y) \int_0^1 t^{x-1} (1-t)^{y-1} dt; x, y \geq 0$$

$$1.2.2.2 \Gamma(x) \Gamma(y) = 2 \int_0^{\frac{\pi}{2}} \sin^{2x-1} \theta \cos^{2y-1} \theta d\theta; x, y \geq 0$$

$$1.2.2.3 \int_0^{\frac{\pi}{2}} \sin^p \theta \cos^q \theta d\theta = \frac{1}{2} \left(\frac{p+1}{2}, \frac{q+1}{2} \right) \Gamma\left(\frac{p+1}{2}\right) \Gamma\left(\frac{q+1}{2}\right) \Gamma\left(\frac{p+q+1}{2}\right)^{-1}$$

1.2.2.4 Relation between Beta and Gamma function

$$\Gamma(x) \Gamma(y) = \frac{\Gamma(x) \Gamma(y)}{\Gamma(x+y)}, m, n > 0$$

$$1.2.2.5 \Gamma\left(\frac{1}{2}\right) = \sqrt{\pi}$$

$$1.2.2.6 \Gamma(x) \Gamma(y) = \int_0^{\infty} \frac{x^{m-1}}{(1+x)^{m+n}} dx$$

$$1.2.2.7 \Gamma(x) \Gamma(y) = \int_0^{\infty} \frac{x^{m-1}}{(a+bx)^{m+n}} dx$$

$$1.2.2.8 \Gamma(x) \Gamma(y) = \int_0^1 \frac{x^{m-1} (1-x)^{n-1}}{(1+x)^{m+n}} dx$$

1.2.2.9 Duplication formula of Gamma function.

1.2.3 Examples based on 1.2.2

Unit 2.

(15 Hrs.)

2.1 Differentiation under the integral sign

- 2.1.1 Leibnitz first rule of differentiation under the integral sign.
- 2.1.2 Leibnitz second rule of differentiation under the integral sign.
- 2.1.3 Examples based on articles 2.1.1 and 2.1.2.

2.2 Multiple Integrals

- 2.2.1 Double Integral: Evaluation of double integrals.
- 2.2.2 Evaluation of double integrals in Cartesian form.
- 2.2.3 Evaluation of double integrals in Polar form.
- 2.2.4 Evaluation of double integrals in Cartesian form over the given region.
- 2.2.5 Evaluation of double integrals from Cartesian form to Polar form.
- 2.2.6 Triple integrals: Evaluation of triple integrals.
- 2.2.7 Proof of

$$\int_0^1 \int_0^1 \frac{1}{1+x^n y^m} dx dy = \frac{1}{m} \left(1 - \frac{1}{n} \right) \int_0^1 \frac{1}{1+x^n} dx, m, n > 0$$

Recommended Books:-

1. Shanti Narayan and Dr. P. K. Mittal, Integral Calculus, S. Chand and Company, New Delhi, 2015. [**Scope** Chapter VII: 7.1 to 7.3, 7.5]
2. P. N. Wartikar and J. N. Wartikar, A text book of Applied Mathematics, Pune Vidhyarthi Griha Prakashan, Pune. Vol. I, 2011. [Scope Chapter XVI: 16.1 to 16.5, Chapter XIX: 19.1 to 19.3]

Reference Books:-

1. P. N. Wartikar and J. N. Wartikar, A text book of Applied Mathematics, Pune Vidhyarthi Griha Prakashan, Pune. Vol. I, 2011.
2. Shanti Narayan and Dr. P. K. Mittal, Integral Calculus, S. Chand and Company, New Delhi, 2015.
3. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, Delhi, 2012.
4. Gorakh Prasad, Integral Calculus, Pothishala Pvt. Ltd., Allahabad
5. Dass H. K, Advanced Engineering Mathematics, 22e, S. Chand and Company, New Delhi, 2018.

SEMESTER – IV
Major Mathematics Practical-IV (2602USMTMJ403)
(based on Major Paper VII and VIII)

CREDIT: 2. PRACTICAL HOURS:60 MARKS:50

Course Outcomes:

After successful completion of this course, the students will be able to:

CO1	evaluate the limit and examine the continuity of a function at a point.
CO2	understand conceptual variations while advancing from one variable to several variables in differential calculus.
CO3	set and solve optimization problems involving several variables.
CO4	learn the concept of Jacobian of a transformation.
CO5	understand special functions.
CO6	understand types of multiple integrals.
CO7	apply special functions to evaluate multiple integrals.
CO8	solve integrals using differentiation under the integral sign

SYLLABUS

Sr. No	Title of the Practical	No. of Practical(s)
1	Examples on evaluation of Limit	01
2	Examples on Continuity	01
3	Examples on Euler's theorems on homogeneous functions	01
4	Examples on Jacobian	02
5	Extreme values of functions of two variables	01
6	Lagrange's method of undetermined multipliers	01
7	Gamma function	02
8	Beta function	02
9	Differentiation under integral sign	02
10	Evaluation of double integrals in Cartesian form over the given region.	01
11	Evaluation of triple integrals	01
	TOTAL	15

Mathematics MINOR PAPER VII: Laplace Transform (2602USMTMN401)

CREDITS: 2, LECTURE HOURS: 2 PER WEEK, MARKS: 50

Course Outcomes:

After successful completion of this course students will able to:

CO1	understand definitions and existence conditions of the Laplace transform
CO2	apply key properties of the Laplace transform
CO3	understand inverse Laplace transform
CO4	Apply Laplace transform to solve differential equations.

SYLLABUS

Unit1. Laplace Transform

(15Hrs.)

- 1.1 Definitions: Piecewise or Sectional Continuity, Function of Exponential Order, Function of Class 'A'.
- 1.2 The Transform Concept, Definition of Laplace Transform, Notation.
- 1.3 Existence of Laplace Transform (Statement only).
- 1.4 Linear Property, First Shifting Theorem, Second Shifting Theorem and Change of Scale Property.
- 1.5 Some Standard Results
- 1.6 Laplace transform of derivatives, Laplace transform of integrals.
- 1.7 Multiplication by powers of 't', Division by 't'.
- 1.8 Periodic functions.
- 1.9 Examples based on 1.1 to 1.8

Unit2. Inverse Laplace Transform

(15Hrs.)

- 2.1 Definition of Inverse Laplace Transform and Null function. Uniqueness Theorem.
- 2.2 Linear property
- 2.3 First shifting theorem, second shifting theorem, Unit step function, change of scale property.
- 2.4 Inverse Laplace transform of derivatives, Division by 's'.
- 2.5 The Convolution theorem, Multiplication by 's'.
- 2.6 Inverse Laplace by partial fractions, Heaviside's Expansion formula.
- 2.7 Application to solve Ordinary Linear Differential Equations with constant and Variable Coefficients
- 2.8 Examples based on 2.1 to 2.7

Recommended Book:

1. J.K. Goyal, K.P. Gupta, Integral Transforms, A Pragati Prakashan, Meerut, 21th edition, 2021.

Scope:

Unit1: Chapter 1 Part I: 1.0 to 1.6, **Unit2:** Chapter 1 Part II: 1.0 to 1.3. Part III 1.0 to 1.1

Reference Books:

1. Dr. S. Sreenadh, Fourier series and Integral Transform, S. Chand, New Delhi, 2021
2. B. Davies, Integral Transforms and Their Applications, Springer Science, 2017.
3. Murray R. Spiegel, Laplace Transforms, Schaum's outlines, 2018.

Mathematics MINOR PAPER VIII: Computational Mathematics-II (2602USMTMN402)

CREDITS: 2, LECTURE HOURS: 2 PER WEEK, MARKS: 50

Course Outcomes:

After successful completion of this course students will able to:

CO1	apply various interpolation methods.
CO2	Approximate polynomials for the real-life data.
CO3	Construct and interpret finite difference tables for data analysis.
CO4	Apply interpolation techniques in solving problems related to computer science, such as curve fitting and numerical estimation.

SYLLABUS

Unit1. Interpolation on Evenly Spaced Points

(15Hrs.)

1.1 Introduction: Interpolation, Extrapolation, Interpolating polynomial.

1.2 Finite Differences: Forward Differences (Δ), Backward Differences (∇), Central Differences (δ).

1.3 Shift Operator (E) and mean operator (μ).

1.4 Symbolic Relations and Separation of Symbols.

1.4.1. Show that $\Delta = E - 1$, $\nabla = 1 - E^{-1}$, $\delta = E^{\frac{1}{2}} - E^{-\frac{1}{2}}$, $\mu = \frac{1}{2}(\delta + \delta^{-1})$,

$$\delta^2 = 1 + \frac{1}{4}\delta^{-2}, \Delta^2 = \delta\delta^{-1}\delta = \delta\delta^{-1}\delta^{-1}\delta^2.$$

1.4.2. Show that $\delta \equiv \delta^{hd}$, where $\delta \equiv \frac{d}{dx}$.

1.4.3. Show that $\Delta^n x^n = n! x$, $\nabla^n x^n = n! x$, $\delta^n x^n = \frac{n(n-1)}{2} x^{n-2} + \dots + (-1)^n x^{n-n}$.

1.4.4. Show that $\delta^n x^n = \left(\frac{x^n}{n!} + \frac{\Delta x^n}{n!} + \frac{\Delta^2 x^n}{2!} + \dots \right) = \frac{x^n}{n!} + \frac{\Delta x^n}{1!} + \frac{\Delta^2 x^n}{2!} + \dots$

1.5 Forward and Backward Differences of a polynomial.

1.6 Newton's Forward and backward Formulae for Interpolation.

1.7 Examples based on 1.1 to 1.6

Unit2. Interpolation on Unevenly Spaced Points

(15Hrs.)

2.1 Lagrange's Interpolation Formula.

2.2 Divided Difference and Their Properties.

2.3 Newton's General Interpolation Formula.

2.4 Method of successive approximations

2.5 Examples based on 2.1 to 2.4

Recommended Book:

1. S.S. Sastry - Introductory Methods of Numerical Analysis: Fifth Edition, Prentice Hall India Learning Private Limited, New Delhi (2012).

Scope:Unit1:Chapter3Section3.1,3.3,3.5,3.6and3.7.1,Unit2:Chapter3Section3.9to3.11

Reference Books:

- 1 B.S.Grewal-NumericalMethodsInEngineeringAndScience:C,C++,andMatLab,Mercury Learning and Information, New Delhi (2012).
- 2 M.K.Jain,S.R.K.IyengarandR.K.Jain,NumericalMethodsforScientificandEngineering Computation, New Age International Publisher, Mumbai (2012).

SEMESTER – IV
Minor Mathematics Practical-IV (2602USMTMN403)
(based on Minor Paper VII and VIII)
CREDIT: 2. PRACTICAL HOURS:60 MARKS:50

Course Outcomes:

After successful completion of this course students will able to:

CO1	apply various interpolation methods.
CO2	approximate polynomials for the real-life data.
CO3	construct and interpret finite difference tables for data analysis.
CO4	apply interpolation techniques in solving problems related to computer science, such as curve fitting and numerical estimation.
CO5	understand definitions and existence conditions of the Laplace transform
CO6	apply key properties of the Laplace transform
CO7	understand inverse Laplace transform
CO8	apply Laplace transform to solve differential equations.

SYLLABUS

Sr. No	Title of the Practical	No. of Practical(s)
1	Properties of Finite Differences	01
2	Forward and Backward Differences of a polynomial	01
3	Examples on Newton's forward difference formula	01
4	Examples on Newton's backward difference formula	01
5	Examples on Lagrange's interpolation formula.	01
6	Examples on Newton's general interpolation formula	01
7	Examples on Method of successive approximations	01
8	Laplace transform of Derivative and Integrals	02
9	Multiplication by powers of 't', and division by 't'.	02
10	Laplace transform of Periodic Functions	01
11	Inverse Laplace by Convolution theorem	01
12	Inverse Laplace by partial fractions	01
13	Application to Linear differential equations	01
	TOTAL	15

SEMESTER-III
OPEN ELECTIVE - IV: VEDIC MATHEMATICS-II (2602USMTOE401)
CREDIT: 2 PRACTICAL HOURS:60 MARKS:50

Course Outcomes:

After successful completion of this course, the students will be able to do:

CO1	division by a flag of one digit
CO2	division with adjustments.
CO3	division by a flag of two and three digits
CO4	simple squares and square roots
CO5	Cube and cuberoots

SYLLABUS

Sr. No	Title of the Practical	No. of Practical(s)
1	Division[भागकार] Division by a flag of one digit (no remainder) [एक अवजांक ठेवनूफ एक अंकाने भागाकार (बाका विरहीत)]	01
2	Division[भागकार] Division by a flag of one digit (with remainder) [एक अवजांक ठेवनूफ एक अंकाने भागाकार (बाका असताना)]	01
3	Division[भागकार] Division with adjustments [काहीतर तूदकरीत भागाकार]	01
4	Division[भागकार] Division with a flag of 2 digits [२ अंकी ठेवांक ठेवनू एक अंकाने भागाकार]	01
5	Division[भागकार] Division with a flag of 3 digits [३ अंकी ठेवांक ठेवनू एक अंकाने भागाकार]	01
6	Simple Squares (सरलवग) Case 1: Numbers ending in 5. [५ हा अंक शेवटचा असतानाची कृती.] Case 2: Two numbers starting with same digit and ending digits adding up to 10. [समान अंकाने सुड होणाऱ्या आणि शेवटचा अंकांची बेरीज १० येणाऱ्या दोन संख्येची लगुणाकार]	01
7	Square of any Number [कोणत्याही अंकाचा वग] I. Definition: Dwandwa or Duplex (० या या: ०० दिक्क वादुष्ट) a) Duplex of a single digit (एक अंकासं येयादुष्ट दची ० या या) b) Duplex of two digits (दोन अंकासं येयादुष्ट दची ० या या) c) Duplex of 3 digits (तीन अंकासं येयादुष्ट दची ० या या) d) Duplex of 4 digits (चार अंकासं येयादुष्ट दची ० या या) e) Duplex of 5 digits (पाच अंकासं येयादुष्ट दची ० या या)	01
8	II. Square of any Number [कोणत्याही अंकाचा वग] Problems on square of any number (कुठल्याही संख्येचा वग)	01
9	Square root of a number (कुठल्याही संख्येचा मूळ काढणे) I) Perfect square root (पूर्णवग मूळ)	01

10	Squarerootofanumber(कुठडयाहीसं येचेवगमूळकाढणे) II) Imperfect squareroot asadecimal number (अपूणN सं%ा असलेले वगNमूळअथान तदशांशच5ातीलवगNमूळ)	01
11	Squarerootofanumber(कुठडयाहीसं येचेवगमूळकाढणे) Perfectsquarerootasadecimalnumber	01
12	Squarerootofanumber(कुठडयाहीसं येचेवगमूळकाढणे) III)Squareroot withadjustments(काहीतडजोडीकN वगNमूळकाढणे)	01
13	CubesandCubeRoots[घनआणघनमूळ] Computingcubesof2-digitnumbers[दोनअंकीसं%ांचाघनकाढणे]	01
14	CubesandCubeRoots[घनआणघनमूळ] Computing cube roots of 2-digit numbers [दोन अंकी सं%ांचे घनमूळकाढणे]	01
15	CubesandCubeRoots[घनआणघनमूळ] Computing fourth power of 2-digit numbers [दोन अंकी सं%ांचा चुभयतांक काढणे]	01
	TOTAL	15

RecommendedBooks:

- 1) **The power of Vedic Maths with Trigonometry** (English 2nd Edition): By Atul Gupta, Jaico Publishing House Ahmedabad, Bangalore, Chennai, Delhi, Hyderabad, Kolkata, Mumbai.

Scope:[Chapter-6to10]

- 2) **वैदिक गिणताचे सामाििकोणिमतीसह** (मराठी २ री आवृKी) : अतुल गुमा, जयको पपीसिंग हाउस अहमदाबाद , बैंगलोर , चेई , िदवी , हैाबाद , कोलकका , मुंबई .

Scope:[पंकरण-६ते१०]

ReferenceBooks:

- 1) Vedic Mathematics (English Edition): The original Vedic Mathematics in Marathi by Jagadguru Swami Sri Bharati Krishna Tirthaji Maharaj (Author), S. N. Bhaavsar (Author), Publisher: Motilal Banarsidass.
- 2) वैदिकगिणत(मराठीआवृKी):अनुवादक:संदीपदकाअलेले,संपादक:डॉ.सं.ना.भावसार,मोतीलाल बनारसीदासपुपीशसनायपेटिलिमटेड,िदवी.
- 3) Vedic Mathematics Made Easy (English 2nd Edition): By Dhaval Bathia, Jaico Publishing House Ahmedabad, Bangalore, Chennai, Delhi, Hyderabad, Kolkata, Mumbai.
- 4) सरळवैदिकगिणत(मराठी२रीआवृKी):धवलबिथया,जयकोपपीसिंगहाउसअहमदाबाद,बैंगलोर, चेई , िदवी , हैाबाद , कोलकका , मुंबई .

SEMESTER–III
SKILL ENHANCEMENT COURSE-II Mathematics Typesetting using Latex-II
(2602USMTSE401)

CREDIT: 2

PRACTICAL HOURS:60

MARKS:50

Course Outcomes:

After successful completion of this course, the students will be able to :

CO1	learn basic document structure in LaTeX title,author,and date information and creating a table of contents
CO2	learn Spacing in Documents, Inserting images and Captions, Labels, and References for Figures
CO3	learn adding math to LaTeX, fractions and binomials and Integral and limits
CO4	learn Page numbering, Hyper links, References and citations and Creating Multicolumn Documents
CO5	learn Creating Footnotes and Endnotes, Customizing Fonts and Colors and Formatting Headers and Footers
CO6	learn Customizing Margins and Page Layout

SYLLABUS

Sr. No	Title of the Practical	No. of Practical(s)
1	Basic document structure in LaTeX	01
2	Title,author,and date information	01
3	Creating a table of contents	01
4	Spacing in Documents	01
5	Creating tables	01
6	Inserting images	01
7	Captions,Labels,andReferencesforFigures	01
8	Pagenumbering	01
9	Hyperlinks	01
10	Referencesandcitations	01
11	CreatingMulticolumnDocuments	01
12	CreatingFootnotesandEndnotes	01
13	CustomizingFontsandColors	01
14	FormattingHeadersandFooters	01
15	CustomizingMarginsandPageLayout	01
	TOTAL	15

Reference books:

1. "LaTeX Tutorials - A Primer" by Indian TeX Users Group, Trivandrum, India 2003 September.
Link:<https://www.tug.org/twg/mactex/tutorials/ltxprimer-1.0.pdf>
2. The Not So Short Introduction to LATEX, Tobias Oetiker, Marcin Serwin Hubert Partl, Irene Hyna and Elisabeth Schlegl.
Link<https://tobi.oetiker.ch/lshort/lshort.pdf>
3. LaTeXWikibook
Link:<https://upload.wikimedia.org/wikipedia/commons/2/2d/LaTeX.pdf>

SCHEME OF EXAMINATION:

- The examination shall be conducted at the end of each term for semester pattern.
- The theory paper shall carry 30 marks.
- The evaluation of the performance of the students in theory papers shall be on the basis of Semester Examination of 30 marks.
- The internal evaluation for each paper shall carry 10 marks. (Semester I and II: Home assignment, class assignment, unit test a and midterm test)
- Question paper will be set in the view of the /in accordance with the entire syllabus and preferably covering each unit of syllabi.

STANDARD OF PASSING: As prescribed under rules and regulation for each degree.

SPECIAL INSTRUCTIONS, IF ANY

Determination of CZPA, Grading and Declaration of result

University has adopted 10-point Grading System as follows:**In each semester, marks obtained in each course (Paper) are converted to grade points:** If the total marks of course are 100 and passing criteria is 40%, then use the following Table for the conversion.

Gradation Chart:

Table

Marks Obtained	Numerical Grade (Grade Point)	CGPA	Letter Grade
Absent	0 (zero)	-	Ab: Absent
0–39	0 to 4	0.0– 4.99	F: Fail
40– 49	5	5.00–5.49	C: Average
50– 54	6	5.50–6.49	B: Above Average
55– 64	7	6.50–7.49	B+: Good
65– 74	8	7.50–8.49	A: VeryGood
75– 84	9	8.50–9.49	A+: Excellent
85– 100	10	9.50–10.0	O: Outstanding

Note:

1. Marks obtained ≥ 0.5 shall be rounded off to next higher digit.
2. The SGPA & CGPA shall be rounded off to 2 decimal points.
3. Marks obtained in 50 marks or 200 marks paper shall be converted to 100 marks.

Calculation of SGPA & CGPA

1. Semester Grade Point Average (SGPA)

$$SGPA = \frac{\sum (\text{Course credits} \times \text{Grade points obtained}) \text{ of a semester}}{\sum (\text{Course credits}) \text{ of respective semester}}$$

2. Cumulative Grade Point Average (CGPA)

$$CGPA = \frac{\sum (\text{Total credits of a semester} \times \text{SGPA of respective semester}) \text{ of all semesters}}{\sum (\text{Total course credits}) \text{ of all semesters}}$$

NATURE OF THEORY QUESTION PAPER AND SCHEME OF MARKING:

Duration of question paper: As per University rule:

- | | | | |
|------|---------------------------------------|-----------|---------|
| i. | Duration of Examination for | 60 marks- | 2 Hours |
| ii. | Duration of Examination for | 30 marks- | 1 Hours |
| iii. | Duration of Practical Examination for | 50 marks- | 2 Hours |

Assessment pattern

For 4 Credits 60:40 (SSE : CIE)

For 2 Credits 30:20 (SSE : CIE)

ESE Question paper pattern for theory
(Mathematics Major and Minor)

Duration: 1 Hr

Total Marks: 30

Q. 1. Multiple choices questions (6-questions)

6 Marks

(It may include Wh que., match the pairs, true/false, multiple correct options MCQ etc.)

- i)
- ii)
- iii)
- iv)
- v)
- vi)

Q. 2. Attempt any two of the following

12 Marks

- A.
- B.
- C.

Q. 3. Short answer questions (any four) (out of six).

12 Marks

(It may include short notes, label the diagram, compare between, distinguish between etc.)

- a.
- b.
- c.
- d.
- e.
- f.

SSE Question paper pattern for Practical
(Mathematics Practical Major, Minor and SEC)

Duration: 2 Hr

Total Marks: 30

Q. 1.A 10 Marks

OR

Q.1 B 10 Marks

Q. 2.A 10 Marks

OR

Q.2 B 10 Marks

Q.3 Attempt any TWO

a)

b)

c)

Internal Evaluation

20 Marks

Journal 5

Practical Note Book 5

Oral based on practical 5

Tour report / Project/ Model etc. 5

SSE Question paper pattern for Practical
(Botany Open Elective – III and IV)

Duration: 3 Hr

Total Marks: 50

Q. 1. Long answer que -	10 Marks
Q. 2. Long answer que -	10 Marks
Q. 3. Long answer que -	10 Marks
Q. 4. Short answer que –	
a.	05 Marks
b.	05 Marks
Q. 5. Submission	
a. Journal	05 Marks
b. Field visit/ work Report	05 Marks

