Estd. 1962
"A++" Accredited by NAAC (2021)
With CGPA 3.52

SHIVAJI UNIVERSITY, KOLHAPUR - 416004, MAHARASHTRA
PHONE:EPABX-2609000, www.unishivaji.ac.in, bos@unishivaji.ac.in
शिवाजी विद्यापीठ, कोल्हापूर -४१६००४,महाराष्ट्र
दूरध्वनी-ईपीएबीएक्स -२६०९०००, अभ्यासमंडळे विभाग दुरध्वनी ०२३१—२६०९०९४
०२३१—२६०९४८७

Ref.No.SU/BOS/Science/434 **Date: 15/07/2025**

To,

The Principal,
All Concerned Affiliated Colleges/Institutions
Shivaji University, Kolhapur.

Subject: Regarding revised syllabi of B.Sc. Part-II (Sem.III & IV) degree programme under the Faculty of Science and Technology as per NEP-2020 (2.0)

Ref: No.SU/BOS/Science/270 & 271 Date: 03/05/2025 Letter.

Sir/Madam,

With reference to the subject mentioned above, I am directed to inform you that the university authorities have accepted and granted approval to the syllabi, nature of question paper of B.Sc. Part-II (Sem.III & IV) degree programme under the Faculty of Science and Technology as per NEP-2020 (2.0).

B.Sc.Part-II (Sem. III & IV) as per NEP-2020 (2.0)			
1.	Botany	8.	Geology
2.	Statistics	9.	Zoology
3.	Mathematics	10.	Chemistry
4.	Microbiology	11.	Electronics
5.	Plant Protection	12.	Industrial Microbiology
6.	B.A./B.A.B.Ed. Geography	13.	Biotechnology(Voc/Opt)
7.	Biotechnology(Entire)		

This syllabus, nature of question and equivalence shall be implemented from the academic year 2025-2026 onwards. A soft copy containing the syllabus is attached herewith and it is also available on university website www.unishivaji.ac.in NEP-2020@suk(Online Syllabus)

The question papers on the pre-revised syllabi of above-mentioned course will be set for the examinations to be held in October /November 2025 & March/April 2026. These chances are available for repeater students, if any.

You are, therefore, requested to bring this to the notice of all students and teachers concerned.

Thanking you,

Dy Registrar
Dr. S. M. Kubal

Encl: As above

for Information and necessary action

Copy to:

1	Dean, Faculty of Science & Technology	6	Appointment Section A & B
2	Director, Board of Examinations and Evaluation	7	I.T.Cell /Computer Centre
3	Chairman, Respective Board of Studies	8	Eligibility Section
4	B.Sc.-M.Sc. Exam Section	9	Affiliation Section (T.1) (T.2)
5	Internal Quality Assurance Cell (IQAC Cell)	10	P.G. Seminar Section

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MAHARASHTRA
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शिवाजी विद्यापीठ, कोल्हापूर -४१६००४,महाराष्ट्र
दूरध्वनी-ईपीएबीएक्स -२६०९०००, अभ्याससमंडळे विभाग दुरध्वनी ०२३१—२६०९०९४
०२३१—२६०९४८७

Ref.No.SU/BOS/Science/270 **Date: 03/05/2025**

To,

The Principal,
All Concerned Affiliated Colleges/Institutions
Shivaji University, Kolhapur.

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With reference to the subject mentioned above, I am directed to inform you that the university authorities have accepted and granted approval to the syllabi, nature of question paper of B.Sc. Part-II (Sem.III & IV) degree programme under the Faculty of Science and Technology as per NEP-2020 (2.0).

B.Sc.Part-II (Sem. III & IV) as per NEP-2020 (2.0)			
1.	Botany	8.	Geology
2.	Physics	9.	Zoology
3.	Statistics	10.	Chemistry
4.	Mathematics	11.	Electronics
5.	Microbiology	12.	Drug Chemistry
6.	Plant Protection	13.	Industrial Microbiology
7.	Astrophysics and Space Science	14.	Sugar Technology (Entire)

This syllabus, nature of question and equivalence shall be implemented from the academic year 2025-2026 onwards. A soft copy containing the syllabus is attached herewith and it is also available on university website www.unishivaji.ac.in NEP-2020@suk(Online Syllabus)

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You are, therefore, requested to bring this to the notice of all students and teachers concerned.

Thanking you,

Yours faithfully,

By Registrar
Dr. S. M. Kubal

Encl: As above

for Information and necessary action

Copy to:

1	Dean, Faculty of Science & Technology	6	Appointment Section A & B
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SHIVAJI UNIVERSITY, KOLHAPUR.

Accredited By NAAC with 'A++' Grade

Structure and Syllabus in Accordance with

National Education Policy - 2020

with Multiple Entry and Multiple Exit

Bachelor of Science (Mathematics) Part II (Level-5.0)

Semester III and IV

under the

Faculty of Science and Technology

(To Be Implemented from Academic Year 2025-26)

SHIVAJI UNIVERSITY, KOLHAPUR
NEP-2020(2.0): Credit Framework for UG(B.Sc.) Programme under Faculty of Science and Technology

PROGRAM STRUCTURE:

Structure in Accordance with National Education Policy – 2020
With Multiple Entry and Multiple Exit Options
B.Sc. (Mathematics) Part – II (Level-5.0)

SEM (Level)	COURSES			OE	VSC/SEC	AEC/VEC/IKS	OJT/FP/CEP /CC/RP	Total Credits	Degree/Cum. Cr. MEME
	MAJOR		MINOR						
SEM – III (5.0)	**MAJOR -V (2)** Differential Equations - II **MAJOR -VI (2)** Numerical Methods **MAJOR Pract.-III(2)** Mathematics Practical-III	--	**MIN-V (2)** Computational Mathematics for Sciences-I **MIN-VI (2)** Improper Integrals & Special Functions **MIN Pract.-III(2)** Mathematics Practical-III	**OE-3 (2) (P)** Vedic Mathematics Part- II [वैदिक गणित भाग-१]	**VSC-I(2)(P)** Introduction to SciLab **SEC-I(2)(P)** Mathematics Typesetting using Latex-I	**AEC-I(2)** (English)	**CC-I(2)**	**22**	**UG Diploma 88**
SEM - IV (5.0)	**MAJOR -VII (2)** Differential Calculus **MAJOR -VIII (2)** Integral Calculus **MAJOR Practi.-IV (2)** Mathematics Practical-IV	--	**MIN-VII (2)** Computational Mathematics for Sciences-II **MIN-VIII (2)** Laplace Transform **MIN Practi.-IV(2)** Mathematics Practical-IV	**OE-4 (2) (P)** Vedic Mathematics Part- II [वैदिक गणित भाग-२]	**SEC-II(2)(P)** Mathematics Typesetting using Latex-II	**AEC-II(2)** (English) **VEC-II(2)** (Environmental Studies)	**CEP-I(2)**	**22**	
Credits	**8(T)+4(P)=12**		**8(T)+4(P)=12**	**2(P)+2(P)=4**	**4(P)+2(P)=6**	**2+4=6**	**2+2=4**	**44**	**Exit Option:4 credits NSQF/Internship/Skillcourses**

Abbreviations:

AEC	Ability Enhancement Course
CC	Co-curricular Courses
CEP	Community Engagement and Service
DSC	Department Specific Core
DSE	Department Specific Elective
FP	Field Project
GE	Generic Elective
IDC	Inter-Disciplinary Course
IKS	Indian Knowledge System
MDC	Multidisciplinary Course
MIN	Minor
OE	Open Elective
OEC	Open Elective Course
OJT	On Job Training
P	Practical
RP	Research Project
SEC	Skill Enhancement Course
T	Theory
VEC	Value Education Course
VSC	Vocational Skill Course

Semester III

B.Sc. (Mathematics) (Part II) (Level 5.0) (Semester – III)
(NEP – 2020)
Syllabus to be implemented from Academic Year 2025-26

Course type	**:**	**Major -V (Theory)**
Title of course	**:**	**Differential Equations-II**
Credit	**:**	**02**

Course Learning Outcomes: Upon successful completion of this course students will 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.

Unit 1: ***(15 Hrs.)***

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 p
- 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: ***(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:- Unit1: 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 10.5 A), 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.

B.Sc. (Mathematics) (Part II) (Level 5.0) (Semester – III)
(NEP – 2020)
Syllabus to be implemented from Academic Year 2025-26

Course type	**:**	**Major -VI(Theory)**
Title of course	**:**	**Numerical Methods**
Credit	**:**	**02**

Course Learning Outcomes: Upon successful completion of this course students will 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.

Unit 1: ***(15 Hrs.)***

1.1 Solutions of Algebraic and Transcendental Equations:

1.1.1 Introduction
1.1.2 Basic properties of equations
1.1.3 Synthetic division of a polynomial by a linear expression
1.1.4 Bisection Method
1.1.5 Method of False Position or Regula-Falsi Method
1.1.6 Newton- Raphson method
1.1.7 Examples based on art.1.1.2 to 1.1.6

1.2 Interpolation

1.2.1 Introduction
1.2.2 Finite differences
  1.2.2.1 Forward and inverse forward difference operator
  1.2.2.2 Backward and inverse backward difference operator
1.2.3 Shift and inverse shift operator
1.2.4 Relations between above operators
1.2.5 Interpolation with equal intervals
  1.2.5.1 Newton's forward interpolation formula
  1.2.5.2 Newton's backward interpolation formula
1.2.6 Interpolation with unequal intervals : Lagrange's interpolation formula
1.2.7 Examples based on art.1.2.2 to 1.2.6

Unit 2: ***(15 Hrs.)***

2.1 Numerical Integration

2.1.1 Introduction
2.1.2 Newton-Cotes Quadrature Formula
2.1.3 Trapezoidal rule
2.1.4 Simpson's $1/3^{rd}$- rule
2.1.5 Simpson's $3/8^{th}$ - rule
2.1.6 Examples based on art. 2.1.3 to 2.1.5.

2.2 Numerical Solutions of ODE:

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

Recommended Book: -

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]

Reference Books: -

1. G. Haribaskaran, Numerical Methods, Laxmi Publications Pvt. Ltd, New Delhi, First Edition (2006).
2. H.C. Saxena - Finite Differences and Numerical Analysis, S. Chand & Company Ltd.(2005).
3. M.K.Jain, S.R.K.Iyengar & R.K.Jain - Numerical Methods (Problems and Solutions): 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).

B.Sc. (Mathematics) (Part II) (Level 5.0) (Semester – III)
(NEP – 2020)
Syllabus to be implemented from Academic Year 2025-26

Course type : Major (Practical)
Title of course : Mathematics Practical (Major) – III
Credit : 02
Student Engagement : 04 hrs. per week per batch

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 linear 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
	T O T A L	**15**

B.Sc. (Mathematics) (Part II) (Level 5.0) (Semester – III)
(NEP – 2020)
Syllabus to be implemented from Academic Year 2025-26

Course type	**:**	**Minor - V(Theory)**
Title of course	**:**	**Computational Mathematics for Sciences-I**
Credit	**:**	**02**

Course Learning Outcomes: Upon successful completion of this course students will able to:

CO 1. learn the partial differentiation and Euler's theorem on homogeneous functions.
CO 2. learn the concept of Jacobian of a transformation.
CO 3. understand the concepts of gradient, divergence and curl of point functions in terms of cartesian co-ordinate system.
CO 4. evaluate the gradient, divergence and curl of point functions

Unit 1: Partial differentiation and Jacobians ***(15 Hrs.)***

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

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

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

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

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

1.2.2.3. If p,q are functions of u,v and u,v are functions of x,y then prove that $\frac{\partial(p,q)}{\partial(u,v)}=\frac{\partial(p,q)}{\partial(x,y)}\cdot\frac{\partial(x,y)}{\partial(u,v)}$.

1.2.2.4. If p,q,r are functions of u,v,w and u,v,w are functions of x,y,z then prove that $\frac{\partial(p,q,r)}{\partial(u,v,w)}=\frac{\partial(p,q,r)}{\partial(x,y,z)}\cdot\frac{\partial(x,y,z)}{\partial(u,v,w)}$.

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 grad $\emptyset$, where $\emptyset$ 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

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

ii. $\text{div}(\bar{f} \pm \bar{g}) = \text{div}\ \bar{f} \pm \text{div}\ \bar{g}$

iii. $\text{curl}(\bar{f} \pm \bar{g}) = \text{curl}\ \bar{f} \pm \text{curl}\ \bar{g}$

2.1.9 Gradient, Divergence and Curl of Products

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

ii. $\text{div}(\emptyset\bar{f}) = \emptyset\ \text{div}\ \bar{f} + (\text{grad}\ \emptyset) \cdot \bar{f}$

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

iv. $\text{curl}(\emptyset\bar{f}) = \text{grad}\ \emptyset \times \bar{f} + \emptyset\ \text{curl}\ \bar{f}$

2.1.10 Second order differential operators

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

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

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

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:

1. 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]
2. 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.

B.Sc. (Mathematics) (Part II) (Level 5.0) (Semester – III)
(NEP – 2020)
Syllabus to be implemented from Academic Year 2025-26

Course type	**:**	**Minor - VI(Theory)**
Title of course	**:**	**Improper Integrals and Special Functions**
Credit	**:**	**02**

Course Learning Outcomes: Upon successful completion of this course students will able to:

CO 1. analyze and evaluate improper integrals with infinite limits.

CO 2. apply Beta and Gamma functions to solve integrals and demonstrate their properties and interrelationships.

CO 3. evaluate parameter-dependent improper integrals and understand the conditions for interchanging limits, differentiation, and integration.

CO 4. interpret and apply the Error function in solving integrals and problems arising in applied mathematics and engineering contexts.

Unit 1. Improper Integrals ***(15 Hrs.)***

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. $\Gamma(n+1) = n\Gamma(n)$
1.5.3. $\Gamma(n+1) = n!$, for any positive integer n.
1.5.4. $\Gamma\left(\frac{1}{2}\right) = \sqrt{\pi}$
1.5.5. $\Gamma(n) = 2\int_0^\infty e^{-x^2} x^{2n-1}\, dx, n > 0$
1.5.6. $\Gamma(n) = k^n \int_0^\infty e^{kx} x^{n-1}\, dx, n, k > 0$
1.6 Beta Function
1.7 Some Identities of Beta function
1.7.1 $\beta(m,n) = \beta(n,m)$
1.7.2 $\beta(m,n) = 2\int_0^{\frac{\pi}{2}} \sin^{2m-1}\theta \cos^{2n-1}\theta \; d\theta$
1.7.3 $\beta(m,n) = \int_0^\infty \frac{x^{m-1}}{(1+x)^{m+n}}\, dx$
1.7.4 $\beta(m,n) = \frac{\Gamma(m)\Gamma(n)}{\Gamma(m+n)}$
1.7.5 $\beta(m,n) = \beta(m+1,n) + \beta(m,n+1)$
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.)***

2.1. Definition of improper integral involving a parameter
2.2. Integral with its limits as constants (Statement only)
2.3. Integral with limits as functions of the parameter (Leibnitz's Rule) (Statement only)
2.4. Examples based on 2.2 and 2.3
2.5. Error Function Integral $\mathrm{erf}(x)$

2.6. Complementary Error Function Integral $\text{erf}_c(x)$

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

2.8. Properties of error-integral functions

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

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

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

iv) Integral of error function: $\int_0^u \text{erf}\,(ax)\; dx = u\,\text{erf}(au) + \frac{e^{-a^2x^2}}{a\sqrt{\pi}} - \frac{1}{a\sqrt{\pi}}$

2.9. 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, Chenni, 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 Vidyarthi 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, 22e, S. Chand and Company, New Delhi, 2018.

B.Sc. (Mathematics) (Part II) (Level 5.0) (Semester – III)
(NEP – 2020)
Syllabus to be implemented from Academic Year 2025-26

Course type : Minor (Practical)
Title of course : Mathematics Practical (Minor) - III
Credit : 02
Student Engagement : 04 hrs. per week per batch

Sr. No	Title of the Practical	No. of Practical(s)
1	Euler's theorems on homogeneous functions	02
2	Jacobians	02
3	Curl, Divergence and Gradient	02
4	Solenoidal and Irrotational vector field.	01
5	Directional Derivatives	01
6	Gamma function	02
7	Definition of beta function	01
8	Identities of Beta function	02
9	Differentiation under integral sign	02
	T O T A L	**15**

B.Sc. (Mathematics) (Part II) (Level 5.0) (Semester – III)
(NEP – 2020)
Syllabus to be implemented from Academic Year 2025-26

Course type	**:**	**Practical**
Course Name	**:**	**Vocational Skill Course (Major Specific)**
Title of course	**:**	**Introduction to programming in Scilab**
Credit	**:**	**02**
Student Engagement	**:**	**4 hrs. per week per batch**

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
	T O T A L	**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 leap year or not.

- **Looping structure (for loop)**

4. Write a program to find 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 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 reverse 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 $\binom{n}{k}$.
16. Write a recursive function to find factorial of number and use it to find $\binom{n}{k}$.
17. Using recursive function write a program that convert given decimal number to binary number.

B.Sc. (Mathematics) (Part II) (Level 5.0) (Semester – III)
(NEP – 2020)
Syllabus to be implemented from Academic Year 2025-26

Course type	**:**	**Practical**
Course Title	**:**	**Skill Enhancement Course – I**
Title of course	**:**	**Mathematics Typesetting using LaTeX - I**
Credit	**:**	**02**
Student Engagement	**:**	**4 hrs. per week per batch**

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	Delimeters	01
11	Matrix	01
12	Creating list	01
13	Math Functions	01
14	Creating and Using Theorems	01
15	Drawing Diagrams	01
	T O T A L	**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. LaTeX Wikibook

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

B.Sc. (Mathematics) (Part II) (Level 5.0) (Semester – III)
(NEP – 2020)
Syllabus to be implemented from Academic Year 2025-26

Course type : Practical
Course Title : Open Elective – III
Title of course : Vedic Mathematics Part- I [वैदिक गणित भाग-१]
Credit : 02
Student Engagement : 4 hrs. per week per batch

Sr. No	Title of the Practical	No. of Practical(s)
1	Multiplication (NIKHILAM) [गुणाकार (निखीलम)] Case 1: Integers less than the base (100) (पायाभूत संख्येपेक्षा (१००) लहान असणारे पूर्णांक)	01
2	Multiplication (NIKHILAM) [गुणाकार (निखीलम)] Case 2: Integers above the base (100) (पायाभूत संख्येपेक्षा (१००) मोठे असणारे पूर्णांक)	01
3	Multiplication (NIKHILAM) [गुणाकार (निखीलम)] Case 3: Integers below and above the base (100) (पायाभूत संख्येपेक्षा (१००) मोठे किंवा लहान असणारे पूर्णांक)	01
4	Multiplication (NIKHILAM) [गुणाकार (निखीलम)] Case 4: Examples of decimal numbers (दशांश अपूर्णांकांची 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)] Problems on secondary base of 50 [दुय्यम पायाभूत संख्या ५०]	01
7	Multiplication (NIKHILAM) [गुणाकार (निखीलम)] Problems on secondary base of 250 [दुय्यम पायाभूत संख्या २५०]	01
8	Multiplication (NIKHILAM) [गुणाकार (निखीलम)] Problems on secondary base of 500 [दुय्यम पायाभूत संख्या ५००]	01
9	Multiplication (NIKHILAM) [गुणाकार (निखीलम)] Problems on secondary base of 40 and 60 [दुय्यम पायाभूत संख्या ४० आणि ६०]	01
10	Multiplication (NIKHILAM) [गुणाकार (निखीलम)] Problems on secondary base of 300 [दुय्यम पायाभूत संख्या ३००]	01
11	Multiplication (URDHVA TRIYAK) [गुणाकार (उर्ध्व् तिर्यक)] Multiplication of two 2-digit numbers (२ अंकी संख्यांचा गुणाकार) Multiplication of two 3-digit numbers (३ अंकी संख्यांचा गुणाकार)	01
12	Multiplication (URDHVA TRIYAK) [गुणाकार (उर्ध्व् तिर्यक)] Multiplication of two 4-digit numbers (४ अंकी संख्यांचा गुणाकार)	01

Sr. No	Title of the Practical	No. of Practical(s)
13	Multiplication (URDHVA TRIYAK) [गुणाकार (उर्ध्व् तिर्यक)] Multiplication of 2-digit with 3-digit number [२ -अंकी संख्येसोबत ३-अंकी संख्येचा गुणाकार]	01
14	Multiplication (URDHVA TRIYAK) [गुणाकार (उर्ध्व् तिर्यक)] Multiplication of 2-digit with 4-digit number [२ -अंकी संख्येसोबत ४-अंकी संख्येचा गुणाकार]	01
15	Multiplication (URDHVA TRIYAK) [गुणाकार (उर्ध्व् तिर्यक)] Multiplication of 3-digit with 4-digit number [३ -अंकी संख्येसोबत ४-अंकी संख्येचा गुणाकार]	01
	T O T A L	**15**

Recommended Books:

1) **The power of Vedic Maths with Trigonometry** (English 2nd Edition): By Atul Gupta, Jaico Publishing House Ahmedabad, Bangalore, Chenni, Delhi, Hyderabad, Kolkata, Mumbai.
   Scope: [Chapter-4, Chapter-5]
2) **वैदिक गणिताचे सामर्थ्य त्रिकोणमितीसह** (मराठी २ री आवृत्ती) : अतुल गुप्ता, जयको पब्लीसिंग हाउस अहमदाबाद , बँगलोर, चेन्नई , दिल्ली, हैद्राबाद , कोलकत्ता , मुंबई .
   Scope: [प्रकरण -४, प्रकरण -५]

Reference Books:

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 गणित (मराठी आवृत्ती) : अनुवादक: संदीप दत्तात्रय लेले, संपादक: डॉ. सं. ना. भावसार, मोतीलाल बनारसीदास पब्लीशर्स प्रायव्हेट लिमिटेड, दिल्ली.
3) Vedic Mathematics Made Easy (English 2nd Edition): By Dhaval Bathia, Jaico Publishing House Ahmedabad, Bangalore, Chenni, Delhi, Hyderabad, Kolkata, Mumbai.
4) सरळ वैदिक गणित (मराठी २ री आवृत्ती) : धवल बथिया, जयको पब्लीसिंग हाउस अहमदाबाद , बँगलोर, चेन्नई, दिल्ली, हैद्राबाद , कोलकत्ता , मुंबई .

Semester IV

B.Sc. (Mathematics) (Part II) (Level 5.0) (Semester – IV)
(NEP – 2020)
Syllabus to be implemented from Academic Year 2025-26

Course type	**:**	**Major – VII(Theory)**
Title of course	**:**	**Differential calculus**
Credit	**:**	**02**

Course Learning Outcomes: Upon successful completion of this course students will 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.

Unit – 1: Limit, Continuity and Differentiability ***(12 hrs.)***

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 $\lim_{x \to c} f(x) = l$, $\lim_{x \to c} g(x) = m$ then

(i) $\lim_{x \to c}(f+g)(x) = l + m$

(ii) $\lim_{x \to c}(f-g)(x) = l - m$

(iii) $\lim_{x \to c}(f \cdot g)(x) = lm$

(iv) $\lim_{x \to c}(f/g)(x) = l/m$ 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 $f + g$, $f - g$, fg are also continuous at c and if $g(c) \neq 0$, 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 c of an interval $[a,\ b]$ and $f(c) \neq 0$, then $\exists$ a $\delta > 0$ such that $f(x)$ has the same sign as $f(c)$, for every $x \in (c-\delta,\ c+\delta)$.

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

1.5.7 Corollary (Statement only): If f is continuous at the end point 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 $\alpha \in (a,\ b)$ such that $f(\alpha) = 0$.

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 ***(18 hrs.)***

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 theorems 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 $J.J' = 1$ 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, 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 New York, 1993.

B.Sc. (Mathematics) (Part II) (Level 5.0) (Semester – IV)
(NEP – 2020)
Syllabus to be implemented from Academic Year 2025-26

Course type	**:**	**Major – VIII(Theory)**
Title of course	**:**	**Integral Calculus**
Credit	**:**	**02**

Course Learning Outcomes: Upon successful completion of this course students will 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

Unit 1. ***(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 $\Gamma(n+1) = n\Gamma(n)$ in general.
1.1.2.3 $\Gamma(n+1) = n!$ if n is positive integer.
1.1.2.4 $\Gamma(0) = \infty,\ \Gamma(\infty) = \infty$
1.1.2.5 $\Gamma(n) = 2\int_0^{\infty} e^{-x^2} x^{2n-1} dx,\ n > 0$
1.1.2.6 $\Gamma(n) = k^n \int_0^{\infty} e^{-kx} x^{n-1} dx, n, k > 0$
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 $\beta(m,n) = \beta(n,m);\ m,n \geq 0$
1.2.2.2 $\beta(m,n) = 2\int_0^{\frac{\pi}{2}} \sin^{2m-1}\theta \cos^{2n-1}\theta d\theta;\ m,n \geq 0$
1.2.2.3 $\int_0^{\frac{\pi}{2}} \sin^p\theta \cos^q\theta d\theta = \frac{1}{2}\beta\left(\frac{p+1}{2}, \frac{q+1}{2}\right)$ p, q > -1

1.2.2.4 Relation between Beta and Gamma function

$$\beta(m,n) = \frac{\Gamma(m)\Gamma(n)}{\Gamma(m+n)},\ \text{m, n} > 0$$

1.2.2.5 $\Gamma\left(\frac{1}{2}\right) = \sqrt{\pi}$
1.2.2.6 $\beta(m,n) = \int_0^{\infty} \frac{x^{m-1}}{(1+x)^{m+n}} dx$
1.2.2.7 $\beta(m,n) = a^n b^m \int_0^{\infty} \frac{x^{m-1}}{(a+bx)^{m+n}} dx$

1.2.2.8 $\beta(m,n) = \int_0^1 \frac{x^{m-1}+x^{n-1}}{(1+x)^{m+n}} dx$
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 integral sign

2.1.1 Leibnitz first rule of differentiation under integral sign.
2.1.2 Leibnitz second rule of differentiation under 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

$$\beta(m,n) = \frac{\lceil(m)\lceil(n)}{\lceil(m+n)}, \text{ m, n} > 0$$

2.2.8 Examples based on 2.2.1 TO 2.2.7

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.

B.Sc. (Mathematics) (Part II) (Level 5.0) (Semester – IV)
(NEP – 2020)
Syllabus to be implemented from Academic Year 2025-26

Course type : Major (Practical)
Title of course : Mathematics Practical – IV
Credit : 02
Student Engagement : 4 hrs. per week per batch

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
	T O T A L	**15**

B.Sc. (Mathematics) (Part II) (Level 5.0) (Semester – IV)
(NEP – 2020)

Syllabus to be implemented from Academic Year 2025-26

Course type	**:**	**Minor – VII(Theory)**
Title of course	**:**	**Computational Mathematics for Sciences-II**
Credit	**:**	**02**

Course Learning Outcomes: Upon successful completion of this course students will able to:

CO 1. apply various interpolation methods.
CO 2. approximate polynomials for the real-life data.
CO 3. construct and interpret finite difference tables for data analysis.
CO 4. apply interpolation techniques in solving problems related to computer science, such as curve fitting and numerical estimation.

Unit 1. Interpolation on Evenly Spaced Points ***(15 Hrs.)***

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 means operator (μ).

1.4 Symbolic Relations and Separation of Symbols.

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

$\mu^2 = 1 + \left(\frac{1}{4}\right)\delta^2,\ \Delta = \nabla E = \delta E^{\frac{1}{2}}.$

1.4.2. Show that $E \equiv e^{hD}$, where $D \equiv \frac{d}{dx}$.

1.4.3. Show that $\Delta^n u_{x-n} = u_x - n u_{x-1} + \frac{n(n-1)}{2} u_{x-2} + \cdots + (-1)^n u_{x-n}.$

1.4.4. Show that $e^x\left(u_0 + x\Delta u_0 + \frac{x^2}{2!}\Delta^2 u_{0+\cdots}\right) = u_0 + u_1 x + u_2 \frac{x^2}{2!} + \cdots$

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

Unit 2. Interpolation on Unevenly Spaced Points ***(15 Hrs.)***

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*: Unit 1:** Chapter 3 Section 3.1, 3.3, 3.5, 3.6 and 3.7.1, **Unit 2:** Chapter 3 Section 3.9 to 3.11

Reference Books:

1 B. S. Grewal - Numerical Methods in Engineering And Science: C, C++, and MatLab, Mercury Learning and Information, New Delhi (2012).

2 M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International Publisher, Mumbai (2012).

B.Sc. (Mathematics) (Part II) (Level 5.0) (Semester – IV)
(NEP – 2020)

Syllabus to be implemented from Academic Year 2025-26

Course type : Minor – VIII(Theory)
Title of course : Laplace Transform
Credit : 02

Course Learning Outcomes: Upon successful completion of this course students will able to:

CO 1. understand definitions and existence conditions of the Laplace transform
CO 2. apply key properties of the Laplace transform
CO 3. understand inverse Laplace transform
CO 4. apply Laplace transform to solve differential equations.

Unit 1. Laplace Transform ***(15 Hrs.)***

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

Unit 2. Inverse Laplace Transform ***(15 Hrs.)***

2.1 Definitions 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, Heavi-side'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:

Unit 1: Chapter 1 Part I: 1.0 to 1.6, **Unit 2:** 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.

B.Sc. (Mathematics) (Part II) (Level 5.0) (Semester – IV)
(NEP – 2020)
Syllabus to be implemented from Academic Year 2025-26

Course type : Minor(Practical)
Title of course : Mathematics Practical (Minor) - IV
Credit : 02
Student Engagement : 4 hrs. per week per batch

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
	T O T A L	**15**

B.Sc. (Mathematics) (Part II) (Level 5.0) (Semester – IV)
(NEP – 2020)
Syllabus to be implemented from Academic Year 2025-26

Course type	**:**	**Practical**
Course Title	**:**	**Skill Enhancement Course – I**
Title of course	**:**	**Mathematics Typesetting using LaTeX - II**
Credit	**:**	**02**
Student Engagement	**:**	**4 hrs. per week per batch**

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, and References for Figures	01
8	Page numbering	01
9	Hyperlinks	01
10	References and citations	01
11	Creating Multicolumn Documents	01
12	Creating Footnotes and Endnotes	01
13	Customizing Fonts and Colors	01
14	Formatting Headers and Footers	01
15	Customizing Margins and Page Layout	01
	T O T A L	**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. LaTeX Wikibook

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

B.Sc. (Mathematics) (Part II) (Level 5.0) (Semester – IV)
(NEP – 2020)
Syllabus to be implemented from Academic Year 2025-26

Course type	**:**	**Practical**
Course Title	**:**	**Open Elective – IV**
Title of course	**:**	**Vedic Mathematics Part- II [वैदिक गणित भाग-२]**
Credit	**:**	**02**
Student Engagement	**:**	**4 hrs. per week per batch**

Sr. No	Title of the Practical	No. of Practical(s)
1	Division [भागाकार] Division by a flag of one digit (no remainder) [एक ध्वजांक ठेवून फक्त एका अंकाने भागाकार (बाकीविरहीत)]	01
2	Division [भागाकार] Division by a flag of one digit (with remainder) [एक ध्वजांक ठेवून फक्त एका अंकाने भागाकार (बाकी असताना)]	01
3	Division [भागाकार] Division with adjustments [काही तरतूद करीत भागाकार]	01
4	Division [भागाकार] Division with a flag of 2 digits [२ अंकी ध्वजांक ठेवून एका अंकाने भागाकार]	01
5	Division [भागाकार] Division with a flag of 3 digits [३ अंकी ध्वजांक ठेवून एका अंकाने भागाकार]	01
6	Simple Squares (सरल वर्ग) Case1: 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 सुरु होणाऱ्या आणि शेवटच्या अंकांची बेरीज १० येणाऱ्या दोन संख्यामधील गुणाकार]	01
7	Square of any Number [कोणत्याही अंकाचा वर्ग] I. Definition: Dwandwa or Duplex (व्याख्या: द्वंद किंवा दुप्पट) a) Duplex of a single digit (एक अंकी संख्येच्या द्वन्दची व्याख्या) b) Duplex of two digits (दोन अंकी संख्येच्या द्वन्दची व्याख्या) c) Duplex of 3 digits (तीन अंकी संख्येच्या द्वन्दची व्याख्या) d) Duplex of 4 digits (चार अंकी संख्येच्या द्वन्दची व्याख्या) e) Duplex of 5 digits (पाच अंकी संख्येच्या द्वन्दची व्याख्या)	01
8	II. Square of any Number [कोणत्याही अंकाचा वर्ग] Problems on square of any number (कुठल्याही संख्येचा वर्ग)	01
9	Square root of a number (कुठल्याही संख्येचे वर्गमूळ काढणे) I)Perfect square root (पूर्ण वर्गमूळ)	01
10	Square root of a number (कुठल्याही संख्येचे वर्गमूळ काढणे) II) Imperfect square root as a decimal number (अपूर्ण संख्या असलेले वर्गमूळ अर्थात दशांश चिन्हातील वर्गमूळ)	01

Sr. No	Title of the Practical	No. of Practical(s)
11	Square root of a number (कुठल्याही संख्येचे वर्गमूळ काढणे) Perfect square root as a decimal number	01
12	Square root of a number (कुठल्याही संख्येचे वर्गमूळ काढणे) III) Square root with adjustments (काही तडजोडी करून वर्गमूळ काढणे)	01
13	Cubes and Cube Roots [घन आणि घनमूळ] Computing cubes of 2-digit numbers [दोन अंकी संख्यांचा घन काढणे]	01
14	Cubes and Cube Roots [घन आणि घनमूळ] Computing cube roots of 2-digit numbers [दोन अंकी संख्यांचे घनमूळ काढणे]	01
15	Cubes and Cube Roots [घन आणि घनमूळ] Computing fourth power of 2-digit numbers [दोन अंकी संख्यांचा चतुर्थ घातांक काढणे]	01
	T O T A L	**15**

Recommended Books:

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

Scope: [Chapter-6 to 10]

2) **वैदिक गणिताचे सामर्थ्य त्रिकोणमितीसह** (मराठी २ री आवृत्ती) : अतुल गुप्ता, जयको पब्लीसिंग हाउस अहमदाबाद , बँगलोर, चेन्नई , दिल्ली, हैद्राबाद , कोलकत्ता , मुंबई .

Scope: [प्रकरण -६ ते १०]

Reference Books:

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 गणित (मराठी आवृत्ती) : अनुवादक: संदीप दत्तात्रय लेले, संपादक: डॉ. सं. ना. भावसार, मोतीलाल बनारसीदास पुब्लीशर्स प्रायव्हेट लिमिटेड, दिल्ली.
3) Vedic Mathematics Made Easy (English 2nd Edition): By Dhaval Bathia, Jaico Publishing House Ahmedabad, Bangalore, Chenni, Delhi, Hyderabad, Kolkata, Mumbai.
4) सरळ वैदिक गणित (मराठी २ री आवृत्ती) : धवल बथिया, जयको पब्लीसिंग हाउस अहमदाबाद , बँगलोर, चेन्नई, दिल्ली, हैद्राबाद , कोलकत्ता , मुंबई .

NATURE OF QUESTION PAPER:

A. **Continuous Assessment (CA):**
Term work shall be of 10 marks for the courses of 2 credits.

B. **End Semester Assessment:**

1. End Semester examination shall be of 40 marks for the courses of 2 credits.
2. The nature of Question Paper for Theory Examination:

Maximum Marks: 40 **Duration: 1.5 hrs.**

Q. 1) Choose the correct alternative from the following and rewrite the sentence. [08]

a) to h) MCQ one mark each with four options

i) ii) iii) iv)

Q. 2) Attempt any TWO of the following [16]

a)
b)
c)

Q. 3) Attempt any FOUR of the following [16]

a)
b)
c)
d)
e)
f)

C. DSC, MIN, VSC Practical Examination:

1. Practical examination shall be of 50 marks for the courses of 02 credits.
2. Distribution of marks: Practical question paper – 40 marks, Certified Journals – 05 marks, Viva – voce – 05 marks and Duration: 04 hrs.
3. The nature of Question Paper for Practical Examination:

Q.1 (A) (10 Marks)
(B) (05 Marks)

OR

Q.1 (A) (10 Marks)
(B) (05 Marks)

Q.2 (A) (10 Marks)
(B) (05 Marks)

OR

Q.2 (A) (10 Marks)
(B) (05 Marks)

Q.3 Attempt any TWO of the following

(A) (05 Marks)
(B) (05 Marks)
(C) (05 Marks)
(D) (05 Marks)

D. SEC and OE Practical Examination:

1. Practical examination shall be of 50 marks for the courses of 02 credits.
2. Distribution of marks: Practical question paper – 40 marks, Certified Journals – 05 marks, Viva – voce – 05 marks and Duration: 04 hrs.
3. The nature of Question Paper for Practical Examination:

Q.1 Attempt any THREE of the following (15 Marks)

(A)
(B)
(C)
(D)

Q.2 Attempt any THREE of the following (15 Marks)

(A)
(B)
(C)
(D)

Q.3 Attempt any TWO of the following (10 Marks)

(A)
(B)
(C)

Equivalence of Courses

B. Sc. Part II (Semester III and IV)

Old Course				Equivalent Course		
Sem No.	**Course Code**	**Title of Old Course**	**Credit**	**Course Code**	**Title of New Course**	**Credit**
III	DSC – C5	Elements of Differential Equations	2	DSC – V	Differential Equations - II	2
III	DSC – C6	Numerical Methods	2	DSC – VI	Numerical Methods	2
IV	DSC – D5	Vector Calculus	2	DSC – VII	Differential Calculus	2
IV	DSC – D6	Integral Calculus	2	DSC – VIII	Integral Calculus	2
III and IV	CCPM-III	Core Course Practical in Mathematics - II	4	DSC Practical – III	Mathematics Practical – I and Mathematics Practical - II	2 + 2
III and IV	CCPM-IV	Core Course Practical in Mathematics - III	4	VSC– I and II	Introduction to SciLab	2+2