SRIDEV SUMAN UTTARAKHAND UNIVERSITY

BADSHAHI THAUL (TEHRI GARHWAL), UTTARAKHAND-249199

National Education Policy-2020

SYLLABUS

Four Year Undergraduate Programme
FYUP/Honours Programme/Master in Science

DEPARTMENT OF MATHEMATICS

(From the session 2025-26)

Curriculum Design Committee, Uttarakhand

S. No.	Name & Designation	
1.	Prof. D. S. Rawat Vice-Chancellor, Kumaon University, Nainital,Uttarakhand	**Chairman**
2.	Prof. N. K. Joshi Vice-Chancellor, Sri Dev Suman Uttarakhand University, Badshahi Thaul, Tehri Garhwal, Uttarakhand	**Member**
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5.	Prof. Satpal Singh Bisht Vice-Chancellor, Soban Singh Jeena University, Almora	**Member**
6.	Prof. M.S.M. Rawat Advisor, Rashtriya Uchchatar Shiksha Abhiyan, Uttarakhand	**Member**
7.	Prof. K.D. Purohit Advisor Rashtriya Uchchatar Shiksha Abhiyan, Uttarakhand	**Member**

Member of Board of Studies- Mathematics
Sri Dev Suman Uttarakhand University

Prof. G.K. Dhingra, Dean Faculty of Science - chairperson BoS

S. No.	Name	Designation	Affiliation	Signature
1.	Prof. Anita Tomar	Professor & Head	Pt. L.M.S. Campus, Sri Dev Suman Uttarakhand University, Rishikesh	16/06/25
2.	Prof. K. S. Rawat	Professor	S.R.T. Campus, Badshahi Thaul, Tehri	16/06/25
3.	Prof. Dipa Sharma	Professor	Pt. L.M.S. Campus, Sri Dev Suman Uttarakhand University, Rishikesh	16/6/25
4.	Dr. Gaurav Varshney	Associate Professor	Pt. L.M.S. Campus, Sri Dev Suman Uttarakhand University, Rishikesh	16/06/25

(Board of Studies on June 16, 2025)

16/06/25

Contents:

List of Papers (DSC, DSE, GE) with Semester wise Titles for 'Mathematics'					
Year	**Semester**	**Course Code**	**Course Title**	**Course Type**	**Credits**
Certificate in Science (Mathematics as one of the major Subject)					
FIRST YEAR	I	DSC Maths1	Fundamental Mathematics-I	Theory	4
	II	DSC Maths2	Fundamental Mathematics-II	Theory	4
Diploma in Science (Mathematics as one of the major Subject)					
SECOND YEAR	III	DSC Maths3	Differential Calculus	Theory	4
		DSE Maths1	Differential Equations	Theory	4
	IV	DSC Maths4	Integral Calculus	Theory	4
		DSE Maths2	Group Theory	Theory	4
Bachelor of Science (Mathematics as one of the major Subject)					
THIRD YEAR	V	DSC Maths5	Analysis	Theory	4
		DSE Maths3	Ring Theory	Theory	4
	VI	DSC Maths6	Linear Algebra	Theory	4
		DSE Maths4	Linear Programming Problems	Theory	4
Bachelor of Science (Honors)					
FOURTH YEAR	VII	DSC Maths7	Advanced Real Analysis	Theory	4
		DSE Maths5	Metric Spaces	Theory	4
		DSE Maths6	Differential Geometry	Theory	4
		DSE Maths7	Dynamics of Rigid Bodies	Theory	4
		DSE Maths8	Operations Research – I	Theory	4
		DSE Maths9	Special Functions	Theory	4
		Dissertation in DSC/DSE or Academic Project/Entrepreneurship			6
	VIII	DSC Maths8	Complex Analysis	Theory	4
		DSE Maths10	Abstract Algebra	Theory	4
		DSE Maths11	Topology	Theory	4
		DSE Maths12	Theory of Relativity	Theory	4
		DSE Maths13	Integral Equations	Theory	4
		DSE Maths14	Tensor Calculus	Theory	4
		DSE Maths15	Fuzzy Set Theory	Theory	4
		Dissertation in DSC/DSE or Academic Project/Entrepreneurship			6

Master of Science (Mathematics)					
FIFTH YEAR	IX	DSC Maths9	Advanced Linear Algebra	Theory	4
		DSE Maths16	Measure Theory	Theory	4
		DSE Maths17	Mathematical Statistics	Theory	4
		DSE Maths18	Number Theory	Theory	4
		DSE Maths19	Fluid Dynamics	Theory	4
		DSE Maths20	Discrete Mathematics	Theory	4
		DSE Maths21	Operations Research – II	Theory	4
		Dissertation in DSC/DSE or Academic Project/Entrepreneurship			6
	X	DSC Maths10	Functional Analysis	Theory	4
		DSE Maths22	Numerical Methods	Theory	4
		DSE Maths23	Riemannian Geometry	Theory	4
		DSE Maths24	Calculus of Variations	Theory	4
		DSE Maths25	Algebraic Topology	Theory	4
		DSE Maths26	Partial Differential Equations	Theory	4
		DSE Maths27	Introduction to programming using MATLAB	Theory	4
		Dissertation in DSC/DSE or Academic Project/Entrepreneurship			6

GENERIC ELECTIVE (GE)

Year	Semester	Course Code	Paper Title	Paper Type	Credits
First Year	I	GE Maths1	Quantitative Aptitude and Logical Reasoning	Theory	4
	II	GE Maths2	Matrix Theory	Theory	4
Second Year	III	GE Maths3	Basic Calculus	Theory	4
	IV	GE Maths4	Elementary Real Analysis	Theory	4
Third Year	V	GE Maths5	Introduction to Probability	Theory	4
	VI	GE Maths6	Basic Statistics	Theory	4

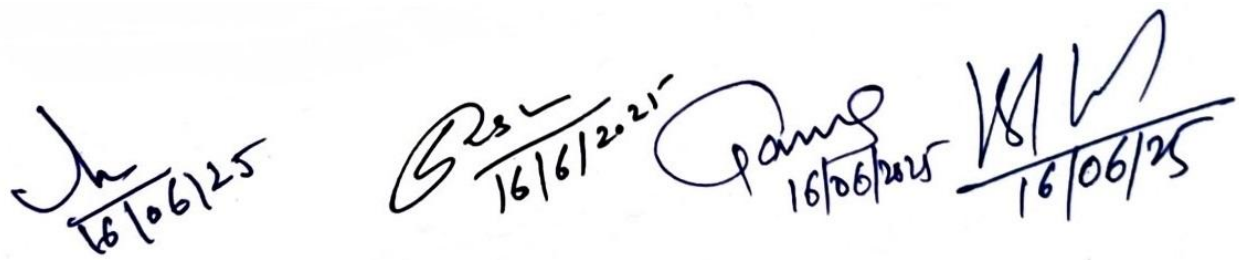
Abbreviations:

- **DSC** – Discipline Specific Course
- **DSE** – Discipline Specific Electives
- **GE** – Generic Electives

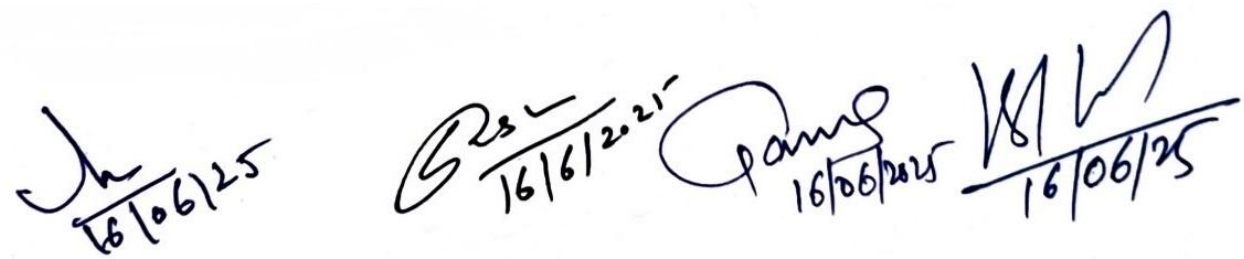
CREDIT FRAMEWORK Four Year Undergraduate Programme FYUP/Honours Programme/Master in Science								
Semester	**Core (DSC)**	**Elective (DSE)**	**Generic Elective (GE)**	**Ability Enhancement Course (AEC)**	**Skill Enhancement Course (SEC)**	**Internship/ Apprentice ship/Project/Field Work* (2)**	**Value added course (VAC)**	**Total Credits**
I	DSC - 1(4) DSC - 2(4) DSC - 3(4)		Choose one from a pool of courses GE-1(4)	Choose one from a pool of AEC courses (2)	Choose one from a pool of courses (2)		Choose one from a pool of courses (2)	22 credits
II	DSC - 4(4) DSC - 5(4) DSC - 6(4)		Choose one from a pool of courses GE-2 (4)	Choose one from a pool of AEC courses (2)	Choose one from a pool of courses (2)		Choose one from a pool of courses (2)	22 credits
Students, upon exit, shall be awarded an Undergraduate Certificate (in the field of study/discipline) after securing the requisite 44 credits upon completion of Semester II.								Total = 44
III	DSC - 7(4) DSC - 8(4) DSC - 9(4)	Choose one from pool of courses, DSE – 1 (4) *or* Choose one from pool of courses, GE – 3 (4)*		Choose one from a pool of AEC courses (2)	Choose one SEC *or* Internship/Apprenticeship/ Project/Community Outreach (IAPC) (2)**		Choose one from a pool of courses (2)	22 credits
IV	DSC - 10(4) DSC - 11(4) DSC - 12(4)	Choose one from pool of courses, DSE – 2 (4) *or* Choose one from pool of courses GE – 4 (4)*		Choose one from a pool of AEC courses (2)	Choose one SEC *or* Internship/ Apprenticeship/ Project/Community Outreach (IAPC) (2) **		Choose one from a pool of courses (2)	22 credits
Students, upon exit, shall be awarded an Undergraduate Diploma (in the field of study/discipline) after securing the requisite 88 credits upon completion of Semester IV.								Total = 88
V	DSC - 13(4) DSC - 14(4) DSC - 15(4)	Choose one from a pool of courses DSE - 3 (4)	Choose one from a pool of courses GE-5 (4)		Choose one SEC *or* Internship/Apprenticeship/ Project/Community Outreach (IAPC) (2)**			22 credits
VI	DSC - 16(4) DSC - 17(4) DSC - 18(4)	Choose one from a pool of courses DSE - 4 (4)	Choose one from a pool of courses GE-6 (4)		Choose one SEC *or* Internship/ Apprenticeship/ Project/Research/ Community Outreach (IAPC) (2)**			22 credits
Students, upon exit, shall be awarded a Bachelor's degree (in the field of study/discipline) after securing the requisite 132 credits upon completion of Semester VI.								Total = 132

Semester	Core (DSC)	Elective (DSE)	Generic Elective (GE)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship/ Apprentice ship/Project (2)	Dissertation Etc.	Total Credits
VII	DSC-19 (4)	Choose three DSE (3x4) courses *or* Choose two DSE (2x4) and one GE (4) course *or* Choose one DSE (4) and two GE (2x4) courses (Total = 12 Credits)***					Dissertation on DSC (6) *or* Dissertation on DSE (6) *or* Academic project/ Entrepreneurship (6)	22 credits
VIII	DSC-20 (4)	Choose three DSE (3x4) courses *or* Choose two DSE- (2x4) and one GE (4) course *or* Choose one DSE (4) and two GE (2x4) courses (Total = 12 Credits)***					Dissertation on DSC (6) *or* Dissertation on DSE (6) *or* Academic project/ Entrepreneurship (6)	22 credits
*Students, upon exit, shall be awarded a **Bachelor's degree (in the field of study/discipline)** — either **Honours with Research / Academic Projects / Entrepreneurship**, or **Honours with Research in Discipline-1 (Major) and Discipline-2 (Minor)** — after securing the requisite 176 credits upon completion of Semester VIII.*								Total = 176
IX	DSC-21 (4)	Choose three DSE (3x4) courses *or* Choose two DSE (2x4) and one GE (4) course *or* Choose one DSE (4) and two GE (2x4) courses (Total = 12 Credits)***					Dissertation on DSC (6) *or* Dissertation on DSE (6) *or* Academic project/ Entrepreneurship (6)	22 credits
X	DSC-22 (4)	Choose three DSE (3x4) courses *or* Choose two DSE (2x4) and one GE (4) course *or* Choose one DSE (4) and two GE (2x4) courses (Total = 12 Credits)***					Dissertation on DSC (6) *or* Dissertation on DSE (6) *or* Academic project/ Entrepreneurship (6)	22 credits
Students, upon exit, shall be awarded a Master's degree in the core subject after securing the requisite 220 credits upon completion of Semester X.								Total = 220

Program Outcomes (POs) (Undergraduate Programme): **After this programme:**	
PO 1.	Students will have a firm foundation in the fundamentals and applications of mathematics and scientific theories.
PO 2.	Students will develop skills in problem solving, critical thinking and analytical reasoning as applied to scientific problems.
PO 3.	Students will be able to explore new directions to pursue higher studies in science subjects.
PO 4.	Students will be able to contest and qualify different competitive exams where graduation degree is one of the essential qualifications.
PO 5.	Students will be able to function as a member of an interdisciplinary problem-solving team.
Program Outcomes (POs) (Honors Programme): **After this programme:**	
PO 6.	Gain advanced knowledge in core areas like Real Analysis, Topology, Algebra, and Functional Analysis.
PO 7.	Understand and apply specialized topics such as Differential Geometry, Number Theory, and Operations Research.
PO 8.	Develop skills for independent thinking and research in modern mathematical areas.
Program Outcomes (POs) (Master Degree Programme): **After this programme:**	
PO 9.	Apply mathematical tools in real-world problems using Numerical Methods, Statistics, and MATLAB.
PO 10.	Enhance logical reasoning, critical thinking, and problem-solving abilities.
PO 11.	Prepare for research, higher studies, and competitive exams like CSIR-NET and GATE.
PO 12.	Work effectively in academic, industrial, and interdisciplinary environments.



PROGRAM SPECIFIC OUTCOMES (PSOS)	
First Year	**Certificate in Science (Mathematics as one of the major Subject)**
	Certificate in Science will give students a basic knowledge of mathematics. Two other major subjects needed for the study of other courses in forthcoming years. It will enable students to join the diploma course (semester III and IV) in any University or College of Higher education in Uttarakhand
Second Year	**Diploma in Science (Mathematics as one of the major Subject)**
	Diploma will enable students to join the Bachelor of Science course (semester V and VI) in any University or College of Higher education in Uttarakhand
Third Year	**Bachelor of Science (Mathematics as one of the major Subject)**
	Upon completion of a degree, students will be eligible for Master Degree in any of the major subject in any of the higher institutions of India. It will give students an ability of critical thinking and scientific study of any discipline. Students after getting Bachelor degree will be eligible for all the competitive examinations where graduation is an essential qualification.
Fourth Year	**Bachelor of Science (Honors)**
	After completing the degree of Bachelor of science (Honors), students will be eligible for one year Master degree programme in the subject. It will explore students to advanced topics / techniques used in mathematics and also will help them to develop the ability to formulate real life problems mathematically and solve using these techniques. They will be eligible to pursue their career in various fields of academics, research and industry as well as to obtain master degree in Mathematics.
Fifth Year	**Master of Science (Mathematics)**
	The Master of Science in Mathematics Programme will enable students to join Ph. D. program in universities and research institutes within India or abroad. The student would get research experience by doing research projects in the last semester under the supervision of faculty which will make them eligible to open up several career options in mathematics and other branches of mathematical sciences and physical sciences.



SEMESTER-I						
DISCIPLINE SPECIFIC COURSE (DSC Maths1): **Fundamental Mathematics-I**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit Distribution of the Course**			**Eligibility Criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSC Maths1: Fundamental Mathematics-I	4	3	2	0	Passed Class XII with Mathematics	Nil
Course Outcomes: This paper is a fundamental course for intermediate pass students who are going to study mathematics as one of the major subjects for their graduation degree. It gives basic knowledge and background to understand other courses either in mathematics or physics.						

Certificate in Science (Mathematics as one of the major Subject)	
Year: I	**Semester**: I
Course Code: DSC Maths1	**Course Title:** Fundamental Mathematics-I
Credits: 4	**Discipline Specific Course**
Min. Passing Marks: As per University rules	**No. of Hours:** 55-60

Unit	Content	Number of Hours
Unit I	**Theory of Equations:** Relations between Roots and Coefficients of algebraic equations, Transformation of equations, Descartes rule of signs, Solutions of Cubic and Bi-quadratic equations.	13-15
Unit II	**Fundamentals of Matrices:** Basic concepts of matrices, Types of matrices, Transpose, trace and determinant of a matrix, Elementary operations, Row Reduced echelon form, Rank and inverse of a matrix, Normal form of a matrix.	14-15
Unit III	**Advanced Matrix Theory:** Solutions of a system of linear equations, Characteristic equation of a matrix, eigenvalues, eigenvectors, Diagonalization of matrices, Cayley-Hamilton theorem.	14-15
Unit IV	**Vector Calculus:** Dot product, cross product and their geometric interpretation, Triple products, Ordinary differentiation of vectors, Differential operators-Del, Gradient, Divergence and Curl. Line, surface and volume integrals, Simple applications of Gauss divergence theorem, Green's theorem and Stokes' theorem.	14-15

Books Recommended:

1. C. C. MacDuffee: *Theory of Equations,* John Wiley & Sons, 1954.
2. Shanti Narayan and P. K. Mittal: A Text Book of Vector Calculus, S. Chand & Company, 1987.
3. J. G. Chakravorty and P. R. Ghosh: *Analytical Geometry and Vector Analysis,* U. N. Dhur & Sons Pvt. Ltd, 1973.
4. Murray Spiegel, Seymour Lipschutz and Dennis Spellman: *Vector Analysis,* Schaum's Outline Series, McGraw Hill Edition, 2017.
5. R. K. Sharma, S. K. Shah and A. G. Shankar: *Complex Numbers and the Theory of Equations,* Anthem Press, 2011.
6. N. Saran and S. N. Nigam*: Introduction to vector analysis,* Pothishala publication, Allahabad, 1990.

Further Readings:

1. William Snow Burnside and Arthur William Panton: *The Theory of Equations Vol. I,* Nabu Press, 2011.
2. Leonard E. Dickson: *First Course in the Theory of Equations*, Merchant Books, 2009.
3. Fuzhen Zhang: *Matrix Theory- Basic Results and Techniques,* Springer, 1999.
4. K. B. Dutta: *Matrix and Linear Algebra,* Prentice Hall of India, 2004.

Digital Platform: NPTEL/SWAYAM/MOOCs.

SEMESTER-II						
DISCIPLINE SPECIFIC COURSE (DSC Maths2): **Fundamental Mathematics -II**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSC Maths2: Fundamental Mathematics-II	4	3	1	0	Passed Class XII with Mathematics	Nil
Course Outcomes: This paper is a fundamental course for intermediate pass students who are going to study mathematics as one of the major subjects for their graduation degree. It gives basic knowledge and background to understand other courses either in mathematics or physics.						

Certificate in Science (Mathematics as one of the major Subject)	
Year: I	**Semester:** II
Course Code: DSC Maths2	**Course Title:** Fundamental Mathematics-II
Credits: 4	**Discipline Specific Course**
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	Content	Number of Hours
Unit I	**Preliminaries:** Sets, Operations on sets, Index set and family of sets, Relations, Equivalence relations and partitions, Functions, Composition of functions, Infinite sets and cardinality, Cantor set, Principle of mathematical induction.	14-15
Unit II	**Numerical Sequence and Series:** Sequences, theorems on limit of sequences, Infinite series, series of non-negative terms, Various tests for convergence, Alternating series, Leibnitz's theorem, Absolute convergence, Conditional convergence.	14-15
Unit III	**Trigonometry:** Complex numbers with elementary properties, De-Moivre's theorem, Exponential Functions, Euler's theorem. Circular and hyperbolic functions of complex variables together with their inverses, Logarithmic Functions, Gregory's series, Summation of Trigonometric series.	14-15
Unit IV	**Partial Derivatives:** Functions of more than one variable, Partial Derivatives, Euler's Theorem for Homogeneous Functions, Jacobians and their applications, Chain rule.	14-15

Books Recommended:

1. C. C. MacDuffee: *Theory of Equations,* John Wiley & Sons, 1954.
2. Shanti Narayan and P. K. Mittal: A Text Book of Vector Calculus, S. Chand & Company, 1987.
3. J. G. Chakravorty and P. R. Ghosh: *Analytical Geometry and Vector Analysis,* U. N. Dhur & Sons Pvt. Ltd, 1973.
4. Murray Spiegel, Seymour Lipschutz and Dennis Spellman: *Vector Analysis,* Schaum's Outline Series, McGraw Hill Edition, 2017.
5. R. K. Sharma, S. K. Shah and A. G. Shankar: *Complex Numbers and the Theory of Equations,* Anthem Press, 2011.
6. N. Saran and S. N. Nigam*: Introduction to vector analysis,* Pothishala publication, Allahabad, 1990.

Further Readings:

1. William Snow Burnside and Arthur William Panton: *The Theory of Equations Vol. I,* Nabu Press, 2011.
2. Leonard E. Dickson: *First Course in the Theory of Equations*, Merchant Books, 2009.
3. Fuzhen Zhang: *Matrix Theory- Basic Results and Techniques,* Springer, 1999.
4. K. B. Dutta: *Matrix and Linear Algebra,* Prentice Hall of India, 2004.

Digital Platform: NPTEL/SWAYAM/MOOCs.

SEMESTER-III						
DISCIPLINE SPECIFIC COURSE (DSC Maths3): **Differential Calculus**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSC Maths3: Differential Calculus	4	3	1	0	Passed Class XII with Mathematics	Completed DSC Maths1 and DSC Maths2
Course Outcomes: This paper provides detailed knowledge of differentiation of various classes of functions. It relates and gives an analytical aptitude for various mathematical problems. After completing this course students will be able to understand basic concepts of calculus and able to apply these concepts in physics and engineering.						

Diploma in Science (Mathematics as one of the major Subject)	
Year: II	**Semester:** III
Course Code: DSC Maths3	**Course Title:** Differential Calculus
Credits: 4	**Discipline Specific Course**
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	**Content**	**Number of Hours**
Unit I	**Limit, Continuity and Differentiability:** Functions of one variable, Limit and Continuity of a function, Indeterminate forms Properties of continuous functions, Classification of Discontinuities, Differentiability of a function, Rolle's Theorem, Mean value theorems and their geometrical interpretations, Applications of mean value theorems. Successive Differentiation, n^{th} Differential coefficient of functions, Leibnitz Theorem; Taylor's Theorem, Maclaurin's Theorem, Taylor's and Maclaurin's series expansions.	14-15
Unit II	**Tangents and Normal:** Geometrical meaning of dy/dx, Definition and equation of Tangent and Normal, Tangent at origin, Angle of intersection of two curves, Subtangent and Subnormal, Tangents and Normal of polar curves, Angle between radius vector and tangent, Perpendicular from pole to tangent, Pedal equation of curve, Polar subtangent and polar subnormal, Intrinsic equations.	14-15
Unit III	**Curvature and Asymptotes:** Curvature, Radius of curvature; Cartesian, Polar and pedal formula for radius of curvature, Tangential polar form, Centre of curvature, Asymptotes of algebraic curves, Methods of finding asymptotes, Parallel asymptotes.	14-15
Unit IV	**Singular Points and Curve Tracing:** Existence and classification of singular points, points of inflexion, Double Points, Cusp, Node and conjugate points, Curve tracing.	14-15

Books Recommended:

1. T. M. Apostol: *Calculus Vol. I*, John Willey & Sons, 1999.
2. Gorakh Prasad: *Differential Calculus*, Pothishala publication, Allahabad, 2016.
3. M. Ray, H. S. Sharma and S. S. Seth: *Differential Calculus*, Shiva Lal Agarwal & Company, Agra.

Further Readings:

1. S. Lang: *A First Course in Calculus*, Springer-Verlag New York Inc.,1986.
2. H. Anton, I. Birens and S. Davis: *Calculus*, John Wiley & Sons, 2007.
3. G. B. Thomas and R. L. Finney: *Calculus*, Pearson Education, 2010.
4. S. Balachandra Rao and C. K. Shantha: *Differential Calculus*, New Age Publication, 1992.

Digital Platform: NPTEL/SWAYAM/MOOCs.

SEMESTER-III						
DISCIPLINE SPECIFIC ELECTIVE (DSE Maths1) – **Differential Equations**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSE Maths1: Differential Equations	4	3	1	0	Passed Class XII with Mathematics	Nil
Course Outcomes: This paper provides detailed knowledge of differential equations and their solutions. This course is useful for the students to solve not only mathematical problems in daily life but also helps to understand typical problems of physics and other related areas.						

Certificate in Science (Mathematics as one of the major Subject)	
Year: II	**Semester:** III
Course: DSE Maths1	Course Title: **Differential Equations**
Credits: 4	**Discipline Specific Elective**
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	**Content**	**Number of Hours**
Unit I	Order and Degree of Differential Equations, Complete primitive (general solution, particular solution and singular solutions), Existence and uniqueness of the solution dy/dx= f(x,y). Differential equations of first order and first degree, Separation of variables, Homogeneous Equations, Linear Differential Equations, Exact Differential Equations, Integrating Factor.	14-15
Unit II	Equation of First order but not of first degree, variation of parameters, Clairaut's form, Singular solutions, Trajectory, Orthogonal Trajectory, Self-Orthogonal family of Curves.	14-15
Unit III	Linear Differential Equations: Linear equations with constant coefficients, Complementary function, Particular integral, working rule for finding solution, Homogeneous linear equations. Linear differential equations of second order with variable coefficients.	14-15
Unit IV	Miscellaneous Equations: Simultaneous differential equations, Differential equations of the form dx/P= dy/Q= dz/R where P, Q, R are functions of x, y and z, Exact differential equations, Total differential equations, Series solutions of differential equations.	14-15

Books Recommended:

1. G. F. Simmons: *Differential Equations with Application and Historical Notes*, McGraw Hill Edition, 2002
2. Shepley L. Ross: *Differential Equations*, John Wiley & Sons, 1984.
3. M. D. Raisinghania: *Ordinary & Partial Differential Equation,* S. Chand & Co. Ltd, 2017.
4. B. Rai, D. P. Choudhary and H. J. Freedman: *A Course of Ordinary Differential Equations,* Narosa, 2002.

Further Readings:

1. Ravi P. Agarwal and Donal O'Regan: *Ordinary and Partial Differential Equations,* Springer, 2009.
2. Martin Braun: *Differential Equations and Their Applications*, Sringer, 1993.
3. Erwin Kreyszig: *Advanced Engineering Mathematics,* John Wiley & Sons, 2011.
4. Ian N. Snedden: *Elements of Partial Differential Equations*, Dover Publication, 2013.

Digital Platform: NPTEL/SWAYAM/MOOCs.

SEMESTER-IV						
DISCIPLINE SPECIFIC COURSE (DSC Maths4): **Integral Calculus**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility Criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSC Maths4: Integral Calculus	4	3	1	0	Passed Class XII with Mathematics	Completed DSC Maths2 and DSC Maths3
Course Outcomes: Students will understand and apply the properties of definite integrals and techniques like differentiation under the integral sign. They will gain familiarity with special functions such as Beta and Gamma functions and use them to evaluate complex integrals. The course also equips students with the ability to evaluate double and triple integrals, including coordinate transformations and change of order. Furthermore, students will apply definite integrals to solve problems related to area, arc length, volume, and surface area of solids of revolution.						

Diploma in Science (Mathematics as one of the major Subject)	
Year: II	**Semester:** IV
Course: DSC Maths4	**Course Title:** Integral Calculus
Credits: 4	**Discipline Specific Course**
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	Content	Number of Hours
Unit I	**Definite Integrals:** Properties of Definite integrals, Summation of series by integration, Differentiation and integration under the integral sign. Beta function, Gamma function, Relation between Beta and Gamma function, Evaluation of integrals using Beta and Gamma functions.	13-15
Unit II	**Beta and Gamma function:** Beta function, Gamma function, Recurrence formula and other relations, Relation between Beta and Gamma function, Evaluation of integrals using Beta and Gamma functions.	14-15
Unit III	**Multiple Integrals:** Double integrals, Repeated integrals, Evaluation of Double integrals, Double integral in polar coordinates, Change of order of integration in Double integrals, Triple integrals, Evaluation of Triple integrals, Dirichlet's theorem and its Liouvelle's extension.	14-15
Unit IV	**Geometrical Applications of Definite Integrals:** Area bounded by curves (quadrature), Rectification (length of curves), Volumes and Surfaces of Solids of revolution.	14-15

Books Recommended:

1. T. M. Apostol: *Calculus Vol. I*, John Willey & Sons, 1999.
2. M. Ray, H. S. Sharma and S. S. Seth: *Differential Calculus*, Shiva Lal Agarwal & Company, Agra.
3. M. Ray, H. S. Sharma and S. S. Seth: *Integral Calculus*, Shiva Lal Agarwal & Company, Agra.

Further Readings:

1. S. Lang: *A First Course in Calculus*, Springer-Verlag New York Inc.,1986.
2. H. Anton, I. Birens and S. Davis: *Calculus*, John Wiley & Sons, 2007.
3. G. B. Thomas and R. L. Finney: *Calculus*, Pearson Education, 2010.
4. S. Balachandra Rao and C. K. Shantha: *Differential Calculus*, New Age Publication, 1992.
5. Frank Ayres and Elliott Mendelson: *Calculus,* Schaum's Outline Series, McGraw Hill Edition, 2009.

Digital Platform: NPTEL/SWAYAM/MOOCs.

SEMESTER-IV						
DISCIPLINE SPECIFIC ELECTIVE (DSE Maths2): **Group Theory**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSE Maths2: Group Theory	4	3	1	0	Passed Class XII with Mathematics	Completed DSC Maths1 and DSC Maths2
Course Outcomes: This course is useful to understand the concepts of algebraic structures and their properties. It will help the students for better understanding of other subjects, especially atomic structures in chemistry and certain concepts of physics.						

Diploma in Science (Mathematics as one of the major Subject)	
Year: II	**Semester:** IV
Course Code: DSE Maths2	**Course Title:** Group Theory
Credits: 4	**Discipline Specific Elective**
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	**Content**	**Number of Hours**
Unit I	**Groups:** Binary operation and Algebraic structure, Abelian groups, Noncommutative groups and Subgroups.	13-15
Unit II	Permutation groups, Cyclic groups, Coset decomposition, Lagrange theorem and its consequences,	14-15
Unit III	Normal subgroups, Quotient group, Homomorphism and Isomorphism, Fundamental theorems of homomorphism, Cayley's theorem.	14-15
Unit IV	Automorphism and inner automorphism, Automorphism groups and their computation, Normalizer and center of group, Finite groups, Commutator subgroups.	14-15

Books recommended:

1. I. N. Herstein: *Topics in Algebra*, John Wiley & Sons, 2006.
2. Joseph A. Gallian: *Contemporary Abstract Algebra,* Narosa Publishing House, 2016.
3. David S. Dummit and Richard M. Foote: *Abstract Algebra*, John Wiley & Sons, 2011.
4. Surjeet Singh and Qazi Zameer Uddin: *Modern Algebra*, Vikas Publishing House, India, 2021.

Further Readings:

1. Michael Artin: *Algebra,* Pearson Education, 2015.
2. N. Jacobson: Lectures in Abstract Algebra-*Vol. I, II & III,* Springer, 2013.
3. N. Jacobson: Basic Algebra-*Vol. I & II,* Dover Publications Inc., 2009.
4. R. S. Aggarwal: *A Textbook on Modern Algebra,* S Chand & Company, 1973.

Digital Platform: NPTEL/SWAYAM/MOOCs.

SEMESTER-V						
DISCIPLINE SPECIFIC COURSE (DSC Maths5): **Analysis**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSC Maths5: Analysis	4	3	1	0	Passed diploma in Science with Mathematics	Completed DSC Maths3 and DSC Maths4
Course Outcomes: Students will understand key concepts in real line topology such as supremum, infimum, open and closed sets, and convergence. They will learn the definition and properties of the Riemann integral, integrability of functions, and evaluation of improper integrals. In complex analysis, they will study analytic and harmonic functions, Cauchy's theorems, series expansions, and the residue theorem for evaluating complex and real integrals.						

Bachelor of Science (Mathematics as one of the major Subject)	
Year: III	**Semester:** V
Course: DSC Maths5	**Course Title:** Analysis
Credits: 4	**Discipline Specific Course**
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	**Content**	**Number of Hours**
Unit I	Topology of Real line: Complete ordered field, Archimedean Property, Supremum, infimum, Neighbourhood of a point, Interior of a set, open set, closed set, Derived set, Closure of a set, Bolzano-Weierstrass Theorem, Brief introduction of compactness and connectedness.	14-15
Unit II	Integration: Riemann integral-definition and properties, Integrability of continuous and monotonic functions, Fundamental theorem of Calculus, Improper integrals and their convergence.	14-15
Unit III	Limit, continuity and differentiability of functions of a complex variable, Cauchy-Riemann equations, Analytic functions, Harmonic conjugates and Harmonic functions.	14-15
Unit IV	Line Integration, Cauchy's theorem, Cauchy's integral formula, Taylor's series, Laurent's series, Poles and singularities. Residues, The Residue theorem, Evaluation of Improper real integrals.	14-15

Books Recommended:

1. Walter Rudin: *Principle of Mathematical Analysis,* McGraw Hill Edition, 1976.
2. R. G. Bartle and D. R. Sherbert: *Introduction to Real Analysis*, John Wiley & Sons, 1999.
3. T. M. Apostol: *Mathematical Analysis*, Narosa Publishing House, New Delhi, 1985.

Further Readings:

1. Richard R. Goldberg: *Methods of Real Analysis*, John Wiley & Sons, 1976.
2. James R. Munkres: *Analysis on Manifolds*, Addison-Wesley Publishing Company, Advanced Book Program, Redwood City, CA, 1991.
3. H. L. Royden: *Real Analysis,* Macmillan Publishing Company, New York, 1988.
4. G. F. Simmons: Introduction to Topology and Modern Analysis, McGraw Hill Edition, 2011.

Digital Platform: NPTEL/SWAYAM/MOOCs.

SEMESTER-V						
DISCIPLINE SPECIFIC ELECTIVE (DSE Maths3): **Ring Theory**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSE Maths3: Ring Theory	4	3	1	0	Passed Class XII with Mathematics	Completed DSE Maths1
Course Outcomes: This course is useful to understand the concepts of algebraic structures and their properties. It will help the students for better understanding of other subjects, especially atomic structures in chemistry and certain concepts of physics.						

Bachelor of Science (Mathematics as one of the major Subject)	
Year: III	**Semester:** V
Course: DSE Maths3	**Course Title:** Ring Theory
Credits: 4	**Discipline Specific Elective**
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	**Content**	**Number of Hours**
Unit I	Rings and their examples, Sub rings, Commutative rings, Divisors of zero, Integral domain, Inverse of an element in a ring, Field.	13-15
Unit II	Skew field, Ideals, Characteristic of a ring, Ring Homomorphism, Quotient rings.	14-15
Unit III	Principal ideals, Maximal ideals, Prime ideals, Principal ideal domains, Polynomial rings and irreducibility.	14-15
Unit IV	Field of quotients of an integral domain, Embedding of an integral domain in a field, Factorization in an integral domain.	14-15

Books Recommended:

1. N. Herstein: *Topics in Algebra*, John Wiley & Sons, 2006.
2. Joseph A. Gallian: *Contemporary Abstract Algebra,* Narosa Publishing House, 2016.
3. David S. Dummit and Richard M. Foote: *Abstract Algebra*, John Wiley & Sons, 2011.
4. Surjeet Singh and Qazi Zameer Uddin: *Modern Algebra*, Vikas Publishing House, India, 2021.

Further Readings:

1. Michael Artin: *Algebra,* Pearson Education, 2015.
2. N. Jacobson: Lectures in Abstract Algebra-*Vol. I, II & III,* Springer, 2013.
3. N. Jacobson: Basic Algebra-*Vol. I & II,* Dover Publications Inc., 2009.
4. R. S. Aggarwal: *A Textbook on Modern Algebra,* S Chand & Company, 1973.

Digital Platform: NPTEL/SWAYAM/MOOCs.

SEMESTER-VI						
DISCIPLINE SPECIFIC COURSE (DSC Maths6): **Linear Algebra**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSC Maths6: Linear Algebra	4	3	1	0	Passed diploma in Science with Mathematics	Completed DSC Maths5
Course Outcomes: Students will understand vector spaces, subspaces, bases, and dimensions. They will study linear transformations, matrix representations, dual spaces, and the rank-nullity theorem. The course also covers eigenvalues, eigenvectors, diagonalizability, and canonical forms like Jordan and triangular forms, preparing students for advanced linear algebra applications.						

Bachelor of Science (Mathematics as one of the major Subject)	
Year: III	**Semester:** VI
Course: DSC Maths6	**Course Title:** Linear Algebra
Credits: 4	**Discipline Specific Course**
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	Content	Number of Hours
Unit I	Vector space, subspaces, Linear combinations, linear spans, Sums and direct sums, Linear dependence and independence, Bases and dimensions, Dimensions and subspaces, Coordinates and change of bases.	14-15
Unit II	Linear transformations, rank-nullity theorem, Linear operators, Invertible linear transformations, Matrix representation of a linear transformation, Transpose of a linear transformation, Similarity of Matrices, Linear functional, Dual space and dual basis, Second dual space, hyperspace.	14-15
Unit III	Eigen values and Eigen vectors, Algebraic and Geometrical Multiplicity, Characteristic and Minimal Polynomials, Annihilators, Cayley-Hamilton theorem, Similar Matrices, Diagonalizable operator.	14-15
Unit IV	Invariant Subspaces, Direct sum decomposition, Projection on a vector space, Primary decomposition theorem, Canonical Forms, Diagonal forms, Triangular forms, Jordan forms.	14-15

Books Recommended:

1. K. Hoffman and R. Kunze: *Linear Algebra*, Prentice Hall of India, 1972.
2. K. B. Dutta: *Matrix and Linear Algebra*, Prentice Hall of India, 2004.
3. Seymour Lipschutz and Marc L. Lipson*: Linear Algebra,* Schaum's Outline Series, McGraw Hill Edition, 2017.
4. S. H. Friedberg, A. J. Insel and L. E. Spence: *Linear Algebra,* Pearson Education, 2015.

Further Readings:

1. G. Hadley: *Linear Algebra,* Narosa Publishing House, 2002.
2. H. Helson: *Linear Algebra*, Hindustan Book Agency, New Delhi, 1994.
3. Gilbert Strang: *Linear Algebra and its Applications,* Cengage Learning India, 2005.

Digital Platform: NPTEL/SWAYAM/MOOCs.

SEMESTER-VI						
DISCIPLINE SPECIFIC ELECTIVE (DSE Maths4): **Linear Programming Problems**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSE Maths4: Linear Programming Problems	4	3	1	0	Passed diploma in Science with Mathematics	Completed DSC Maths3 and DSC Maths4
Course Outcomes: This paper provides detailed knowledge of Linear programming problem and their solutions. This course is useful for the students to solve not only mathematical problems in daily life but also helps to understand typical problems of other related areas.						

Bachelor of Science (Mathematics as one of the major Subject)	
Year: III	**Semester:** VI
Course: DSE Maths4	**Course Title:** Linear Programming Problems
Credits: 4	**Discipline Specific Elective**
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	**Content**	**Number of Hours**
Unit I	This paper provides detailed knowledge of Linear programming problem and their solutions. This course is useful for the students to solve not only mathematical problems in daily life but also helps to understand typical problems of other related areas.	14-15
Unit II	Theory of simplex method, Optimality and unboundedness, The simplex algorithm, Simplex method in tableau format, Introduction to artificial variables.	14-15
Unit III	Two-phase method, Big-M method, and their comparison.	14-15
Unit IV	Duality, formulation of the dual problem, Primal-dual relationships, Economic interpretation of the dual.	14-15

Books Recommended:

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, Linear Programming and Network Flows, 2nd Ed., John Wiley and Sons, India,2004.
2. F. S. Hillierand, G. J. Lieberman, ,Introduction to Operations Research, 8thEd.,Tata McGrawHill, Singapore, 2004.
3. Hamdy A. Taha, Operations Research, An Introduction, 8th Ed., Prentice-Hall India,2006. Digital Platform: NPTEL/SWAYAM/MOOCs.

Further Readings:

Digital Platform: NPTEL/SWAYAM/MOOCs.

SEMESTER-VII						
DISCIPLINE SPECIFIC COURSE (DSC Maths7): **Advanced Real Analysis**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSC Maths7: Advanced Real Analysis	4	3	1	0	Passed diploma in Science with Mathematics	Completed DSC Maths5
Course Outcomes: This course develops the foundational concepts of real analysis for functions of several variables, including limits, continuity, partial derivatives, and differentiability. Students will also learn about vector-valued functions, linear transformations, and key theorems such as the inverse and implicit function theorems.						

Bachelor of Science (Honors)	
Year: IV	**Semester:** VII
Course: DSC Maths7	**Course Title:** Advanced Real Analysis
Credits: 4	**Discipline Specific Course**
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	Content	Number of Hours
Unit I	Functions of several variables: Concept of functions of two variables, Simultaneous and iterated limits in functions of two variables.	14-15
Unit II	Partial derivatives: Definition, Existence and continuity, Interchange of order of differentiation, Directional derivatives.	14-15
Unit III	Composite functions, Linear Continuity of function of two variables, differentiability of functions of two variables, Taylor's Theorem.	14-15
Unit IV	Linear transformation, Vector Valued functions, Differentiation of vector valued functions, inverse function theorem, implicit function theorem.	14-15

Books Recommended:

1. S. C. Malik and Savita Arora: Mathematical Analysis, New Age International.
2. G.F. Simmons: Introduction to Topology and Modern Analysis, Tata McGraw Hill.
3. T. M. Apostol: Mathematical Analysis, Narosa Publishing House, New Delhi, 1985.

Further Readings:

1. W. Rudin: Principles of Mathematical Analysis (3rd edition), Tata Mc Graw Hill Kgakusha, International Student Edition, 1976.
2. Richard R. Goldberg: Methods of Real Analysis, John Wiley & Sons, 1976.

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SEMESTER-VII						
DISCIPLINE SPECIFIC ELECTIVE (DSE Maths5): **Metric Spaces**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSE Maths5: Metric Spaces	4	3	1	0	Passed diploma in Science with Mathematics	Completed DSE Maths3
Course Outcomes: This course introduces the foundational concepts of distance between two elements in a set and convergence through the study of metric spaces. It helps students understand the structure and properties of metric spaces, enhancing their ability to analyze continuity, compactness, and completeness, which are essential in both pure and applied mathematics.						

Bachelor of Science (Honors)	
Year: IV	**Semester:** VII
Course: DSE Maths5	**Course Title:** Metric Spaces
Credits: 4	**Discipline Specific Elective**
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	**Content**	**Number of Hours**
Unit I	Metric on a set, Pseudo-metrics, Equivalent metrics, Limit point, Closed sets, Adherent point, Dense subsets, Interior of a set and its properties, Subspaces, Product spaces.	14-15
Unit II	Convergent sequences, Cauchy sequences, Algebra of convergent sequences, sub-sequences, Continuity at a point, Continuity over a space, Algebra of real valued continuous functions in a metric space, Homeomorphism, Uniform continuity.	14-15
Unit III	Complete metric spaces, Completeness and continuous mappings, Cantor's intersection theorem, Contraction mapping theorem, Connectedness in metric spaces, Properties of connectedness.	14-15
Unit IV	Compact spaces, Compact subsets of the real line, Compactness and continuous mappings, Sequential compactness, Countable compactness, B-W property, B-W property and boundedness, BW property and compactness.	14-15

Books Recommended:

1. Introduction to Topology and Modern Analysis: G.F. Simmons, Tata McGraw-Hill.
2. Metric Spaces: E.T. Copson, Cambridge University Press, 1968.
3. Topology: Robert H. Kasriel, Dover Pub. , 2009.
4. Topology of Metric Spaces: S. Kumaresan, Alpha Science Int. , 2011.

Further Readings:

1. G. F. Simmons: Introduction to Topology and Modern Analysis, McGraw Hill, 1963.

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SEMESTER-VII						
DISCIPLINE SPECIFIC ELECTIVE (DSE Maths6): **Differential Geometry**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSE Maths6: Differential Geometry	4	3	1	0	Passed diploma in Science with Mathematics	Completed DSE Maths3
Course Outcomes: This course is useful to understand the concepts of geometric structures and their properties using differential calculus. It will help the students for better understanding of other subjects, especially atomic structures in chemistry and certain concepts of physics.						

Bachelor of Science (Honors)	
Course: DSE Maths6	Course Title: Differential Geometry
Year: IV	Semester: VII
Credits: 4	Discipline Specific Elective
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	**Content**	**Number of Hours**
Unit I	Curve in space, parameterized curves, regular curves, helices, arc length, reparameterization (by arc length), Tangent, principal normal, binormal, osculating plane, normal plane, rectifying plane, curvature torsion of smooth curves, Frenet- Serret formulae, Frenet approximation of space curve.	14-15
Unit II	Order of contact, osculating circle, osculating sphere, Spherical indicatrices, involutes and evolutes, Bertrand Curves, intrinsic equations of space curves, isometries of R^3, Fundamental theorem of space curves, surfaces in R^3.	14-15
Unit III	Regular Surfaces, coordinates neighbourhoods, parameterized surfaces, change of parameters, level sets of smooth functions on R^3, surfaces of revolution, mean curvature, tangent vector, first and second fundamental forms, classification of points on a surface	14-15
Unit IV	Curvature of curve on surfaces, normal curvature, Meusnier theorem, principal curvatures, geometric interpretation of principal curvatures, Euler theorem, mean curvature, line of curvature, Rodrigue's formula, umbilical points, minimal surfaces, definition and examples, Gaussian curvature.	14-15

Books Recommended:

1. D. Somasundaram: Differential Geometry, A First Course, Narosa Publishing House, New Delhi, 2005.
2. Andrew Pressley: Elementary Differential Geometry, Springer (Undergraduate Mathematics Series), 2001.
3. T. J. Willmore: An Introduction To Differential Geometry, Oxford University Press.

Further Readings:

1. J. A. Thorpe: Elementary Topics in Differential Geometry, Springer (Undergraduate Texts in Mathematics), 1979.
2. B. O. Niell: Elementary Differential Geometry, Academic Press.
3. Do Carmo : Curves and surfaces,

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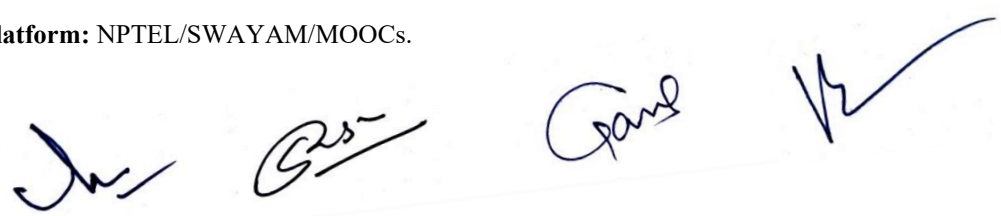

SEMESTER-VII						
DISCIPLINE SPECIFIC ELECTIVE (DSE Maths7) - **Dynamics of Rigid Bodies**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSE Maths7: Dynamics of Rigid Bodies	4	3	1	0	Passed diploma in Science with Mathematics	Completed DSE Maths3
Course Outcomes: This course is useful to understand the concepts of motion of rigid bodies. It will help the students for better understanding of the other subjects, especially in engineering and certain concepts of physics.						

Bachelor of Science (Honors)	
Year: IV	**Semester:** VII
Course: DSE Maths7	Course Title: **Dynamics of Rigid Bodies**
Credits: 4	**Discipline Specific Elective**
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	**Content**	**Number of Hours**
Unit I	D'Alembert's principle, Motion about a fixed axis (Finite and Impulsive forces).	14-15
Unit II	Motion in two dimensions under Finite and Impulsive forces, Principle of conservation of momentum and energy.	14-15
Unit III	Lagrange's equations in generalized co-ordinates.	14-15
Unit IV	Hamilton's principle, principle of least action, Euler's geometrical and dynamical equations.	14-15

Books Recommended:

1. Bhu Dev Sharma: Dynamics of Rigid Bodies, Kedarnath Ramnath Sons, 1984.
2. M. Ray & Harswarup Sharma: A text book of Dynamics of Rigid Body, Students' Friends &Co., Agra-2, 1971.
3. H. Goldstein: Classical Mechanics, Narosa, 1990.

Further Readings:

1. S. L. Loney: Dynamics of rigid bodies.
2. A. S. Ramsey: Dynamics – Part II.

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SEMESTER-VII						
DISCIPLINE SPECIFIC ELECTIVE (DSE Maths8): **Operations Research-I**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSE Maths8: Operations Research-I	4	3	1	0	Passed diploma in Science with Mathematics	Completed DSE Maths3
Course Outcomes: This course will enable students to understand various methods for the solution of optimization problem.						

Master of Science (Mathematics)	
Year: V	**Semester:** VII
Course: DSE Maths8	**Course Title:** Operations Research-I
Credits: 4	**Discipline Specific Elective**
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	**Content**	**Number of Hours**
Unit I	Introduction to Operations research, methodology of Operations research, Features of Operations research problems, Different models in Operations research, Opportunity and shortcomings of Operations research's approach.	14-15
Unit II	**Transportation and assignment Models:** Lp Formulation of TP, Transportation Table, Finding initial basic feasible solution, Test of optimality, Degeneracy, MODI method, Stepping Stone method. Solutions of Assignment problems, Hungerian method, Duality in assignment problem.	14-15
Unit III	**Game theory:** Two persons zero sum game, game with saddle points, rule of dominance; algebraic, graphical and linear programming, concept of mixed strategy.	14-15
Unit IV	**Sensitivity Analysis:** Changes in Objective Function Coefficient, Changes in constants, Changes in coefficients of decision variables in constraints, Structural changes. Dual Simplex Method.	14-15

Books Recommended:

1. H. A. Taha: Operations Research, An Introduction, Pearson.
2. Kanti Swarup, P K Gupta, Manmohan: Operations Research, Sultan Chand & Sons, New Delhi.
3. S.S. Rao: Optimization Theory and Applications Wiley Eastern.

Further Readings:

1. F. S. Hiller and G. J. Leiberman: Introduction to Operation Research (6th Edition), McGraw-Hill International Edition, 1995.

Digital Platform: NPTEL/SWAYAM/MOOCs.

Semester-VII						
DISCIPLINE SPECIFIC ELECTIVE (DSE Maths9): **Special Functions**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSE Maths9: Special Functions	4	3	1	0	Passed diploma in Science with Mathematics	Completed DSE Maths3
Course Outcomes: This course will extend the knowledge of functions to the students by adding the class of functions defined using integrals.						

Master of Science (Mathematics)	
Year: V	**Semester:** VII
Course: DSE Maths9	**Course Title:** Special Functions
Credits: 4	Discipline Specific Elective
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	**Content**	**Number of Hours**
Unit I	Legendre's equation, Legendre's polynomial Pn(x), Legendre's function of the second kind Qn(x), General solution of Legendre's equation, Rodrigue's formula, Legendre polynomials, A generating function of Legendre's polynomial, Orthogonality of Legendre	14-15
Unit II	Bessel's equation, solution of Bessel's equation, Bessel's functions Jn(x), Recurrence Formulae, Equations reducible to Bessel's equation, orthogonality of Bessel's Functions, A generating function for Jn(x), Basic properties.	14-15
Unit III	Gamma function and related functions, Gauss multiplication theorem, the hypergeometric differential equation, Gauss hypergeometric function.	14-15
Unit IV	Integral representation of hypergeometric function, Evaluation of hypergeometric function, the confluent hypergeometric differential equation, Confluent hypergeometric function.	14-15

Books Recommended:

1. E.D. Rainville: Special functions.
2. Nirvikar Saran: Special Functions.
3. W.W. Bell: Special Function for Scientists and Engineers, Dever publications, 2002,
4. U.P. Singh: Special Function & Their Application, WISDOM PRESS, 2012.

Digital Platform: NPTEL/SWAYAM/MOOCs.

SEMESTER-VIII						
DISCIPLINE SPECIFIC COURSE (DSC Maths8): **Complex Analysis**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSC Maths8: Complex Analysis	4	3	1	0	Passed diploma in Science with Mathematics	Completed DSC Maths5
Course Outcomes: Upon successful completion of this course, the students will be able to understand the theory used to solve the mathematical problems. It also helps to enhance the critical thinking of the students.						

Bachelor of Science (Honors)	
Year: IV	**Semester:** VIII
Course: DSC Maths8	Course Title: **Complex Analysis**
Credits: 4	Discipline Specific Course
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	**Content**	**Number of Hours**
Unit I	Conformal mappings, Power series representation of analytic functions, Analytic functions as mappings, Riemann sphere, Linear transformations, Mobius transformation, Cross ratios, Mobius transformation on circles.	14-15
Unit II	Derivative of an analytic function, Higher order derivatives, Cauchy's theorem integral formula. Morera's theorem, Cauchy inequality and Liouville's theorem.	14-15
Unit III	Counting zeros, The open mapping theorem, Maximum modulus principle, Schwarz lemma, The fundamental theorem of algebra.	14-15
Unit IV	Entire functions, Hadmard's three circle theorem, Jensen's formula, Meromorphic functions.	13-15

Books Recommended:

1. J. B. Conway*: Functions of One Complex Variable*, Narosa Publishing House, 1980.
2. R. V. Churchil and J. W. Brown and R. F. Verhey: *Complex Variables and Applications,* McGraw Hill Edition, 1976.

Further Readings:

1. L. V. Ahlfors: *Complex Analysis*, McGraw Hill Edition, 1977.
2. E. T. Copson: *Complex Variables*, Oxford University Press.
3. Richard R. Goldberg: *Methods of Real Analysis*, John Wiley & Sons, 1976.
4. D. Sarason: *Complex Function Theory*, Hindustan Book Agency, Delhi, 1994.
5. James R. Munkres: *Analysis on Manifolds*, Addison-Wesley Publishing Company, Advanced Book Program, Redwood City, CA, 1991.
6. H. L. Royden: *Real Analysis,* Macmillan Publishing Company, New York, 1988.
7. G. F. Simmons: Introduction to Topology and Modern Analysis, McGraw Hill Edition, 2011.

Digital Platform: NPTEL/SWAYAM/MOOCs.

Semester-VIII						
DISCIPLINE SPECIFIC ELECTIVE (DSE Maths10)**: Abstract Algebra**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSE Maths10: Abstract Algebra	4	3	1	0	Passed diploma in Science with Mathematics	Completed DSE Maths2 and DSE Maths3
Course Outcomes: Students will understand the structure of groups through concepts like normal and subnormal series, composition series, and the Jordan–Hölder theorem. They will study solvable and nilpotent groups, including their properties and characterizations. In ring theory, students will learn about ideals, quotient rings, and various classes of rings such as Euclidean domains, PIDs, and UFDs, along with factorization and irreducibility criteria. The course also introduces field theory, including finite fields, field extensions, and the fundamentals of Galois theory.						

Bachelor of Science (Honors)	
Year: IV	**Semester:** VIII
Course: DSE Maths10	Course Title: **Abstract Algebra**
Credits: 4	**Discipline Specific Elective**
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	**Content**	**Number of Hours**
Unit I	Normal and subnormal series, composition series, Jordan Holder theorem, chain conditions.	13-14
Unit II	Commentators. Solvable groups, solvability of subgroups and factor groups. Nilpotent groups and their equivalent characterizations.	14-15
Unit III	Rings, ideals, prime and maximal ideals, quotient rings. Factorization theory in commutative domains. Prime and irreducible elements, Euclidean Domains. Principal Ideal Domain. Divisor chain condition. Unique Factorization Domains, Polynomial rings over domains. Eisenstein's irreducibility criterion. Unique factorization in polynomial rings over UFDs.	15-16
Unit IV	Fields, finite fields, field extensions, Galois extensions.	14-15

Books Recommended:

1. J. Gallian: Abstract Algebra, Narosa Publication.
2. Ramji Lal: Fundamentals in Abstract Algebra, Chakra Prakashan, Allahabad, 1985.
3. I. N. Herstein: Topics in Algebra, Wiley Eastern Ltd., N.D., 1975.

Further Readings:

1. M. Artin: Algebra, Prentice Hall of India.
2. N. Jacobson: Basic Algebra, Vol. I, Hindustan Publishing Co., New Delhi.
3. D. S. Dummit and R. M. Foote: Abstract Algebra, John Wiley, N. Y.

Digital Platform: NPTEL/SWAYAM/MOOCs.

SEMESTER-VIII						
DISCIPLINE SPECIFIC ELECTIVE (DSE Maths11): **Topology**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSE Maths11: Topology	4	3	1	0	Passed diploma in Science with Mathematics	Completed DSE Maths3
Course Outcomes: Students will gain a thorough understanding of topological spaces, including open and closed sets, bases, sub-bases, and countability axioms. They will learn about continuous and homeomorphic maps, topological invariants, and constructions like subspaces, product spaces, and quotient spaces. The course also covers key topological properties such as compactness, connectedness, and separation axioms (T_1 to T_4), enabling students to analyze and classify spaces based on their topological structure.						

Bachelor of Science (Honors)	
Year: IV	**Semester:** VIII
Course: DSE Maths11	**Course Title:** Topology
Credits: 4	**Discipline Specific Elective**
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	Content	Number of Hours
Unit I	Basic concepts in Topology: Topology on a set, a topological space with examples, topologies on the real number system.	14-15
Unit II	Neighbourhood of a point/set, Open and closed sets, interior, boundary, closure, limit point, Derived sets of a set, Base and sub-base of a topology, Separable Spaces, First and Second Countable spaces.	14-15
Unit III	Continuous map, open and closed maps, homeomorphisms, Topological invariants, Pasting Lemma, Subspaces, product spaces, quotient space.	14-15
Unit IV	Compactness, Compact spaces, Compactness of a metric space, Connectedness, connected space, components. Separation axioms: $T_1, T_2, T_3, T_{3\frac{1}{2}}, T_4$, regular, completely regular and normal space.	14-15

Books Recommended:

1. J. R. Munkres: Topology: Narosa Publishing House.
2. Shaum's outlines series: Tata McGraw Hill.
3. K. D. Joshi: Introduction to General Topology, Wiley Eastern, 1983.
4. M. D. Raisinghania & R. S. Aggarwal: Topology, S. Chand & Co.

Further Readings:

1. G. F. Simmons: Introduction to Topology and Modern Analysis, McGraw Hill, 1963.

Digital Platform: NPTEL/SWAYAM/MOOCs.

SEMESTER-VIII						
DISCIPLINE SPECIFIC ELECTIVE (DSE Maths12): **Theory of Relativity**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSE Maths12: Theory of Relativity	4	3	1	0	Passed diploma in Science with Mathematics	Completed DSE Maths3
Course Outcomes: Students will understand key ideas of special relativity, including Lorentz transformations, time dilation, and mass-energy equivalence. They will study spacetime concepts like four-vectors and relativistic momentum. In general relativity, they will learn about geodesics, curvature, Einstein's equations, and gravitational effects in curved spacetime.						

Master of Science (Mathematics)	
Year: IV	**Semester:** VIII
Course: DSE Maths12	Course Title: **Theory of Relativity**
Credits: 4	Discipline Specific Elective
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	**Content**	**Number of Hours**
Unit I	Special Relativity: Inertial Frames of reference, Michelson-Morley experiment, Doppler effect, Stellar aberration, Simultaneity, Postulates of special relativity, Lorentz transformation, Length contraction, Time dilation, Clock paradox, Addition of velocities and accelerations, Four-dimensional space time, Light cone, Mass variation, Velocity four vector, Momentum and force, Mass-Energy relationship.	14-15
Unit II	General Relativity: Geodesics, Geodesic coordinates, Curvature tensor and its algebraic properties, Bianchi's identities, Contracted curvature tensor, Conditions for a flat space time, Displacement of space –time, Killing equations, Groups of motion, Space –time of constant curvature.	14-15
Unit III	Principal of covariance, non-inertial frames of reference, Principal of equivalence, Weak field approximation of geodesic equations, Law of gravitation in empty space-time, Canonical coordinates, Schwarzschild solutions.	14-15
Unit IV	Experimental tests of general relativity, Schwarzschild metric in isotropic coordinates, Brikhoff's theorem, Law of gravitation in non-empty space time.	13-15

Books Recommended:

1. D.F. Lawden: An Introduction to tensor calculus and relativity,
2. J.V. Narlikar: General relativity and cosmology.
3. R.H. Good: Basic concept of relativity, 1978.

Further Readings:

1. A.S. Eddington: Mathematical theory of relativity, 1981.

Digital Platform: NPTEL/SWAYAM/MOOCs.

SEMESTER-VIII						
DISCIPLINE SPECIFIC ELECTIVE (DSE Maths13): **Integral Equations**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSE Maths13: Integral Equations	4	3	1	0	Passed diploma in Science with Mathematics	Completed DSE Maths3
Course Outcomes: Students will understand the classification of integral equations and their relationship with differential equations. They will study Fredholm and Volterra integral equations, resolvent and convolution kernels, and symmetric kernels. The course covers methods like successive approximation and classical Fredholm theory, including singular and Hilbert-type equations, and integral equations involving Green's functions.						

Master of Science (Mathematics)	
Year: IV	**Semester:** VIII
Course: DSE Maths13	**Course Title:** Integral Equations
Credits: 4	**Discipline Specific Elective**
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	**Content**	**Number of Hours**
Unit I	Classification of integral equations, Relation between differential and integral Equations, Fredholm integral equations, Fredholm equations of second kind with separable kernels, Eigen values and eigen functions.	14-15
Unit II	Volterra integral equations, Resolvent kernel of Volterra equation, Convolution type kernel, Integral equations with symmetric kernel.	14-15
Unit III	Method of successive approximation for Fredholm and Volterra equations of the second kind.	14-15
Unit IV	Classical Fredholm theory, Singular integral equations, Hilbert type integral equations, Integral equation with Green's function type kernels.	14-15

Books Recommended:

1. Integral Equations and Boundary Value Problem: M.D. Raisinghania, S. Chand.
2. Linear Integral Equations: W. V. Lovit, Dover Pub. Int. New York.
3. Linear Integral Equations: R.P. Kanwal, Birkhauser Boston, 1996.
4. Integral Equations: L. G. Chambers, International Textbook Co., 1976.

Digital Platform: NPTEL/SWAYAM/MOOCs.

Semester-VIII						
DISCIPLINE SPECIFIC ELECTIVE (DSE Maths14): **Tensor Calculus**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSE Maths14: Tensor Calculus	4	3	1	0	Passed diploma in Science with Mathematics	Completed DSE Maths3
Course Outcomes: The core concepts of tensors have been included in this course with a view that students will be benefitted by the algebra of tensors. This helps students to understand various courses like Einstein's theory of Relativity, Image processing etc.						

Bachelor of Science (Honors)	
Year: IV	**Semester:** VIII
Course: DSE Maths14	Course Title: **Tensor Calculus**
Credits: 4	Discipline Specific Elective
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	Content	Number of Hours
Unit I	n-dimensional real vector space, transformation of coordinates, invariants, contravariant and covariant vectors, tensors of order two: contravariant tensors, covariant tensors and mixed tensors, higher order tensors, operations on tensors: addition, subtraction, multiplication, contraction and inner product.	14-15
Unit II	Symmetric and skew symmetric tensors, quotient law of tensors, relative tensors.	14-15
Unit III	metric tensor, length of a curve, magnitude of vector, angle between two vectors, associated tensors, conjugate symmetric tensors,	14-15
Unit IV	Christoffel symbols, transformation rule and group property, covariant derivative, intrinsic derivative, Gradient, divergence and curl.	14-15

Books Recommended:

1. N. Islam: Tensors and their applications, New Age International Publishers, 2006.
2. C.E. Weatherburn: Riemannian Geometry and Tensor Calculus.
3. B. Spain: Tensor Calculus.

Digital Platform: NPTEL/SWAYAM/MOOCs.

Semester-VIII						
DISCIPLINE SPECIFIC ELECTIVE (DSE Maths15): **Fuzzy Set Theory**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSE Maths15: Fuzzy Set Theory	4	3	1	0	Passed diploma in Science with Mathematics	Completed DSC Maths2
Course Outcomes: Upon completion, students will grasp the concepts of fuzzy sets, fuzzy logic, and approximate reasoning, enabling them to model uncertainty and solve problems in decision-making, control systems, and artificial intelligence.						

Bachelor of Science (Honors)	
Year: IV	**Semester:** VIII
Course: DSE Maths15	Course Title: **Fuzzy Set Theory**
Credits: 4	Discipline Specific **Elective**
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	Content	Number of Hours
Unit I	Fuzzy sets, Basic definitions, Alpha-cut sets, Convex fuzzy sets, Basic operation on fuzzy sets, Types of fuzzy sets, Cartesian products, Algebraic products, Bounded sum and differences, t-norms and t-corners.	14-15
Unit II	The extension principle, The Zadeh's extension principle, Images and inverse image of fuzzy sets, Fuzzy numbers, Element of fuzzy arithmetic.	14-15
Unit III	Fuzzy relation and fuzzy graphs. Fuzzy relation on fuzzy sets, Composition of fuzzy relation, Min-max composition and properties, Equivalence relations, Fuzzy compatibility relation, Fuzzy relation equations.	14-15
Unit IV	Fuzzy logic, An overview of classical logic, Multivalued logic, Fuzzy propositions, Fuzzy qualifiers, Linguistic variables, and hedge.	14-15

Books Recommended:

1. George J. Klir and Bo Yuan: "Fuzzy Sets and Fuzzy Logic: Theory and Applications".
2. Didier Dubois and Henri Prade: "Fuzzy Sets and Systems: Theory and Applications".
3. Hans-Jürgen Zimmermann: "Fuzzy Set Theory and Its Applications".
4. A.K. Bhargava: "Fuzzy set theory, Fuzzy logic and their Applications".
5. Kwang H. Lee: "First Course on Fuzzy Theory and Applications".

Digital Platform: NPTEL/SWAYAM/MOOCs.

SEMESTER-IX						
DISCIPLINE SPECIFIC COURSE (DSC Maths9): **Advanced Linear Algebra**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSC Maths9: Advanced Linear Algebra	4	3	1	0	Passed diploma in Science with Mathematics	Completed DSC Maths5
Course Outcomes: The core concepts of Linear Algebra have been included in this course with a view that students can understand the behaviour of mathematical entities called vector spaces.						

Master of Science (Mathematics)	
Year: V	**Semester:** IX
Course: DSC Maths9	**Course Title:** Advanced Linear Algebra
Credits: 4	**Discipline Specific Course**
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	Content	Number of Hours
Unit I	A brief review of vector space, Inner products, Orthogonality, Best approximations, Projections, Cauchy-Schwartz inequality.	14-15
Unit II	Adjoint of a linear transformation, Self-adjoint transformations, Unitary operators.	14-15
Unit III	Normal operators: Definition and properties, Spectral theorem.	14-15
Unit IV	Eigen vectors and eigen values of a linear operator, Minimal polynomial of a linear operator and its relations to characteristic polynomial, Caley-Hamilton theorem.	14-15

Books Recommended:

1. K. Hoffman and R. Kunze: *Linear Algebra*, Prentice Hall of India, 1972.
2. K. B. Dutta: *Matrix and Linear Algebra*, Prentice Hall of India, 2004.
3. Seymour Lipschutz and Marc L. Lipson*: Linear Algebra,* Schaum's Outline Series, McGraw Hill Edition, 2017.
4. S. H. Friedberg, A. J. Insel and L. E. Spence: *Linear Algebra,* Pearson Education, 2015.

Further Readings:

1. G. Hadley: *Linear Algebra,* Narosa Publishing House, 2002.
2. H. Helson: *Linear Algebra*, Hindustan Book Agency, New Delhi, 1994.
3. Gilbert Strang: *Linear Algebra and its Applications,* Cengage Learning India, 2005.

Digital Platform: NPTEL/SWAYAM/MOOCs.

SEMESTER-IX						
DISCIPLINE SPECIFIC ELECTIVE (DSE Maths16): **Measure Theory**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSE Maths16: Measure Theory	4	3	1	0	Passed diploma in Science with Mathematics	Completed DSE Maths3
Course Outcomes: Students will understand the concept of countability, cardinality, and set algebras including σ-algebras and Boolean structures. They will learn the construction of outer measure, measurable sets, and the Lebesgue measure. The course will cover Lebesgue integration for bounded and nonnegative functions, including convergence theorems. Students will also study properties of functions such as bounded variation, absolute continuity, and differentiation of integrals, building a foundation for advanced analysis.						

Master of Science (Mathematics)	
Year: V	**Semester:** IX
Course: DSE Maths16	Course Title: Measure Theory
Credits: 4	Discipline Specific Elective
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	Content	Number of Hours
Unit I	Countable sets, uncountable sets, relation between the cardinality of a nonempty set and the cardinality of its power set; Boolean ring, σ-ring, Boolean algebra and σ-algebra of sets, Set function.	14-15
Unit II	Introduction, Outer measure, Measurable sets and Lebesgue measure, Example of non-measurable sets, Measurable functions.	14-15
Unit III	The Riemann integral, The Lebesgue integral of a bounded function over a set of finite measure, The integral of nonnegative functions. The general Lebesgue integral, Convergence in measure.	14-15
Unit IV	Differentiation of monotone functions, Functions of bounded variation, Differentiation of an integral, Absolute continuity, Convex functions.	14-15

Books Recommended:

1. P. K. Jain: Measure Theory, New Age International.
2. P. R. Halmons: Measure Theory, Grand Text Mathematics, 14 Springer, 1994.
3. I. K. Rana: An Introduction to Measure and Integration, (Second Edition), Narosa Publishing House, New Delhi, 2005.

Further Readings:

1. E. T. Copson: Complex Variables, Oxford University Press. K.R. Parthasarathy: Introduction to Probability and Measure, TRIM 33, Hindustan Book Agency, New Delhi, 2005.
2. E. Hewit and K. Stromberg: Real and Abstract Analysis, Springer, 1975.
3. H. L. Royden: Real Analysis, Macmillan Publishing Company, New York, 1988.

Digital Platform: NPTEL/SWAYAM/MOOCs.

SEMESTER-IX						
DISCIPLINE SPECIFIC ELECTIVE (DSE Maths17): **Mathematical Statistics**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSE Maths17: Mathematical Statistics	4	3	1	0	Passed diploma in Science with Mathematics	Completed DSE Maths3
Course Outcomes: Students will understand descriptive statistics, probability theory, and the behaviour of random variables and distributions. They will learn expectation, moments, modes of convergence, and key limit theorems. The course introduces Markov chains, Poisson processes, and standard probability distributions. Students will also gain knowledge of correlation, regression, and multivariate techniques such as PCA, discriminant analysis, clustering, and canonical correlation.						

Master of Science (Mathematics)	
Year: V	**Semester:** IX
Course: DSE Maths17	Course Title: Mathematical Statistics
Credits: 4	**Discipline Specific Elective**
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	**Content**	**Number of Hours**
Unit I	Descriptive Statistics: Measures of central tendency, dispersion skewness and kurtosis Elements of probability: Sample space, discrete probability, independent events, Baye's theorem, random variables and distribution functions (univariate, bivariate, and generalization to multivariate).	14-15
Unit II	Mathematical expectation and moments: Moment generating function, Characteristic function and cumulants. Probabilistic inequalities. Modes of convergence: weak and strong laws of large numbers. Central limit theorem (i.i.d. case). Markov chains with finite and countable state space, Poisson and birth- and- death processes.	14-15
Unit III	Some standard discrete and continuous univariate distributions (Binomial, Poisson, Normal, Gamma and Beta), Distribution of order statistics and range.	14-15
Unit IV	Correlation, Rank correlation. Regression lines. Multiple and partial correlation of three variables only, Data reduction techniques: Principal component analysis, discriminant analysis, cluster analysis, canonical correlation.	14-15

Books Recommended:

1. M. G. Kendall: Advanced theory of statistics Vol. I &II, Charle's Griffiin & Co.
2. R. Hogg and A Craig: Introduction to Mathematical Statistics, Mac Millan & Co.
3. C.E. Weatherbun: A first course in Mathematical Statistics, The English Language Book Society And Cambridge University Press, 1961.
4. S.C. Gupta & V.K. Kapoor: Fundamentals of Mathematical Statistics, Sultan Chand & Co

Digital Platform: NPTEL/SWAYAM/MOOCs.

SEMESTER-IX						
DISCIPLINE SPECIFIC ELECTIVE (DSE Maths18) - **Number Theory**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSE Maths18: Number Theory	4	3	1	0	Passed diploma in Science with Mathematics	Completed DSE Maths3
Course Outcomes: The core concepts of numbers have been included in this course with a view that students can understand the behaviour of prime numbers and natural numbers in a critical way.						

Master of Science (Mathematics)	
Year: V	**Semester:** IX
Course: DSE Maths18	**Course Title:** Number Theory
Credits: 4	**Discipline Specific Elective**
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	**Content**	**Number of Hours**
Unit I	Prime Numbers, Unique Factorization theorem, Farey series, Irrational numbers, Congruences, Residues, Quadratic Reciprocity Law, Primitive roots.	14-15
Unit II	Fermat's theorem, Wilson's theorem, Continued fractions, Approximation of irrational of rational, Hurwitz theorem.	14-15
Unit III	The fundamental theorem of arithmetic in K (1), $K(i)$, $K(\rho)$, Diophantine equation $X^2 + Y^2 = Z^2, X^4 + Y^4 = Z^4,\ aX^2 + bY^2 + cZ^2 = 0,$ Quadratic fields, The arithmetic functions:	14-15
Unit IV	d(n), σ(n), μ(n) and $\varphi(n)$ including elementary result on their order and average order.	14-15

Books Recommended:

1. G. H. Hardy and E. M. Wright: Introduction to the theory of numbers, Oxford University Press, 4th Edition.
2. D. M. Burton: Elementary Number Theory, 6th Edition, Tata McGraw Hill.
3. Thomas Koshy: Elementary Number Theory with Applications, Academic Press, 2nd Edition.
4. Kenneth H. Rosen: Elementary Number Theory and its Applications, Addison-Wesley Publishing Company, 1986.

Further Readings: Digital Platform: NPTEL/SWAYAM/MOOCs.

SEMESTER-IX						
DISCIPLINE SPECIFIC ELECTIVE (DSE Maths19) - **Fluid Dynamics**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSE Maths19: Fluid Dynamics	4	3	1	0	Passed diploma in Science with Mathematics	Completed DSE Maths3
Course Outcomes: Students will understand fluid motion through Lagrangian and Eulerian approaches, continuity equation, Euler's equations, and Bernoulli's theorem. They will study 2D and 3D flows, velocity potentials, stream functions, sources, sinks, and image systems. The course includes irrotational flow, circulation theorems, conformal mappings like Joukowski and Kutta transformations, and vortex motion including rectilinear vortices and vortex pairs.						

Master of Science (Mathematics)	
Year: V	Semester: IX
Course: DSE Maths19	Course Title: **Fluid Dynamics**
Credits: 4	Discipline Specific Elective
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	**Content**	**Number of Hours**
Unit I	Lagrangian and Eulerian methods, Equation of continuity, Boundary surface, Stream lines, Velocity potential, Euler's equation of motions, Bernoulli's theorem, Helmholtz equations, Cauchy's integral, Equation of action under impulsive forces, Principal of energy.	14-15
Unit II	Motion in two dimensions, Velocity potential and current functions, Sources and sinks, Doublet and images, Circle theorem, Motion of circular and elliptic cylinder in two dimensions, Joukowski transformation, Motion in three dimensions, Three dimensional sources, Sinks and doublets, Image of source in front of sphere, Motion of spheres, Stroke's stream function.	14-15
Unit III	General theory of irrotational motion, Permanence of irrotational motion circulation, Stroke's theorem, Kelvin's circulation theorem, Green's theorem, Kelvin's minimum energy theorem, Conformal Representation, Kutta and Joukowski transformation, Theorems of Schwartz Christoffel.	14-15
Unit IV	Vortex motion: Rectilinear vortices, Rectilinear vortex with a circular section, An infinite row of parallel rectilinear vortices, Karman stream, Use of conformal transformation, Vortex pairs.	14-15

Books Recommended:

1. S. Ramsey: A Treatise on Hydrodynamics.
2. W. H. Besant and A. S. Ramsey: A Treatise on Hydrodynamics, CBS Publisher and Distributors, Delhi, 1988.
3. M. D. Raisinghania: Fluid Dynamics, S. Chand, 1939

Further Readings:

1. F. Chorlton: A Text Book of Fluid Dynamics, CBC, 1985.
2. S .W. Yuan: Foundations of Fluid Dynamics, Prentice-Hall of India,1988.

Digital Platform: NPTEL/SWAYAM/MOOCs.

SEMESTER-IX						
DISCIPLINE SPECIFIC ELECTIVE (DSE Maths20): **Discrete Mathematics**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSE Maths20: Discrete Mathematics	4	3	1	0	Passed diploma in Science with Mathematics	Completed DSE Maths3
Course Outcomes: This course will enable students to understand various concepts which are useful for higher study in other disciplines of mathematical sciences like computer science, data science etc.						

Master of Science (Mathematics)	
Year: V	**Semester:** IX
Course: DSE Maths20	Course Title: **Discrete Mathematics**
Credits: 4	**Discipline Specific Elective**
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	**Content**	**Number of Hours**
Unit I	Principle of mathematical induction, partially ordered sets, Lattices: Lattices as partially ordered sets, Their Properties, Lattices and algebraic systems. Principle of duality, Sub lattices, Complete, Complemented and Distributive lattices.	14-15
Unit II	Boolean algebra, Boolean functions, Boolean expressions, Applications to switching circuits.	14-15
Unit III	Elements of graph theory: Basic terminology, Paths and circuits, Eulerian and Hamiltonian graphs, planar graphs, Directed graphs.	14-15
Unit IV	Trees: Rooted trees, path lengths, spanning trees, minimum spanning trees.	14-15

Books Recommended:

1. C. L. Liu: Elements of discrete mathematics, Tata McGraw Hill Education, 2008.
2. Ram Babu: Discrete Mathematics, Pearson Edition India, 2011.
3. Lipschutz: Discrete Mathematics, Tata McGraw Hill, 2011.

Digital Platform: NPTEL/SWAYAM/MOOCs.

SEMESTER-IX						
DISCIPLINE SPECIFIC ELECTIVE (DSE Maths21): **OPERATIONS RESEARCH – II**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSE Maths21: OPERATIONS RESEARCH – II	4	3	1	0	Passed diploma in Science with Mathematics	Completed DSE Maths3
Course Outcomes: This course will enable students to understand various concepts which are useful for higher study in other disciplines of mathematical sciences like computer science, data science, etc.						

Master of Science (Mathematics)	
Year: V	**Semester:** IX
Course: DSE Maths21	Course Title: **OPERATIONS RESEARCH – II**
Credits: 4	**Discipline Specific Elective**
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	**Content**	**Number of Hours**
Unit I	**Inventory control:** functional role of inventory, classification of EOQ models (with and without shortages).	14-15
Unit II	**Queuing theory:** characteristics of queuing systems, probability distributions in queuing models, single server (M/M/1) and multiple server models.	14-15
Unit III	**Markov chains:** applications of Markov analysis, states and transition probabilities, steady-state conditions; sequencing problems—processing *n* jobs through two and three machines.	14-15
Unit IV	**Dynamic programming:** deterministic models, non-linear programming methods, quadratic programming, Kuhn–Tucker conditions.	14-15

Books Recommended:

1. C. L. Liu: Elements of discrete mathematics, Tata McGraw Hill Education, 2008.
2. Ram Babu: Discrete Mathematics, Pearson Edition India, 2011.
3. Lipschutz: Discrete Mathematics, Tata McGraw Hill, 2011.

Digital Platform: NPTEL/SWAYAM/MOOCs.

SEMESTER-X						
DISCIPLINE SPECIFIC COURSE (DSC Maths10): **Functional Analysis**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSC Maths10: Functional Analysis	4	3	1	0	Passed diploma in Science with Mathematics	Completed DSC Maths5
Course Outcomes: Students will understand normed and inner product spaces, including Banach and Hilbert spaces, and explore concepts like compactness, bounded operators, dual spaces, and adjoint operators. They will study key theorems such as Hahn-Banach, uniform boundedness, open mapping, and closed graph theorems. The course also includes convergence of operators and sequences, Banach contraction principle, and approximation theory with applications to linear, differential, and integral equations.						

Master of Science (Mathematics)	
Year: V	Semester: X
Course: DSC Maths10	Course Title: **Functional Analysis**
Credits: 4	Discipline Specific Course
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	Content	Number of Hours
Unit I	Metric convergence of sequences, Normed spaces, Banach Space, Properties of Normed spaces, Finite dimensional normed spaces and subspaces; Compactness and finite dimension, linear operators, Bounded and continuous linear operators; Linear functional; linear operators and functional on finite dimensional spaces, Normed spaces of operators, Dual space.	14-15
Unit II	Inner product space; Hilbert space; Properties of Inner product spaces, Orthogonal complements and direct sums, Orthonormal sets and sequences; Hilbert adjoint operators, Self-Adjoint, Unitary and normal operators.	14-15
Unit III	Fundamental Theorems of Normed and Banach Space: Zorn's Lemma, Hahn Banach Theorem, Hahn Banach Theorem for complex vector spaces and normed spaces, Applications to bounded linear functionals on C[a, b], Adjoint operators, Uniform boundedness theorem, strong and weak convergence, convergence of sequences of operators and functional, Applications of summability of sequences, Open mapping theorem and closed graph theorem.	14-15
Unit IV	Banach contraction principle, Applications of Banach's theorem to linear, differential and integral equations, Approximation in Normed spaces, Uniqueness, strict convexity, Uniform approximation, approximation in Hilbert spaces.	14-15

Books Recommended:

1. Erwin Kreyszig: Introductory Functional Analysis, Wiley India edition.
2. G. F. Simmons: Introduction to Topology and Modern Analysis, McGraw Hill, 1963.
3. E. Taylor: Introduction to Functional Analysis, John Wiley, 1958.
4. R. E. Edwards: Functional Analysis, Holt Rinehart and Winston, 1965

Further Readings: Digital Platform: NPTEL/SWAYAM/MOOCs.

SEMESTER-X						
DISCIPLINE SPECIFIC ELECTIVE (DSE Maths22): **Numerical Methods**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSE Maths22: Numerical Methods	4	3	1	0	Passed diploma in Science with Mathematics	Completed DSE Maths3
Course Outcomes: Students will learn error analysis and apply numerical methods for solving equations, linear systems, and differential equations. They will use interpolation, curve fitting, and numerical integration techniques, focusing on accuracy, stability, and convergence.						

Master of Science (Mathematics)	
Year: V	**Semester:** X
Course: DSE Maths22	Course Title: **Numerical Methods**
Credits: 4	Discipline Specific **Elective**
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	**Content**	**Number of Hours**
Unit I	**Errors in numerical Calculations:** Absolute, Relative, Percentage errors, General Error, Error in series approximation. Solutions of Algebraic and Transcendental Equation: Bisection method, false position method, Newton-Raphson and generalized Newton's Method, Graffe's root squaring method, Lin Bairstow's method, Picard's iteration method, convergence and error estimates of iterative methods.	14-15
Unit II	**Linear systems of equations:** Consistency of Linear System of equations, Solutions of Linear Systems by directs method: Gaussian elimination and computation of inverse of a matrix, Method of Factorization, Solutions of Tridiagonal systems and ill conditioned linear systems. Solutions of linear systems by iterative methods: Jacobi method, Gauss- Siedel method.	14-15
Unit III	**Interpolation and curve fitting:** Errors in Polynomial interpolation, Finite differences, Differences of a polynomial, Newton's forward and backward interpolation, Central differences, Gauss, Stirling, Bessel's and Everett's Formulae, Practical interpolation and interpolation with unevenly spaced points, Lagrange's Interpolation formula, Divided difference and Newton's General interpolation formula, Least square curve fitting procedure.	14-15
Unit IV	**Numerical differentiation and integration:** Numerical differentiation, cubic Spline method, Maximum and minimum values of tabulated function, Newton-Cotes Integration formula, Numerical integration by Trapezoidal rule, Simpson'1/3, Simpson's 3/8, Weddle's rule and Romberg Integration, Numerical solution of ODE by Picard's Euler's Modified Euler's and Runge-Kutta methods.	14-15

Books Recommended:

1. S. S. Sastry: Introductory Methods Numerical Analysis, Prentice- Hall of India.
2. C.F. Gerald and P. O. Wheatley: Applied Numerical Analysis, Addison- Wesley, 1998.Further Readings:

Digital Platform: NPTEL/SWAYAM/MOOCs.

SEMESTER-X						
DISCIPLINE SPECIFIC ELECTIVE (DSE Maths23): **Riemannian Geometry**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSE Maths23: Riemannian Geometry	4	3	1	0	Passed diploma in Science with Mathematics	Completed DSE Maths3
Course Outcomes: This course is useful to view geometry of the space where our Euclidean geometry is not applicable. It will help the students for better understanding of other disciplines of physical and natural sciences.						

Master of Science (Mathematics)	
Year: V	**Semester:** X
Course: DSE Maths23	Course Title: **Riemannian Geometry**
Credits: 4	**Discipline Specific Elective**
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	**Content**	**Number of Hours**
Unit I	N-dimensional real vector space and its dual space, multilinear functions on vector spaces, tensor product, contravariant and covariant vectors, second order tensors, tensors of type (r,s). Algebraic Operations on tensors, Symmetric and skew symmetric properties, inner product of vectors, Euclidean vector space.	14-15
Unit II	Differentiable manifold, Lie-bracket, Tangent space, Connections, Covariant derivatives, Curvature tensor, Parallelism, Lie derivative, Exterior derivative, Cartan's structural equations.	14-15
Unit III	Riemannian geometry: Riemannian metric, Christoffel symbols, Curvature tensor with respect to Christoffel symbols, Differential operators, Geodesics, Geodesic coordinates, Riemannian curvature, Conformal curvature tensor, Fernet's formulae.	14-15
Unit IV	Sub-manifolds and Hypersurfaces: Normals, Gauss's formulae, Weingarten equations, Coordinate viewpoint, Lines of curvature, Generalized Gauss and Mainardi-Codazzi equations.	14-15

Books Recommended:

1. R.S. Mishra: A Course in tensors with applications to Riemannian Geometry, Pothishala Pvt. Ltd., Allahabad, 1965.
2. R. L. Bishop and S. I. Goldberg: Tensor Analysis on Manifolds, Dover Publications, New York.
3. S. S. Chern: Differentiable Manifolds, University of Chicago, Chicago.

Further Readings:

1. K. Yano: The theory of Lie derivatives and its applications, North-Holland Publishing Company, Amsterdam, 1957.
2. Matthew S. Smith: Principal and Application of Tensor Analysis, W. Sons (Indianapolis) 1963.
3. H.S. Shukla, Prasad & Dhruwa Narain Dubey: Differential Geometry of Manifolds, Vandana Prakashan, Mohanlalpur, Gorakhpur.

Digital Platform: NPTEL/SWAYAM/MOOCs.

SEMESTER-X						
DISCIPLINE SPECIFIC ELECTIVE (DSE Maths24) - **Calculus of Variations**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSE Maths24: Calculus of Variations	4	3	1	0	Passed diploma in Science with Mathematics	Completed DSE Maths3
Course Outcomes: This course introduces the theory of functionals and techniques to find their extrema using Euler's equation and related conditions. Students will learn to solve variational problems with constraints, understand Noether's theorem, and apply numerical methods like Ritz and Galerkin to boundary value problems.						

Bachelor of Science (Honors)	
Year: V	**Semester:** X
Course: DSE Maths24	Course Title: **Calculus of Variations**
Credits: 4	**Discipline Specific Elective**
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	**Content**	**Number of Hours**
Unit I	Variation of functional, Continuity and differentiability of functional, Necessary condition for an extremum, Euler's equation, Variational problems in parametric form, Functional depending on higher order derivatives and variational problems with subsidiary condition.	14-15
Unit II	The isoperimetric problem, Invariance of Euler's equation under coordinate transformation, General variational of functional, Variable end point problems, Transversality condition transversal theorem, Weierstrass Endmann corner condition.	14-15
Unit III	Sufficient condition for extremum: second variation, Legendre's and Jacobi's necessary condition, Canonical transformation, Noether's theorem, The principle of least action, Conservation law, Hamilton Jacobi's equations.	14-15
Unit IV	Transformation of ODE and PDE into functionals and their solutions by Ritze, Galerkin, Collocation and Kantrovitch methods.	14-15

Books Recommended:

1. I.M. Gelfand and S.V. Fomin: "Calculus of Variations".
2. G.A. Seregin and V.A. Solonnikov: "Calculus of Variations and Partial Differential Equations".
3. Calculus of Variation: Gelfrand and Fomin, Dover Pub. Inc., New York.
4. Calculus of Variation: Elsgolt , University Press of the Pacific, 2003.
5. Calculus of Variation: A. S. Gupta, PHI Learning Pvt. Ltd., 2015.

Digital Platform: NPTEL/SWAYAM/MOOCs.

SEMESTER-X						
DISCIPLINE SPECIFIC ELECTIVE (DSE Maths25): **Algebraic Topology**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSE Maths25: Algebraic Topology	4	3	1	0	Passed diploma in Science with Mathematics	Completed DSE Maths11
Course Outcomes: This course provides a foundational understanding of topological spaces through algebraic tools. Students will learn key concepts such as homotopy, fundamental and homotopy groups, simplicial and singular homology, and their applications in classifying topological spaces. The course also introduces CW-complexes, cellular homology, and basic ideas of category theory in relation to topology.						

Bachelor of Science (Honors)	
Year: V	**Semester:** X
Course: DSE Maths25	Course Title: **Algebraic Topology**
Credits: 4	**Discipline Specific Elective**
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	**Content**	**Number of Hours**
Unit I	Basic definitions and concepts of point-set topology, Homotopy and homotopy quivalence, Fundamental group and its properties	14-15
Unit II	Simplicial complexes and their properties, Simplicial homology and chain complexes, Singular homology and the singular chain complex	14-15
Unit III	Homology groups of spheres, torus, and other spaces, Homology operations and long exact sequences, Applications of homology to classification of spaces	14-15
Unit IV	Homotopy groups and higher homotopy groups, CW-complexes and cellular homology, Category theory and its relation to algebraic topology	14-15

Books Recommended:

1. G.E. Bredon: “Geometry and Topology”, Springer 2014.
2. J.J. Rotman: “An Introduction to Algebraic Topology”, Springer 2011.
3. E.H. Spainer: “Algebraic Topology” Springer 1989.
4. Marcelo Aguilar: “Algebraic Topology from a Homotopical Viewpoint”, Springer 2002.
5. James R. Munkres – “Topology”.

Digital Platform: NPTEL/SWAYAM/MOOCs.

SEMESTER-X						
DISCIPLINE SPECIFIC ELECTIVE (DSE Maths26): **Partial Differential Equations**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSE Maths26: Partial Differential Equations	4	3	1	0	Passed diploma in Science with Mathematics	Completed DSE Maths11
Course Outcomes: To solve any real-world problem mathematically, differential equations are widely used. This course will help students to deal with such problems and use differential equations to solve them.						

Master of Science (Mathematics)	
Year: V	**Semester:** X
Course: DSE Maths26	**Course Title:** Partial Differential Equations
Credits: 4	**Discipline Specific Elective**
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	**Content**	**Number of Hours**
Unit I	Existence and uniqueness of solutions of initial value problems for first order ordinary differential equations, singular solutions of first order ODEs, system of first order ODEs., General theory of homogeneous and non-homogeneous linear ODEs, variation of parameters, Sturm-Liouville boundary value problem, Green's function.	14-15
Unit II	Formation of PDEs, First order PDEs, Complete, general and singular integrals, Lagrange's or quasi-linear equations, Integral surfaces through a given curve. Orthogonal surfaces to a given system of surfaces, Characteristic curves.	14-15
Unit III	Pfaffian differential equations, Compatible systems, Char pit's method, Jacobi's Method. Cauchy problem for first order PDEs.	14-15
Unit IV	Linear equations with constant coefficients, Reduction to canonical forms, Classification of second order PDEs, General solution of higher order PDEs with constant coefficients.	14-15

Books Recommended:

1. G. F. Simmons: Differential Equations with Application and Historical Notes, McGraw Hill Edition, 2002
2. Shepley L. Ross: Differential Equations, John Wiley & Sons, 1984.
3. M. D. Raisinghania: Ordinary & Partial Differential Equation, S. Chand & Co. Ltd, 2017.
4. B. Rai, D. P. Choudhary and H. J. Freedman: A Course of Ordinary Differential Equations, Narosa, 2002.

Further Readings:

1. Earl A. Coddington and Norman Levinson: Theory of Ordinary Differential Equations, McGraw-Hill Edition, 1998.
2. Ravi P. Agarwal and Donal O'Regan: Ordinary and Partial Differential Equations, Springer, 2009.
3. Martin Braun: Differential Equations and Their Applications, Sringer, 1993.
4. Erwin Kreyszig: Advanced Engineering Mathematics, John Wiley & Sons, 2011.
5. Ian N. Snedden: Elements of Partial Differential Equations, Dover Publication, 2013.

Digital Platform: NPTEL/SWAYAM/MOOCs.

SEMESTER-X						
DISCIPLINE SPECIFIC ELECTIVE (DSE Maths27): **Introduction to programming using MATLAB**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
DSE Maths27: Introduction to programming using MATLAB	4	2	1	1	Passed diploma in Science with Mathematics	Completed DSE Maths3
Course Outcomes: This course is useful to do mathematical computations using computer. It will help the students for better understanding of mathematical concepts.						

Master of Science (Mathematics)	
Year: V	**Semester:** X
Course: DSE Maths27	**Course Title:** Introduction to programming using MATLAB
Credits: 4	**Discipline Specific Elective**
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	**Content**	**Number of Hours**
Unit I	**MATLAB Basics:** Introduction to MATLAB, Input and Output, Arithmetic, Algebra; Symbolic Expressions, Variables and Assignments, Solving Equations, Vectors and Matrices, Functions: Built-in Functions, User-Defined Functions.	14-15
Unit II	**Data Classes:** String Manipulation, Symbolic and Floating-Point Numbers, Functions and Expressions, Complex Arithmetic, Matrices, Solving Linear Systems, Calculating Eigenvalues and Eigenvectors, Doing Calculus with MATLAB (Differentiation, Integration, Limits, Sums and Products, Taylor Series etc)	14-15
Unit III	**MATLAB Graphics:** Two-Dimensional Plots, Parametric Plots, Contour Plots and Implicit Plots, Field Plots, Three-Dimensional Plots, Curves in Three-Dimensional Space, Surfaces in Three-Dimensional Space, Special Effects, Animations	14-15
Unit IV	**MATLAB Programming:** Branching with if, Logical Expressions, Branching with switch, Loops, User defined functions, M-Files	14-15
Note: Practical assignments using statistical and numerical techniques.		

Books Recommended:

1. Brian R. Hunt, Ronald L. Lipsman, Jonathan M. Rosenberg: A Guide to MATLAB for Beginners and Experienced Users, Cambridge University Press, 2001
2. Stormy Attaway: MAT LAB A Practical Introduction to Programming and Problem Solving, Elsevier, 2017

Digital Platform: NPTEL/SWAYAM/MOOCs.

GENERIC ELECTIVE COURSE

SEMESTER-I						
GENERIC ELECTIVE (GE Maths1): **Quantitative Aptitude and Logical Reasoning**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
GE Maths1: Quantitative Aptitude and Logical Reasoning	4	3	1	0	Passed Class X with Mathematics	Nil

Course Outcomes: This course is designed to enhance students' quantitative and logical thinking skills applicable in everyday life, academics, and the workplace. By the end of this course, students will be able to:

1. Interpret and analyze quantitative data and graphical information.
2. Apply mathematical reasoning to solve real-world problems.
3. Develop structured and logical arguments.
4. Recognize fallacies and use formal reasoning tools.
5. Make informed decisions using quantitative and logical insights.

GENERIC ELECTIVE COURSE (GE)	
Year: I	**Semester:** I
Course: GE Maths1	**Course Title:** Quantitative Aptitude and Logical Reasoning
Credits: 4	**Generic Elective Course**
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	Content	Number of Hours
Unit I	**Basic Numeracy and Quantitative Tools:** Arithmetic operations, percentages, ratios, proportions, averages, unit conversions, estimation, interpretation of tables and graphs.	14-15
Unit II	**Problem Solving and Quantitative Applications:** Word problems, financial literacy (interest, loans, discounts), data interpretation, probability basics, quantitative puzzles.	14-15
Unit III	**Introduction to Logic and Reasoning:** Propositions, logical operators, truth tables, types of reasoning (deductive and inductive), common logical fallacies.	14-15
Unit IV	**Critical and Analytical Thinking:** Analyzing arguments, syllogisms, Venn diagrams, puzzles, decision-making based on logic and data, introduction to algorithms and flowcharts.	14-15

Books Recommended:

1. Quantitative Aptitude by R.S. Aggarwal, S. Chand Publications.
2. Critical Thinking by William Hughes and Jonathan Lavery, Broadview Press.
3. Mathematics for Liberal Arts by Jason I. Brown, CRC Press.
4. Introduction to Logic by Irving M. Copi, Pearson.
5. Quantitative Reasoning: Tools for Today's Informed Citizen by Alicia Sevilla and Kay Somers.
6. Thinking Mathematically by John Mason et al., Pearson

Digital Platform: NPTEL/SWAYAM/MOOCs.

SEMESTER-II						
GENERIC ELECTIVE (GE Maths2): **Matrix Theory**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
GE Maths2: Matrix Theory	4	3	1	0	Passed Class X with Mathematics	Nil

Course Outcomes: This course provides a comprehensive understanding of matrix theory and its applications. By the end of this course, students will be able to:

1. Understand the definition, types, and fundamental properties of matrices.
2. Perform matrix operations such as addition, multiplication, and finding the adjoint and inverse, and apply elementary row/column transformations.
3. Determine the rank of a matrix and reduce matrices to their normal form using elementary operations.
4. Solve the systems of linear equations using matrix methods and understand the consistency and general solutions.
5. Compute eigenvalues and eigenvectors, understand the characteristic equation, and use Cayley-Hamilton theorem.

GENERIC ELECTIVE COURSE (GE)	
Year: I	**Semester:** II
Course: GE Maths2	**Course Title:** Matrix Theory
Credits: 4	**Generic Elective Course**
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	Content	Number of Hours
Unit I	Definition of matrices, matrix operations with their properties, types of matrices – symmetric, skew-symmetric, Hermitian, skew-Hermitian, idempotent, nilpotent, involuntary, orthogonal, and unitary matrices, singular and non-singular matrices.	14-15
Unit II	Elementary operations on matrices, adjoint and inverse of a matrix, singular and non-singular matrices, negative integral powers of a non-singular matrix, Trace of a matrix.	14-15
Unit III	Rank of a matrix, elementary transformations of a matrix and invariance of rank through elementary transformations, normal form of a matrix, elementary matrices, rank of the sum and product of two matrices, inverse of a non-singular matrix through elementary row transformations, equivalence of matrices.	14-15
Unit IV	Solutions of a system of linear equations, condition of consistency and nature of the general solution of a system of linear non- homogeneous equations. Characteristic equation of a matrix, eigenvalues and eigenvectors, Cayley-Hamilton theorem.	14-15

Books Recommended:

1. Hari Kishan, A Textbook of Matrices, Atlantic Publishers, 2008
2. Fuzhen Zhang, Matrix Theory- Basic Results and Techniques, Springer, 1999
3. Shanti Narayan, P.K. Mittal, A Textbook of Matrices, S Chand & Company, 2010

Digital Platform: NPTEL/SWAYAM/MOOCs.

SEMESTER-III						
GENERIC ELECTIVE (GE Maths3): **Basic Calculus**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
GE Maths3: Basic Calculus	4	3	1	0	Passed Class X with Mathematics	Nil

Course Outcomes: This course introduces the fundamental principles of differential and integral calculus. Students will gain mathematical maturity and analytical skills necessary for understanding continuous change.
By the end of this course, students will be able to:

1. Understand functions, limits, and continuity.
2. Perform differentiation and integration of elementary functions.
3. Apply derivatives to solve problems involving maxima, minima, and rates of change.
4. Use integrals to calculate areas under curves and solve applied problems.
5. Interpret mathematical problems using graphical and analytical techniques.

GENERIC ELECTIVE COURSE (GE)	
Year: I	**Semester:** III
Course: GE Maths3	**Course Title:** Basic Calculus
Credits: 4	**Generic Elective Course**
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	Content	Number of Hours
Unit I	**Functions, Limits and Continuity:** Definition and types of functions, graphical representation. Limits and continuity, epsilon-delta definition, continuity of standard functions.	14-15
Unit II	**Differentiation and Its Applications:** Derivative as rate of change, techniques of differentiation, higher order derivatives. Applications: tangents and normal, monotonicity, maxima and minima, curve sketching.	14-15
Unit III	**Integration and Its Applications:** Indefinite integrals, methods of integration (substitution, by parts, partial fractions). Definite integrals, properties and applications: area under curves, average value of functions.	14-15
Unit IV	**Applications of Calculus:** Motion in a straight line, exponential growth and decay, basic differential equations, introduction to calculus in economics and biology.	14-15

Books Recommended:

1. G.B. Thomas and R.L. Finney, Calculus and Analytic Geometry, Pearson.
2. James Stewart, Calculus: Early Transcendentals, Cengage Learning.
3. Shanti Narayan and P.K. Mittal, Differential Calculus, S. Chand & Company.
4. H. Anton, I. Bivens, S. Davis, Calculus, Wiley India.
5. Michael Spivak, Calculus, Cambridge University Press.
6. R. Courant and F. John, Introduction to Calculus and Analysis, Springer.
7. T.M. Apostol, Calculus, Vol. 1, Wiley.

Digital Platform: NPTEL/SWAYAM/MOOCs.

SEMESTER-IV						
GENERIC ELECTIVE (GE Maths4): **Elementary Real Analysis**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
GE Maths4: Elementary Real Analysis	4	3	1	0	Passed Class X with Mathematics	Nil

Course Outcomes: This course provides an introduction to the foundational concepts of real analysis. By the end of this course, students will be able to:

1. Understand the real number system and its completeness.
2. Analyze sequences and series for convergence and divergence.
3. Study limits, continuity, and differentiability of real-valued functions.
4. Develop a rigorous understanding of the properties of real functions.
5. Apply analytical techniques to solve theoretical and practical problems.

GENERIC ELECTIVE COURSE (GE)	
Year: I	**Semester:** IV
Course: GE Maths4	**Course Title:** Elementary Real Analysis
Credits: 4	**Generic Elective Course**
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	Content	Number of Hours
Unit I	**Real Number System:** Completeness property, Archimedean property, density of rational numbers, supremum and infimum. Intervals and neighbourhoods.	14-15
Unit II	**Sequences:** Convergence and divergence of sequences, limit of a sequence, monotonic sequences, bounded sequences, Cauchy sequences, limit superior and limit inferior.	14-15
Unit III	**Series:** Infinite series, convergence tests (comparison, ratio, root). Absolute and conditional convergence.	13-14
Unit IV	**Continuity and Differentiability with Applications:** Functions, continuity, types of discontinuities, properties of continuous functions. Definition of derivative, rules of differentiation, Rolle's Theorem, Mean Value Theorem, Intermediate Value Theorem, applications to monotonicity and convexity.	15-16

Books Recommended:

1. S.C. Malik and Savita Arora, Mathematical Analysis, New Age International.
2. R.G. Bartle and D.R. Sherbert, Introduction to Real Analysis, Wiley.
3. Shanti Narayan and M.D. Raisinghania, Elements of Real Analysis, S. Chand.
4. T.M. Apostol, Mathematical Analysis, Narosa.
5. Walter Rudin, Principles of Mathematical Analysis, McGraw-Hill.
6. Charles Chapman Pugh, Real Mathematical Analysis, Springer.
7. G.B. Thomas and R.L. Finney, Calculus and Analytic Geometry, Pearson.

Digital Platform: NPTEL/SWAYAM/MOOCs.

SEMESTER-V						
GENERIC ELECTIVE (GE Maths5): **Introduction to Probability**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
GE Maths5: Introduction to Probability	4	3	1	0	Passed Class X with Mathematics	Nil

Course Outcomes: This course provides a foundational understanding of probability theory and its applications. By the end of this course, students will be able to:

1. Understand basic concepts and principles of probability.
2. Analyze random experiments and calculate probabilities of events.
3. Understand conditional probability, independence, and Bayes' theorem.
4. Study discrete and continuous random variables and their distributions.
6. Compute expectation, variance, and higher moments of random variables.

GENERIC ELECTIVE COURSE (GE)	
Year: I	**Semester:** V
Course: GE Maths5	**Course Title:** Introduction to Probability
Credits: 4	**Generic Elective Course**
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	Content	Number of Hours
Unit I	**Introduction to Probability:** Sample spaces, events, definitions of probability – classical, empirical, and axiomatic. Algebra of events.	14-15
Unit II	**Conditional Probability and Independence:** Conditional probability, multiplication rule, independent events. Bayes' theorem and its applications.	14-15
Unit III	**Random Variables and Expectation:** Definition of discrete and continuous random variables. Probability mass function (pmf), probability density function (pdf), cumulative distribution function (cdf). Mathematical expectation, moments, mean and variance.	14-15
Unit IV	**Standard Distributions:** Binomial, Poisson, and Normal distributions – definitions, properties, and applications. Approximation of binomial by normal distribution.	14-15

Books Recommended:

1. Sheldon Ross, A First Course in Probability, Pearson.
2. A.M. Mood, F.A. Graybill, D.C. Boes, Introduction to the Theory of Statistics, McGraw-Hill.
3. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand.
4. Robert V. Hogg and Allen T. Craig, Introduction to Mathematical Statistics, Pearson.
5. William Feller, An Introduction to Probability Theory and Its Applications, Wiley.
6. Jay Devore, Probability and Statistics for Engineering and the Sciences, Cengage.
7. Hines, Montgomery, Goldsman, Borror, Probability and Statistics in Engineering, Wiley.

Digital Platform: NPTEL/SWAYAM/MOOCs.

SEMESTER-VI						
GENERIC ELECTIVE (GE Maths6): **Basic Statistics**						
CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITE OF THE COURSE						
Course Title	**Credits**	**Credit distribution of the Course**			**Eligibility criteria**	**Pre-requisite of the course (if any)**
		Lecture	Tutorial	Practical/Practice		
GE Maths6: Basic Statistics	4	3	1	0	Passed Class X with Mathematics	Nil

Course Outcomes: This course introduces fundamental concepts of descriptive and inferential statistics. By the end of this course, students will be able to:

1. Understand and apply measures of central tendency, dispersion, skewness, and kurtosis.
2. Compute and interpret moments, factorial moments, and Shephard's correction.
3. Analyze bivariate data using correlation and regression techniques, including rank and intra-class correlation.
4. Understand basic probability concepts including conditional probability and Bayes' theorem.
5. Distinguish between discrete and continuous random variables and compute related probabilities.
6. Calculate expectations, moment-generating functions, and fit curves using the method of least squares.

GENERIC ELECTIVE COURSE (GE)	
Year: I	**Semester:** VI
Course: GE Maths6	**Course Title:** Basic Statistics
Credits: 4	**Generic Elective Course**
Min. Passing Marks: As per University rules	**No. of Hours: 55-60**

Unit	Content	Number of Hours
Unit I	Measures of central tendency (mean, median, mode) Measures of dispersion (range, variance, standard deviation, coefficient of variation) Skewness and kurtosis: concepts and interpretation Graphical representation of data: bar charts, histograms, box plots.	14-15
Unit II	Mathematical expectation and variance of a random variable (intuitive understanding) Moments and moment generating functions (basic introduction and interpretation) Common discrete and continuous distributions: Binomial, Poisson, Normal (focus on application and properties) Distribution of order statistics and range (basic concepts only).	14-15
Unit III	Law of large numbers (weak form only) and its practical implication Central limit theorem (statement and relevance in sampling) Introduction to Markov chains with simple real-life examples Concept of Poisson process and its applications in business and economics.	14-15
Unit IV	Correlation and rank correlation (Pearson and Spearman) Linear regression and regression lines (two variables) Introduction to multiple and partial correlation (three variables only) Basics of principal component analysis and cluster analysis (conceptual overview with examples).	14-15

Books Recommended:

1. Mood, A. M., Graybill, F. A., & Boes, D. C. (1974). Introduction to the Theory of Statistics (3rd ed.). Tata McGraw-Hill Pub. Co. Ltd. Reprinted 2017.
2. Hogg, Robert V., McKean, Joseph W., & Craig, Allen T. (2013). Introduction to Mathematical Statistics (7th ed.). Pearson Education, Inc.
3. Miller, Irwin & Miller, Marylees. (2014). John E. Freund's Mathematical Statistics with Applications (8th ed.). Pearson. Dorling Kindersley (India).
4. Ross, Sheldon M. (2014). Introduction to Probability Models (11th ed.). Elsevier Inc.

Digital Platform: NPTEL/SWAYAM/MOOCs.

Pattern of Examination Theory Papers

1. Theory

- *Each theory paper shall consist of two sections – A and B.*
- ***Section A** (Short answers type with reasoning): **45 marks**, eight questions of nine marks each, any five have to be attempted.*
- ***Section B** (Long answers type): **30 marks**, two questions of fifteen marks each, and both questions are compulsory with internal choice.*

2. Internal Assessment

- *For each theory paper internal assessment shall be conducted periodically (in the form of class tests and/or assignments/ group discussion/ oral presentation/ overall performance) during the semester period.*
- *Total marks allotted to internal assessment shall be 25.*
- *The evaluated answer sheets/assignments have to be retained by the Professor In-Charge for the period of six months and can be shown to the students if students want to see the evaluated answer sheets.*
- *The marks obtained by the students shall be submitted to the Head of concerned department/ the Principal of the College for uploading onto the University examination portal.*