KUMAUN UNIVERSITY, NAINITAL

Four Year Undergraduate Programme
FYUP/Honours Programme

MATHEMATICS SYLLABUS

DEPARTMENT OF MATHEMATICS

Bachelor of Science (Honors)					
Year	Semester	Course	Paper Title		Credits
FOURTH YEAR	VII	DSC Maths7	Real Analysis	Theory	4
		DSE Maths5	Topology	Theory	4
		DSE Maths6	Differential Geometry	Theory	4
		DSE Maths7	Number Theory	Theory	4
	VIII	DSC Maths8	Complex Analysis	Theory	4
		DSE Maths8	Algebra	Theory	4
		DSE Maths9	Partial Differential Equations	Theory	4
		DSE Maths10	Dynamics of Rigid Bodies	Theory	4

Abbreviations-
DSC-Discipline Specific Course; DSE- Discipline Specific Electives; GE-Generic Electives;

Programme Outcomes (POs) **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 SPECIFIC OUTCOMES (PSOS)	
Fourth Year	Bachelor (Research) of Science in Mathematics
	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, researchand industry as well as to obtain master degree in Mathematics.

Semester-VII

Bachelor of Science (Honors)

DISCIPLINE SPECIFIC COURSE (DSC Maths7)- Real Analysis

No. of Hours: 50-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES 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: Real Analysis	4	3	2	0	Passed diploma in Science with Mathematics	Completed DSC Maths5

Bachelor of Science (Honors)			
Programme :	*Bachelor of Science (Honors)*	Year: IV	Semester: VII Paper: DSCMaths7
Subject: Mathematics			
Course: DSC Maths7	Course Title: Real Analysis		
Course Outcomes: The core concepts of Real Analysis has been included in this course with a view that students can understand the behavior of different sets with respect to metric or distance function.			
Credits: 4			Discipline Specific Course
Max. Marks: As per Univ. rules			Min. Passing Marks: As per Univ. rules
Unit	Content		Number of Hours
Unit I	Metric spaces: metric, Various examples of metric spaces, open sets, interior of a set, Structure of open subsets of the real line, limit points, closed sets, closure of a set, Cauchy sequences, completeness, compactness.		12-15

Unit II	Functions of several variables: Concept of functions of two variables, Simultaneous and iterated limits in functions of two variables, Partial derivatives: Definition, Existence and continuity, Interchange of order of differentiation, Directional derivatives.	12-15
Unit III	Composite functions, Linear Continuity of function of two variables, differentiability of functions of two variables, Taylor's Theorem.	10-15
Unit IV	Linear transformation, Vector Valued functions, Differentiation of vector valued functions, inverse function theorem, implicit function theorem.	10-15

Books Recommended:

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

Further Readings:

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

Digital Platform: NPTEL/SWAYAM/MOOCs.

Semester-VII

Bachelor of Science (Honors)

DISCIPLINE SPECIFIC ELECTIVE (DSE Maths5)- Topology

No. of Hours: 50-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES 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: Topology	4	3	2	0	Passed diploma in Science with Mathematics	Completed DSE Maths3

Bachelor of Science (Honors)			
Programme :	*Bachelor of Science (Honors)*	Year: IV	Semester: VII Paper: DSEMaths5
Subject: Mathematics			
Course: DSE Maths5	Course Title: Topology		
Course Outcomes: This course is useful to open up a new direction to view different shapes and other mathematical objects. This course helps to understand the concepts of topologies on a set and their properties. It will help the students for better understanding of mathematical and other disciplines of physical and natural sciences.			
Credits: 4			Discipline Specific Elective
Max. Marks: As per Univ. rules			Min. Passing Marks: As per Univ. rules

Unit	Content	Number of Hours
Unit I	Topological spaces with examples, Open sets, Neighbourhood of a point, Comparable topologies, Base and sub-base of a topology,Topologies on the real number system.	10-15
Unit II	Oder topology, Product topology, Box topology, Comparison of the box and product topologies, Subspace topology, Closed sets, Closure and interior of a set, Limit points, Derived sets of a set.	12-15

Unit III	Continuous functions, Open and closed functions, Homeomorphisms, Topological invariants, Rules for constructing continuous functions.	10-15
Unit IV	Connectedness, Path connected, Components, Compact spaces, Compactness of a metric space, First countable space, Second countable space, Lindelof space, Separable space, $T_1, T_2, T_3, T_{3\frac{1}{2}}, T_4, T_5, T_6$.	12-15

Books Recommended:

J. R. Munkres: Topology: Narosa Publishing House.
Shaum's outlines series: Tata McGraw Hill.
K. D. Joshi: Introduction to General Topology, Wiley Eastern, 1983.
M. D. Raisinghania& R. S. Aggarwal: Topology, S. Chand & Co.
Further Readings:
G. F. Simmons: Introduction to Topology and Modern Analysis, McGraw Hill, 1963.
Digital Platform: NPTEL/SWAYAM/MOOCs.

Semester-VII

Bachelor of Science (Honors)

DISCIPLINE SPECIFIC ELECTIVE (DSE Maths6)- Differential Geometry

No. of Hours: 50-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES 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	2	0	Passed diploma in Science with Mathematics	Completed DSE Maths3

Bachelor of Science (Honors)			
Programme :	*Bachelor of Science (Honors)*	Year: IV	Semester: VII Paper: DSEMaths6
Subject: Mathematics			
Course: DSE Maths6	Course Title: Differential Geometry		
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.			
Credits: 4			Discipline Specific Elective
Max. Marks: As per Univ. rules			Min. Passing Marks: As per Univ. rules
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.		12-15
Unit II	Order of contact, osculating circle, osculating sphere, Spherical indicatrics, involutes and evolutes, Bertrand Curves, intrinsic equations of space curves, isometries of		10-15

	R^3, Fundamental theorem of space curves, surfaces in R^3.	
Unit III	Regular Surfaces, coordinates neighborhoods, 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	12-15
Unit IV	Curvature of curve on surfaces, normal curvature, Meusnier theorem, principle 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.	12-15

Books Recommended:

D. Somasundaram: Differential Geometry, A First Course, Narosa Publishing House, New Delhi, 2005.
Andrew Pressley: Elementary Differential Geometry, Springer (Undergraduate Mathematics Series), 2001.
T.J.Willmore: An Introduction To Differential Geometry, Oxford University Press.
Further Readings:
J. A. Thorpe: Elementary Topics in Differential Geometry, Springer (Undergraduate Texts in Mathematics), 1979.
B.O.Niell: Elementary Differential Geometry, Academic Press.
Do Carmo : Curves and surfaces,
Digital Platform: NPTEL/SWAYAM/MOOCs.

Semester-VII

Bachelor of Science (Honors)

DISCIPLINE SPECIFIC ELECTIVE (DSE Maths7)- Number Theory

No. of Hours: 50-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES 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: Number Theory	4	3	2	0	Passed diploma in Science with Mathematics	Completed DSE Maths3

Bachelor of Science (Honors)			
Programme :	*Bachelor of Science (Honors)*	Year: IV	Semester: VII Paper: DSEMaths7
Subject: Mathematics			
Course: DSE Maths7	Course Title: Number Theory		
Course Outcomes: The core concepts of numbers have been included in this course with a view that students can understand the behavior of prime numbers and natural numbers in a critical way.			
Credits: 4			Discipline Specific Elective
Max. Marks: As per Univ. rules			Min. Passing Marks: As per Univ. rules

Unit	Content	Number of Hours
Unit I	Divisibility theory, Prime Numbers, Unique factorization theorem,The fundamental theorem of arithmetic, Diophantine equation, Congruence.	8-10
Unit II	Fermet's theorem, Wilson's theorem, Continued fractions, Approximation of irrational of rational.	10-12
Unit III	The arithmetic functions: d(n), σ(n), μ(n) and $\varphi(n)$ including elementary result on their order and average order.	10-12
Unit IV	Farey series, Irrational numbers, Residues, Quadratic Reciprocity Law, Primitive roots, Non-linear diophantine equation $X^2+Y^2=Z^2, X^4+Y^4=Z^4,\ aX^2+bY^2+cZ^2=0.$	10-12

Books Recommended:

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

Semester-VIII

Bachelor of Science (Honors)

DISCIPLINE SPECIFIC COURSE (DSC Maths8)- Complex Analysis

No. of Hours: 50-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES 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	2	0	Passed diploma in Science with Mathematics	Completed DSC Maths5

Bachelor of Science (Honors)			
Programme :	*Bachelor of Science (Honors)*	Year: IV	Semester: VIII Paper: DSCMaths8
Subject: Mathematics			
Course: DSC Maths8	Course Title: Complex Analysis		
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.			
Credits: 4			Discipline Specific Course
Max. Marks: As per Univ. rules			Min. Passing Marks: As per Univ. rules

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.	12-15
Unit II	Complex integration, Cauchy theorem, Cauchy integral formula, Derivative of an analytic function, Higher order derivatives, Morera's theorem, Cauchy inequality and Liouville's theorem.	12-15

Unit III	Counting zeros, The open mapping theorem, Maximum modulus principle, Schwarz lemma, The fundamental theorem of algebra.	12-15
Unit IV	Entire functions, Hadmard's three circle theorem, Jensen's formula, Meromorphic functions, Argument principle, Rouche's theorem.	12-15

Books Recommended:

J. B. Conway*: Functions of One Complex Variable*, Narosa Publishing House, 1980.
R. V. Churchil and J. W. Brown and R. F. Verhey: *Complex Variables and Applications,* McGraw HillEdition, 1976.
Further Readings:
L. V. Ahlfors: *Complex Analysis*, McGraw HillEdition, 1977.
E. T. Copson: *Complex Variables*, Oxford University Press.
Richard R. Goldberg: *Methods of Real Analysis*, John Wiley & Sons, 1976.
D. Sarason: *Complex Function Theory*, Hindustan Book Agency, Delhi, 1994.
James R. Munkres: *Analysis on Manifolds*, Addison-Wesley Publishing Company, Advanced Book Program, Redwood City, CA, 1991.
H. L. Royden: *Real Analysis,* Macmillan Publishing Company, New York, 1988.
G. F. Simmons: Introduction to Topology and Modern Analysis, McGraw HillEdition, 2011.
Digital Platform: NPTEL/SWAYAM/MOOCs.

Semester-VIII

Bachelor of Science (Honors)

DISCIPLINE SPECIFIC ELECTIVE (DSE Maths8)- Algebra

No. of Hours: 50-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES 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: Algebra	4	3	2	0	Passed diploma in Science with Mathematics	Completed DSE Maths3

Bachelor of Science (Honors)			
Programme :	*Bachelor of Science (Honors)*	Year: IV	Semester: VIII Paper: DSEMaths8
Subject: Mathematics			
Course: DSE Maths8	Course Title: Algebra		
Course Outcomes: This course will help students to understand the concept of algebraic structures especially groups and rings.			
Credits: 4			Discipline Specific Elective
Max. Marks: As per Univ. rules			Min. Passing Marks: As per Univ. rules

Unit	Content	Number of Hours
Unit I	Normal and subnormal series, Composition series, Jordan Holder theorem, Chain conditions.	12-15
Unit II	Commutators, Solvable groups, Solvability of subgroups and factor groups. Nilpotent groups and their equivalent characterizations.	13-15
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	15-18

	rings over UFDs.	
Unit IV	Fields, finite fields, field extensions, Algebraic extension, Splitting fields, Normal extension, Galois extensions.	10-15

Books Recommended:

J. Gallian: Abstract Algebra, Narosa Publication.
Ramji Lal: Fundamentals in Abstract Algebra, Chakra Prakashan, Allahabad, 1985.
I. N. Herstein: Topics in Algebra, Wiley Eastern Ltd., N.D., 1975.
Further Readings:
M. Artin: Algebra, Prentice Hall of India.
N. Jacobson: Basic Algebra, Vol. I, Hindustan Publishing Co., New Delhi.
D. S. Dummit and R. M. Foote: Abstract Algebra, John Wiley, N. Y.
Digital Platform: NPTEL/SWAYAM/MOOCs.

Semester-VIII

Bachelor of Science (Honors)

DISCIPLINE SPECIFIC ELECTIVE (DSE Maths9)- Partial Differential Equations

No. of Hours: 50-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES 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: Partial Differential Equations	4	3	2	0	Passed diploma in Science with Mathematics	Completed DSE Maths3

Bachelor of Science (Honors)			
Programme :	*Bachelor of Science (Honors)*	Year: IV	Semester: VIII Paper: DSEMaths9
Subject: Mathematics			
Course: DSE Maths9	Course Title: Partial Differential Equations		
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.			
Credits: 4			Discipline Specific Elective
Max. Marks: As per Univ. rules			Min. Passing Marks: As per Univ. rules
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.		10-15
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,		12-15

	Characteristic curves.	
Unit III	Pfaffian differential equations, Compatible systems, Char pit's method, Jacobi's Method. Cauchy problem for first order PDEs.	12-15
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.	10-15

Books Recommended:

G. F. Simmons: Differential Equations with Application and Historical Notes, McGraw Hill Edition, 2002
Shepley L. Ross: Differential Equations, John Wiley & Sons, 1984.
M. D. Raisinghania: Ordinary & Partial Differential Equation, S. Chand & Co. Ltd, 2017.
B. Rai, D. P. Choudhary and H. J. Freedman: A Course of Ordinary Differential Equations, Narosa, 2002.
Further Readings:
Earl A. Coddington and Norman Levinson: Theory of Ordinary Differential Equations, McGraw-Hill Edition, 1998.
Ravi P. Agarwal and Donal O'Regan: Ordinary and Partial Differential Equations, Springer, 2009.
Martin Braun: Differential Equations and Their Applications, Sringer, 1993.
Erwin Kreyszig: Advanced Engineering Mathematics, John Wiley & Sons, 2011.
Ian N. Snedden: Elements of Partial Differential Equations, Dover Publication, 2013.
Digital Platform: NPTEL/SWAYAM/MOOCs.

Semester-VIII

Bachelor of Science (Honors)

DISCIPLINE SPECIFIC ELECTIVE (DSE Maths10)- Dynamics of Rigid Bodies

No. of Hours: 50-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES 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: Dynamics of Rigid Bodies	4	3	2	0	Passed diploma in Science with Mathematics	Completed DSE Maths3

Bachelor of Science (Honors)			
Programme :	*Bachelor of Science (Honors)*	Year: IV	Semester: VIII Paper: DSEMaths10
Subject: Mathematics			
Course: DSE Maths10	Course Title: Dynamics of Rigid Bodies		
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.			
Credits: 4			Discipline Specific Elective
Max. Marks: As per Univ. rules			Min. Passing Marks: As per Univ. rules
Unit	Content		Number of Hours
Unit I	D'Alembert's principle, Motion about a fixed axis (Finite and Impulsive forces).		10-15
Unit II	Motion in two dimensions under Finite and Impulsive forces, Principle of conservation of momentum and energy.		12-15

Unit III	Generalized coordinates, Lagrange's equations in generalized co-ordinates.	10-15
Unit IV	Hamilton's principle, Hamilton's equations, principle of least action, Euler's geometrical and dynamical equations.	12-15

Books Recommended:

Bhu Dev Sharma: Dynamics of Rigid Bodies, Kedarnath Ramnath Sons, 1984.
M. Ray & Harswarup Sharma: A text book of Dynamics of Rigid Body, Students' Friends &Co., Agra-2, 1971.
H. Goldstein: Classical Mechanics, Narosa, 1990.
Further Readings:
S. L. Loney: Dynamics of rigid bodies.
A. S. Ramsey: Dynamics – Part II.
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 ninemarks 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.