DAV UNIVERSITY JALANDHAR

Course Scheme & Syllabus
For
Ph.D. Mathematics
(Program ID-238)

Syllabi Applicable for Admissions in 2017 onwards
# Scheme of Course

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Course Code</th>
<th>Course Name</th>
<th>Course Type</th>
<th>L</th>
<th>T</th>
<th>P</th>
<th>Credits</th>
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<tbody>
<tr>
<td>1</td>
<td>PHD 800</td>
<td>Research Methodology</td>
<td>Core</td>
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<td>2</td>
<td>MTH 801</td>
<td>Seminar-I</td>
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<td>3</td>
<td>MTH xxx</td>
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<td>Departmental Elective</td>
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**Total Credits: 14**

L: Lectures  T: Tutorial  P: Practical  Cr: Credits
# Departmental Elective (Choose any two courses)

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Course Code</th>
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<td>1</td>
<td>MTH 802</td>
<td>Advanced Algebra</td>
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<td>MTH 803</td>
<td>Commutative Algebra</td>
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<td>Univalent Function Theory</td>
<td>Departmental Elective</td>
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<td>4</td>
<td>MTH 805</td>
<td>Theory of Differential Subordination</td>
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<td>Harmonic Mappings in the Plane</td>
<td>Departmental Elective</td>
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<td>MTH 811</td>
<td>Homological Algebra</td>
<td>Departmental Elective</td>
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Objective: The major objective of this course is the understanding and application of emerging trends and new skills associated with research. The course will also introduce students to the safeguards against various errors in conducting any research.

UNIT-I 13 Hours

UNIT-II 14 Hours

UNIT-III 13 Hours

UNIT-IV 12 Hours

Reference Books:
Course Title: Seminar
Course Code: MTH 801

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**Instructions and Guidelines for Seminar**

1. Since PhD students must demonstrate the ability to interact with their peer group coherently, this course is designed to prepare students for research presentations.
2. This seminar will be related to the field of research.
3. During the course, researchers are expected to meet their guides regularly to seek guidance.
4. The final responsibility for giving effective presentations lies with researchers, not guides.
5. The evaluation will be based on contents and presentation skills of students.
6. Researchers must have a sound understanding of the research tools.
7. Students will have to meet the deadlines given by their respective guides and the department.
8. Each researcher will have to prepare a PPT on the topic approved by his/her guide.
9. Each researcher will be given 30-40 minutes for presentation
10. Slides must present researchers’ work comprehensively.
Course Title: Advanced Algebra  
Course Code: MTH 802

Objective: This is advanced course in Algebra for students who wish to pursue research work in Algebra. Galois Theory, canonical forms and structure of semisimple modules will be discussed in detail.

UNIT-I  
13 Hours

Introduction to Galois Theory: Automorphism groups and fixed fields, Fundamental theorem of Galois theory, Proof of fundamental theorem of Algebra using Galois theory.

UNIT-II  
13 Hours

Applications of Galois Theory to classical problems: Roots of unity and cyclotomic polynomials, cyclic extensions, Polynomials solvable by radicals, Symmetric functions, Ruler and compass constructions.

UNIT-III  
12 Hours


UNIT-IV  
12 Hours

Simple and semisimple modules and rings, Structure of semisimple rings: Wedderburn-Artin theorem.

Reference Books:


Course Title: Commutative Algebra  
Course Code: MTH 803

**Objective:** This course will give the student a solid grounding in commutative algebra which is used in both algebraic geometry and number theory.

**UNIT-I**

12 Hours

Rings and ideals - Rings and ring homomorphism, Ideals, quotient rings, zero-divisors, nilpotent elements, units, The prime spectrum of a ring, the nil radical and Jacobson radical, operation on ideals, extension and contraction.

**UNIT-II**

13 Hours

Modules - Modules and modules homomorphism, sub-modules and quotient modules, direct sums, free modules, finitely generated modules, Nakayama Lemma, simple modules, exact sequences of modules, Tensor product of modules.

**UNIT-II**

12 Hours

Rings and Modules of fractions, Local properties, extended and contracted ideals in ring of fractions, primary decomposition, $1^{st}$ uniqueness theorem, $2^{nd}$ uniqueness theorem.

**UNIT-IV**

13 Hours

Modules with chain conditions - Artinian and Noetherian modules, modules of finite length, Artinian rings, Noetherian rings, Hilbert basis theorem.

**Reference Books:**

Course Title: Univalent Function Theory  
Course Code: MTH 804

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Objective: The objective of this course is to teach advanced concepts and topics in theory of Univalent Functions.

UNIT-I 13 Hours


UNIT-II 14 Hours


UNIT-III 14 Hours

Subclasses of Univalent Functions: Classes of Convex, Starlike and Close-to-convex functions and their properties in the unit disk, Spirallike functions, Typically Real functions, Growth of Integral Means, Odd Univalent functions, Asymptotic Bieberbach Conjecture.

UNIT-IV 14 Hours

Bounded functions, radius of Univalence, Convexity and Starlikeness, Combinations, Convolution and Subordination of Univalent functions.

Reference Books:

Objective: This course will give the student a solid grounding in differential subordination and differential superordination for future research.

UNIT-I 14 Hours


UNIT-II 13 Hours

Jack-Miller-Mocanu Lemma, Admissible functions and fundamental theorems, open door lemma and integral existence theorem, Classical Results of Geometric Function Theory Revisited.

UNIT-III 14 Hours

First order linear differential subordination, Briot-Bouquet differential subordinations, Briot-Bouquet applications in Univalent function theory, Generalized Briot-Bouquet differential subordinations, Analytic Integral operators between classes of functions, Subordination-preserving Integral operators.

UNIT-IV 14 Hours

Second order linear differential subordinations, Integral operators preserving functions with positive real part, Integral operators preserving bounded functions, Averaging Integral operators, Hypergeometric functions, Schwarzian derivative, Applications to starlikeness and convexity.

Reference Books:

Course Title: Harmonic Mappings in the Plane
Course Code: MTH 806

Objective: This course is designed to understand the basics and applications of the emerging research topic Planar Harmonic Mappings.

UNIT-I 13 Hours

Complex valued harmonic mappings and their properties, decomposition of harmonic mappings into analytic and co-analytic parts, Jacobian and dilatation of harmonic mappings. The Argument principle, The Dirichlet problem, Lewy's Theorem.

UNIT-II 12 Hours


UNIT-III 12 Hours

Linear combination and convolutions: Univalence of linear combination and convolution of harmonic mappings. Convolutions of harmonic right half plane mapping and related results.

UNIT-IV 13 Hours

Basics of differential geometry and minimal surfaces, Isotheremal parameters, Weierstrass representation of minimal surfaces, connection of planar harmonic mappings and minimal surfaces.

Reference Books:


Course Title: Continuum Mechanics  
Course Code: MTH 807

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Objective: The objective of this course is to introduce the concept of strains tensors, stress tensors and basic concepts of elastic body deformation and to make students familiar about the constitutive relations and field equations. Dynamics of elastic bodies and basic problems related to elastic wave propagation are also introduced.

UNIT-I  
12 Hours

Tensors: Summation convention, coordinate transformation, tensors of several orders, algebra of tensors, symmetric and skew-symmetric tensors, Kronecker’s delta, Gradient, Divergence, Curl tensor notations, contra-variant and covariant tensors.

UNIT-II  
11 Hours

Stress and Strain: Deformation in elastic bodies, affine transformation, strain-displacement relation, principal direction, stress and strain tensors, components of stress and strain, generalised Hooke’s Law- relation between stress and strain, elastic constants and their physical significance.

UNIT-III  
13 Hours

Dilatation and Distortion waves: Two dimensional propagation of elastic waves in isotropic solid, waves of dilatation and waves of distortion, equation of motion in classical theory of elasticity, Helmholtz decomposition theorem.

UNIT-IV  
12 Hours

Surface Waves: Introduction to surface waves, Rayleigh and Love waves, Frequency equations of Rayleigh waves and Love waves.

Reference Books:

Objective: The objective of this course is to teach numerical methods for differential equations.

UNIT-I 13 Hours
Initial value problems for systems of ordinary differential equations, Taylor series method, Euler’s method, Modified Euler’s method, Runge-Kutta methods (explicit, implicit), order of convergence, stability, extrapolation.

UNIT-II 12 Hours

UNIT-III 12 Hours
Routh- Hurwitz criterion, difference methods for parabolic partial differential equations, one and two space dimensions, second and fourth order methods, spherical and cylindrical coordinate systems, nonlinear equations, convergence and stability.

UNIT-IV 13 Hours

Reference Books:
Objective: The objective of this course is to teach the basics of computer and computer programming so that one can develop the computer program in C their own. For the purpose of learning programming skill, some Numerical methods which are extremely useful in scientific research are included. For practising the programmes of the numerical methods, the course of practical has also been included in this paper.

UNIT-I 13 Hours
Errors, Error propagation, Order of approximation.

UNIT-II 12 Hours
Operators: Forward, Backward and Shift (Definitions and some relations among them).
Interpolation: Finite differences, divided differences, Newton’s formulae for interpolation, Lagrange and Hermite interpolation, Cubic Spline interpolation.

UNIT-III 13 Hours
Programming in C: Historical development of C, Character set, Constants Variables, Keywords, Operators, Hierarchy of arithmetic operations, if and if –else statements, logical and computational Operators, Switch structure while structure, do-while and For-Loops, Nested Loops, Break and Continue statements.

UNIT-IV 12 Hours

Reference Books:

Course Title: Computational Lab
Paper Code: MTH 810

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Objective: Writing Programs in C for the problems based on the methods studied in theory paper and to run the Program on PC.

List of Practicals

(i) To find the absolute value of an integer
(ii) Bisection Method
(iii) Newton-Raphson Method
(iv) Secant Method
(v) Regula Falsi Method
(vi) Newton’s method for system of non-linear equations
(vii) Newton’s forward interpolation
(viii) Newton’s backward interpolation
(ix) Lagrange interpolation
(x) Hermite interpolation
**Course Title:** Homological Algebra  
**Course Code:** MTH 811

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**Objective:** The objective of this course is to introduce the basic concepts of modern Category Theory and Homological Algebra.

**UNIT-I**  
12 Hours

Homology functors: Diagrams over a ring, Translations of diagrams, Translation category, split exact sequence, images and kernel as functors, Homology functors, The connecting homomorphism, Complexes, boundary homomorphism, differentiation homomorphism, homology modules, right and left complexes, exact homology sequence and Homotopic translations.

**UNIT-II**  
12 Hours

Projective and injective modules: Projective modules, injective modules, An existence theorem for injective modules, Complexes over a modules, right and left complexes over a module, augmentation translation and augmentation homomorphism, acyclic right and acyclic left complexes over a module, Projective and injective resolutions of a module, Properties of resolutions of a module.

**UNIT-III**  
13 Hours

Derived Functors: Projective and injective resolutions of an exact sequence, Properties of resolutions of sequences, Functors of complexes, Associated translations, Functors of two complexes, Right-derived functors, the defining systems and the connecting homomorphisms, the functor $R^nT$, Left-derived functors, the functor $L_0T$.

**UNIT-IV**  
13 Hours

Torsion and Extension Functors: Connected sequences of functors, connected right and left sequences of covariant and contravariant functors, homomorphism and isomorphism as a natural equivalence between connected sequences of functors. Torsion functors $T_{rn}$, Basic properties of Torsion functors, Extension functors and Basic properties of extension functors.

**Reference Books:**