Central University of Himachal Pradesh
(Established under Central Universities Act 2009)
PO BOX: 21, DHARAMSHALA, DISTRICT KANGRA – 176215, HIMACHAL PRADESH
Website: www.cuhimachal.ac.in

Course Code: MTH-
Course Name: Commutative Algebra
Instructor Name: Dr. Ravinder Singh
Credit Equivalent: 04 Credits (One credit is equivalent to 10 hours of lectures / organised classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual / group work; obligatory / optional work placement; literature survey / library work; data collection / field work; writing of papers / projects / dissertation / thesis; seminars, etc.)

Attendance Requirement:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must, failing which a student may not be permitted to appear in the examination.

Evaluation Criteria:
1. Mid Term Examination: 25%
2. End Term Examination: 50%
3. Continuous Internal Assessment: 25%
    i) Assignments 20%
    ii) Class participation 5%

Course Contents:

Unit-I:

Rings and Ring Homomorphisms, Ideals, Quotient Rings, Prime and Maximal Ideals, Nilradical and Jacobson Radical, Sum and Product of Ideals, Extension and Contraction of Ideals, The Prime Spectrum of a Ring, the Zariski Topology on the Prime Spectrum.

Unit-II:

Modules and Module Homomorphisms, Submodules and Quotient Modules, Sum, Product and Annihilator of a Module, Exact Sequences, Free Modules, Tensor Product of Modules, Restriction and Extension of Scalars, Exactness Properties of the Tensor Product, Alegbras , Projective Modules, Flat Modules

Unit-III:

Multiplicatively Closed Sets, the Ring of Fractions (Localisation), and Module of Fractions, Examples of Localisation, Exactness of Localisation Operation, Local Properties, Extended and contracted Ideals in Rings of Fractions, Notherian Rings and Modules, Hilbert's Basis Theorem

Unit-IV:

Primary Ideal, Primary Decomposition of and Ideal, the First Uniqueness Theorem, the Second Uniqueness Theorem. Integral Dependence, The Going-Up Theorem, Integrally Closed Domains, the Going -Down Theorem, Valuation Rings

Prescribed Text Book:

(i) Introduction to Commutative Algebra by Atiyah and Macdonald, Addison-Wesley Publishing Company
(ii) Commutative Algebra by N.S. Gopala Krishnan, Second Edition, University Press

CENTRAL UNIVERSITY OF HIMACHAL PRADESH

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PO BOX: 21, DHARAMSHALA, DISTRICT KANGRA - 176215 (HP)

www.cuhimachal.ac.in

Course Name: Finite Element Methods **Course Code: IAM 506**

Credit: 04

Course Instructor: Dr. Rakesh Kumar

Credits Equivalent: 04 Credits (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objective: The purpose of this course is to acquaint the students with the finite element method and its application in various scientific fields.

Attendance Requirements:

Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:

1. Mid Term Examination: 25%
2. End Term Examination: 50%
3. Counseling, Activities and Tutorials (CAT): 25%

i. Subjective / Objective Assignment: 10 %

ii. Numerical Assignments using programming: 10 %

iii. Presentations and Class Tests: 5 %

Course Contents:

Unit I: Basic concepts of FEM, Mathematical preliminaries, Variational Methods, Overview of Finite Element Method, Discretization of the domain, Derivation of Element Matrices and Vectors; Solution of equilibrium, integral formulations and Variational Methods; Derivation of Finite Element Equations using Variational Method; Weighted Residual Approach. **(12 Hours)**

Unit II: Assembly of Element Matrices; Vectors and Derivation of System equations; Second Order Differential Equations in one Dimension, FEM models and applications. **(08 Hours)**

Unit III: Eigen Value and Time Dependent Problems, single variable problems in two dimensions. **(08 Hours)**

Unit IV: Interpolation functions: compatibility and completeness, polynomial forms, geometric isotropy, triangular elements, rectangular elements, three dimensional elements, isoparametric formulation, axisymmetric elements, numerical integration, modeling consideration, errors in finite element analysis. **(12 Hours)**

Prescribed Text Books:

1. J.N. Reddy (2006).An Introduction to Finite Element Method. McGraw Hill.
2. S.R. Singiresu (2005). The Finite Element Method in Engineering. Fourth Edition. Elsevier Inc.

Suggested Additional Readings:

1. S.C. Brenner, L.R. Scott (2008). The Mathematical Theory Of Finite Element Methods, Springer

3. D.V. Hutton (2004). Fundamentals if Finite element Analysis, McGraw Hill Higher Education.
2. R.D. Cook, D.S. Malkus, M.E. Plesha & R.J. Witt (2002). Concepts and Applications of Finite Element Analysis, John Wiley and Sons, INC.

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Course Code: MTH
Course Name: Galois Theory
Instructor Name: Dr. Ravinder Singh
Credit Equivalent: 04 Credits (One credit is equivalent to 10 hours of lectures / organised classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual / group work; obligatory / optional work placement; literature survey / library work; data collection / field work; writing of papers / projects / dissertation / thesis; seminars, etc.)

Attendance Requirement:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must, failing which a student may not be permitted to appear in the examination.

Evaluation Criteria:
1. Mid Term Examination: 25%
2. End Term Examination: 50%
3. Continuous Internal Assessment: 25%
    i) Assignments 20%
    ii) Class participation 5%

Course Contents:

Unit-I:

Polynomials, Irreducibility of a polynomial, Primitive polynomials, Gauss's Lemma, Eisenstein's Criterion, Prime Fields, Field Extensions, Finite Fields, Algebraic Elements, Degree of an Element, Transcendental Elements, Degree of Field Extension, Finite Extensions, Multiplicative Property of the Degree, Algebraic Extensions

Unit-II:

Construction with Straight-Edge (Ruler) and Compass: Trisection of angles, Duplication of the Cube, Construction of Regular p-gons, p a prime, Adjoining Roots, Splitting Field of a Polynomial, Simple Root, Multiple Roots of a Polynomial

Unit-III:

Primitive Elements, Primitive Element Theorem, Symmetric Functions, Symmetric Functions Theorem, Separable Polynomials, Perfect Fields, Isomorphisms of Field Extensions, Fixed Fields, Solvable Groups, Jordan Holder Theorem

Unit-IV:

Galois Extensions, Characteristic Properties of Galois Extensions, Galois Groups, Examples of Galois Groups, the Fundamental Theorem of Galois Theory, Cubic Equations, Quartic Equations, Roots of Unity, Galois's Criterion for Solvability by Radicals

Prescribed Text Books:

(i) Algebra by M. Artin, Second Edition, PHI.
(ii) Basic Algebra Vol. 1 by N. Jacobson, Hindustan Publishing Corporation

Suggested Additional Reading:

(i) Abstract Algebra by Dummit and Foote, Third Edition, Wiley

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PO BOX: 21, DHARAMSHALA, DISTRICT KANGRA - 176215 (HP)

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Course Code: IAM 403 **Credits: 04**

Course Name: NUMERICAL ANALYSIS

Name of Teacher: Dr. Rakesh Kumar,

Credits Equivalent: 04 Credits (One credit is equivalent to 10 hours of lectures / organised classroom activity /contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objective: The purpose of this course is to acquaint the students with the Numerical analysis which is necessary to develop the basic understanding of numerical algorithm for solving problems in Science, Engineering and Technology.

Attendance Requirements:

Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of
75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:

1. Mid Term Examination: 25%
2. End Term Examination: 50%
3. Counselling, Activities and Tutorials (CAT): 25%

i. Subjective / Objective Assignment: 10 %
ii. Numerical Assignments using programming: 10 %
iii. Presentations and Class Tests: 5 %

Course Contents:

Unit I: Lagrange and Newton interpolations, interpolations using finite differences, Hermite interpolation, piecewise and spline interpolation, bivariate interpolation. **[10 Hours]**

Unit II: Polynomial approximation: least square approximation, orthogonal polynomials, uniform approximation, rational approximation.

[10 Hours]

Unit III: Numerical Differentiation and Integration: methods based on interpolation, methods based on undetermined coefficients, composite integration methods, Romberg integration.

[10 Hours]

Unit IV: Initial and Boundary value problems for ordinary differential equations: Taylor's series method, Euler and modified Euler method, Runge-Kutta methods, stability analysis, finite-difference method, shooting method. **[10 Hours]**

Prescribed Text Books:

1. M.K. Jain, S. R. K. Iyengar and R. K. Jain: Numerical Methods, 6th Edition, New Age International (P) Limited, Publishers, New Delhi.

Suggested Additional Readings:

1. S. S. Sastri; Introductory Methods of Numerical Analysis, PHI Learning Pvt. Ltd., 2005.
2. S.C. Chapra: Applied Numerical Methods with MATLAB, McGraw Hill, 2012.

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Course Code: MTH-406

Course Name: Real Analysis

Instructor Name: Dr. Ravinder Singh

Credit Equivalent: 04 Credits (One credit is equivalent to 10 hours of lectures / organised classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual / group work; obligatory / optional work placement; literature survey / library work; data collection / field work; writing of papers / projects / dissertation / thesis; seminars, etc.)

Attendance Requirement:

Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must, failing which a student may not be permitted to appear in examination.

Evaluation Criteria:

1. Mid Term Examination: 25%
2. End Term Examination: 50%
3. Continuous Internal Assessment: 25%
   - i) Assignment 15%
   - ii) Class participation 5%
   - ii) Class tests 5%

Course Contents:

Unit-I:

Finite Sets, At most Countable Sets, Countable Sets: Countability of countable union, Countability of the Rational numbers, Uncountable Sets: Uncoutability of the Real numbers, Uncoutability of the set of all sequences whose elements are digits 0 and 1 . Metric Spaces, Examples of metric spaces. Basic Topology of Metric Spaces: Neighbourhood of a point, Limit Point, Isolated Point, Closed Set, Interior Point, Open Set, Bounded Set, Dense Set. Compact Sets: Finite intersection property of a sequence of Compact subsets of a Metric Space, the Heine-Borel Theorem, Weierstrass's Theorem. The Cantor Set. Connected Sets: characterization of connected subsets of the real line.

Unit-II:

Sequences: Definition, Range of a Sequence, Bounded Sequences, Unbounded Sequences, Convergent Sequences. Algebraic Operations on Convergent Sequences. Subsequences, Cauchy Sequences, Complete Metric Spaces, Monotonic Sequnces, Upper and Lower Limits of a Sequence. Convergent Series of numerical terms, The Root and Ratio Tests for the Convergence of Series, The Leibnitz Test, Absolute Convergence of Series, Summation by Parts. Definiton of a continuous function in a Metric Space, Characterization of continuity in terms of Open and Closed Sets of Metric Spaces, Conitinuity and Compactness.

Unit-III:

Continuity and Connectedness. The Derivative of a Real function, Mean Value Theorems, Derivative and Monotonicity of Real functions, Continuity of Derivative, Differentiation of Vector-Valued functions. Definition and Existence of the Integral

Unit-IV:

Upper and Lower Riemann integrals of a function, Definition and the Existence of the Riemann-Stieltjes Integral, Existence of Riemann-Stieltjes Integral for continuous functions and related results. Properties of the Riemann-Stieltjes Integral, Behaviour of Inegration with respect to Differentiation: Fundamental Theorem of Calculus, Integration by Parts. Integration of Vector-Valued Functions.

Prescribed Text Book:

- **Walter Rudin:** Principles of Mathematical Analysis, Third Edition. McGraw-Hill, Inc.

Suggested Additional Reading:

1. **Tom Apostol:** Mathematical Analysis, Second Edition. Addison Wesley.

Course Code: IAM 407

Course Name: Differential geometry

Course Instructor: Dr S. K. Srivastava (Batch: 2016-2018)

Credits Equivalent: 04 Credits (One credit is equivalent to 10 hours of lectures / organised classroom activity /contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objective: The purpose of this course is to acquaint the students with the Differential geometry which is closely related to differential topology, and to the geometric aspects of the theory of differential equations and uses the techniques of differential calculus and integral calculus, as well as linear algebra and multilinear algebra, to study problems in geometry.

Attendance Requirements:
Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:
1. Mid Term Examination: 25%
2. End Term Examination: 50%
3. Counselling, Activities and Tutorials (CAT): 25%

Assignment	15%
Class participation	5%
Class tests	5%

Course Contents:

Unit I: Curve, Arc-length, Reparametrization, Level curves, Curvature of Plane curve, Frenet-Formulas. **(10 Hours)**

Unit II: Global Properties of Curves: Simple closed curves, The Isoperimetric Inequality, Four vertex Theorem, Surfaces in Euclidean Spaces, Length of curves on surface, Isometries and conformal mappings of surfaces, Surface area. **(10 Hours)**

Unit III: The Second Fundamental Form, Curvature of curves on surface, Normal and Principal Curvatures, Gaussian and Mean curvatures. **(10 Hours)**

Unit IV: The Pseudosphere, Gauss map, Geodesics: Basic Properties,Theorema Egregium and Gauss-Bonnet Theorem. **(10 Hours)**

Prescribed Text Books:

Andrew Pressley, Elementary Differential Geometry, Springer, 2010.

Suggested Additional Readings:

M.P. doCarmo, Differential Geometry of Curves and Surfaces, Prentice Hall, 1976.
B. O'Neill, Elementary Differential Geometry, Academic Press, New York, 1966.

Course Code: IAM 404 **Credits: 04**

Course Name: Mathematical Methods

Credits Equivalent: 04 Credits (One credit is equivalent to 10 hours of lectures / organized classroom activity / contact hours; 5 hours of laboratory work / practical / field work / Tutorial / teacher-led activity and 15 hours of other workload such as independent individual/ group work; obligatory/ optional work placement; literature survey/ library work; data collection/ field work; writing of papers/ projects/dissertation/thesis; seminars, etc.)

Course Objective: The purpose of this course is to acquaint the students with integral equations and calculus of variations, and enable them to solve the problems in the fields of physical, medical and information sciences.

Attendance Requirements:

Students are expected to attend all lectures in order to be able to fully benefit from the course. A minimum of 75% attendance is a must failing which a student may not be permitted to appear in examination.

Evaluation Criteria:

1. Mid Term Examination: 25%
2. End Term Examination: 50%
3. Counselling, Activities and Tutorials (CAT): 25%

i. Subjective / Objective Assignment: 10 %

ii. Numerical Assignments using programming: 10 %

iii. Presentations and Class Tests: 5 %

Course Contents:

Unit I: Review the basic concepts for solving ODE: First order and second order Linear differential equations, Series solution for ODE where x=0 is ordinary point, Leibnitz rule for differentiation of integrals, Cauchy formula for reducing multiple integrals to single integral and Laplace transforms. Integral equations: classification of integral equations; conversion from IVP to Volterra integral equations and conversely; conversion from BVP to Fredholm integral equations and conversely, Integral equations with separable kernels. **(10 Hours)**

Unit II: Method of successive approximations, eigenvalues and eigenfunctions, Resolvent kernels, Symmetric kernels, Hilbert Schmidt theorem and solution of symmetric integral equations.

(12 Hours)

Unit III: Calculus of Variations: Concept of variation, Linear functional, Euler-Lagrange equation, Necessary and sufficient conditions for extrema, Euler-Lagrange differential equation for n-dependent variables, Functionals dependent on higher order derivatives, Functionals dependent on functions of several variables.

(10 Hours)

Unit IV: Applications of calculus of variations to various problems: Shortest distance, minimum surface of revolution, Brachistochrone problem, geodesic, Isoperimetric problem, Calculus of variations for problems in parametric form, Variational problems with moving boundaries. **(08_Hours)**

Prescribed Text Books:

M.D. Raisinghania (2016), Integral equations and boundary value problems, S. Chand Publishing.

I. M. Gelfand and S.V. Fomin (2012): Calculus of Variations, Prentice Hall Inc.

Suggested Additional Readings:

F.G. Tricomi, (1985): Integral Equations, Cambridge University Press.

A. S. Gupta (1996): Calculus of Variations with Applications, Prentice–Hall of India.

Robert Weinstock (1975): Calculus of Variations with applications to Physics and Engineering, Dover Publications Inc.