M.Sc. Mathematics

Vision
To upgrade performance standards in the field of mathematics in order to be a leading department in the Pakistan in academic arena.

Mission
The main purpose is to achieve the highest possible standard of education, teaching, and research in Mathematics. More specific goal are to encourage intellectual development and scholarship in Mathematics, to impart sound theoretical and applied knowledge of Mathematics, to develop awareness in the students to prepare themselves for national and international challenges, to develop an ability in the students to become effective independent researchers, learners and to prepare students to enhance knowledge and welfare of the society.

Objective

1 To provides for professional cadres in the field of mathematics to support the national development programs within public and higher education institutes
2 To encourage scientific research and publications in the accredited scientific publications.
3 To encourage participation in scientific forums and seminars
4 To encourage follow up of latest scientific research and techniques in the field
5 To encourage Scientific all abortion with other related areas such as statistics, operations research, physics, branches of engineering and specially in Agriculture.

Eligibility criteria for admission in M.Sc. Mathematics
B.Sc. Math A course and Math B course with any other subject.
B.Sc. Engineering.
BS Ed. with Physics and Math.
B.A . Math A course and B course with any other subject.
B.Sc. (two years) and B.Sc. B.Ed. (three years). However, the marks of all those graduates who have passed their examination under semester system will be multiplied by the factor 0.85.

Course for M.Sc. Mathematics

Course no.	Course	Credit Hours
MATH-710	REAL ANALAYSIS	3(3-0)
MATH-711	ALGEBRA AND TOPOLOGY	3(3-0)
MATH-712	COMPLEX ANALYSIS	3(3-0)
MATH-713	VECTOR AND TENSOR ANALYSIS	3(3-0)
MATH-714	DIFFERENTIAL EQUATIONS	3(3-0)
MATH-715	ADVANCED REAL ANALYSIS	3(3-0)
MATH-716	LINEAR ALGEBRA	3(3-0)
MATH-717	CLASSISICAL MECHANICS	3(3-0)
MATH-718	ELEMENTRY FLUID MECHANICS	3(3-0)
MATH-719	SPECIAL PROBLEM	1(1-0)
MATH-720	SEMINAR	1(1-0)
MATH-721	PARTIAL DIFFERENTIAL EQUATIONS	3(3-0)
MATH-722	DIFFERENTIAL GEOMETRY	3(3-0)
MATH-723	RESEARCH REPORT/THESIS	4(0-4)
MATH-724	SPECIAL THEORY OR RELATIVITY	3(3-0)
MATH-725	ANALYTICAL DYDNAMICS	3(3-0)

MATH-726	**DISCRETE MATHEMATICS**	**3(3-0)**
MATH-727	**ADVANCED FLUID MECHANCICS**	**3(3-0)**
MATH-728	**QUANTUM MECHANICS**	**3(3-0)**
MATH-729	**ELECTROMAGNETIC THERORY**	**3(3-0)**
MATH-730	**THEORY OF ELASTICITY**	**3(3-0)**
MATH-731	**INTEGRAL EQUATIONS AND VARIATIONAL CALCULUS**	**3(3-0)**
MATH-732	**FUNCTIONAL ANALYSIS**	**3(3-0)**
MATH-733	**ADVANCED NUMERICAL ANALYSIS**	**3(3-0)**

MATH-710: 3(3-0) REAL ANALAYSIS

Learning objectives

The main purpose is to introduce real analysis, and a secondary purpose is used to the idea of writing rigorous mathematical proofs.

Course Contents

Real number system, Ordered sets, Bounded sets, Real Field and extended real number system, Euclidean Spaces, Equivalent sets, Concept of cardinality number, Addition and multiplication of cardinals, Neighbour of a point, Isolated point, Open, Closed, Perfect, denes, compact and Connected sets. Numerical Sequences and series, Convergent and diverting sequence series, Subsequences ,Cauchy Sequences Completeness, Infinite series, Tests of convergence, Power series, Countinous function on closed and bounded sets, discontinuities, Uniformcontinuity, Differentiability, mean value theorem, L Hospital rule and Error estimates.

Suggested readings:

- Halsey, R. Real Analysis. 4th edition, Pearson .
- Jonathan, W. A. L. 2003, An Interactive to Introduction to Mathematical Analyses: Cambridge University Press.
- Utpal, C. Advanced Mathematical Analyses. Edition, 2nd : McGraw Hill.
- Walter, R. 2009, Principal of Mathematical Analyses, 3rd edition : McGraw Hill Inc.

MTH-711: 3(3-0) ALGEBRA AND TOPOLOGY

Learning objectives

The student is expected to learn the basics of the theory of smooth manifolds which appear in many areas of research in math and physics.

Course Contents

Group Order of a group, Order of an element ,Subgroup, generators, Cyclic groups, Lagrange theorem, Conjugacy class, Centralizer, Normalizers, Normal Subgroup, Permutations, Symmetric groups, Quotient groups, Homomorphism, Isomorphism theorems, Endomorphism and auto morphsin of groups, Rings, Subring, Ideals, Zero divisors, Integral domain, Division ring fields.

Metric Space, Peudometric ,Open and Closed spheres, Open and Closed sets, Countinous mapping, Topological Space, Open and Closed sets, Subspaces, Mertizable Topological Space, Neighbourhood, Interior and exterior of a set, Clourse of a set, Dense set, separable spaces. Open Basics and subspaces. First and second countable spaces. Open and closed Mapping, Homeomorphism, Separationaxiom Compactness, Connectedness,

Suggested readings:

- Stephen F. H. and S. E. Lawraence, 2003, Linear Algebra, 4th edition: Pearson Education
- Gilbert S. 2010 Linear Algebra and Its Applications, 4th edition: Pearson Education.
- Herstein I. N. 2006, Topics in Algebra, 2nd edition: Wiley India Pvt. Limited.
- Joseph C. G. A, 2010 Contemporary Abstract Algebra edition: 7th Amazon.

MTH-712 3(3-0)Complex Analysis

Learning objectives

In this course students will learn the algebra and geometry of complex numbers, mappings in the complex plane, the theory of multi-valued functions, the calculus of functions of single complex variable and the Fourier transform.

Course Contents

Complex function, Limits and continuity, Derivatives, Analytic function, Cauchy-Riemann equations, Harmonic function ,Entire Function, Elementary complex function (exponential, trigonometric, hyperbolic, Logarithmic and general Power),simply and multiply connected domains. Complex integration, Properties of complex line integrals, Cauchy Goursat's theorem, Cauchy 's integral formula Related Theorems, Power series, Taylor's and Laurent's series, Zeros and singularities, Poles, Residues, Residue theorem and its applications, Contour integration, Analytic continuation.

Suggested readings:

- Dennis, Z. G and, S. Patrick, 2011, A First Course in Complex Analyses with application, 2nd edition : Brooks Cole.
- Harold, C. 2007, Complex Analysis with Applications in Science and Engineering, 2nd edition, : Springer.
- Elias, S. M. and S. Rami 2010, Complex Analysis 1st edition, Amazon.
- Kreyzig, E. 2007, Introductory Functional Analysis with Applications, 1st edition, : Wiley India Pvt. Limited.
- Walter, T. R. 2006, Functional Analysis, 2nd edition, McGraw-Hill..
- Walter, T. R. 2006, Real and Complex Analysis, 3rd edition, McGraw-Hill.

MTH-713 3(3-0) Vector and Tensor Analysis

Learning objectives

Introduce the concepts, theories, and operational implementation of vectors, and more generally tensors, in advanced engineering analysis. The emphasis is on geometric and physical interpretations for engineering applications.

Course Contents

Scalar and vector point functions, Gradient, Directional derivative, Divergence, Curl, Vector identities, Tangential line integrals, Independence of path, Normal surface integrals, Volume integrals, Green's theorem in the plane, Gauss divergence theorem, Curvilinear coordinates, Cylindrical and spherical polar coordinates.

Summation convention, kroneeker delta, alternating symbol, relation between alternating symbol and kroneekar delta, tensors of first,second,and higher orders, algebra of tensors, contraction of a tensor, quotion theorem, symmetric and anti-symmetric tensors, invariance property , isotropic tensors, differentiation of tensors, application to vector analysis, eigenvalues and eigenvector's of a tensor of rank 2, orthogonally and reality of eigenvalues.

Suggested readings:

- Chatterjee, U. and N. Chatterje 2010,Vector and tensor analysis, 1st edition Academic.
- Lebedev, L. P. and M. J Cloud 2003, Tensor Analysis, 1st edition, :World Scientific Publishing Company.
- Shah, A. N. 2003, vector and tensor analysis, 1st edition, A-one publisher, Urdu bazaar, Lahore.
- Talpaert, T. Y. R. 2003, Tensor Analysis and Continuum Mechanics, 1st edition Springer.

MTH-714 3(3-0) DIFFERENTIAL EQUATIONS

Learning objectives

Identify an differential equation and its order, Verify whether a given function is a solution of a given differential equation (as well as verifying initial conditions when applicable). Differential equations into linear and nonlinear equations. Find solutions of differential equation.

Course Contents

Review of ordinary differential equations with constant and variable coefficients, Methods of undetermined coefficients and variation of parameters, Existence and uniqueness of solutions, systems of linear ordinary differential equations, modeling of physical system and their solutions, Simple harmonic Motion, Damped vibrations. Series solution of different equations, Power Series method, method of Forbenius, Bessel, Legendre, Lagguere, Hermite and Hyper geometric differential equation and their solutions,Sturm-Liouvile systems, Greens' s Function for ordinary differential equations , Introduction of partial differential equations.

Suggested readings:

- Marcel, B. F. 2012, A First Course in Elementary Differential Equations, 1st edition, : Arkansas Tech University Press.
- Richard, H. 2003, Differential equations, 4th Edition, : Pearson.
- Stroud, K. A. and B. J. Dexter 2003, Advanced Engineering Mathematics, 4th Edition : Palgrave Macmillan.
- William, B. E and R. D. C. Richard 2008, Elementary Differential Equations, 9th Edition, : Wiley.

MTH-715 3(3-0) ADVANCED REAL ANALYSIS

Learning objectives

The objective of this cours is to be able to write rigorous mathematical proofs for basic theorems in multi-variable calculus involving the fundamental tools such as continuity and differentiability.

Course Contents

Riemann integration and its properties, fundamental theorem of calculus, Riemann Steles integration of functions of bounded variation. Sequences and series of functions, Uniform convergence of sequences an series of functions, Red valued functions of several variables, Continuity and differentiability Derivatives and differentials of composite functions, Change of order, Schwarz's and young's theorems, Taylor's series for functions of more than one variables. Implicit functions. Jacobean's Maxima and minima, improper integrals and their kinds, convergence and uniform convergence tests for improper integrals, improper multiple integrals.

Suggested readings:

- Halsey, R. 2010, Real Analysis , 4th Edition, : Pearson.
- Jonathan, L. 2003, An Interactive to Introduction to Mathematical Analysis Adision Wesley, Published by Combridge University Press.
- Steven, D. A. , Introduction To Mathematical Analysis, Bookseller: Amazing Book Deals (Springfield, IL, U.S.A.).
- Utpal, C. 2010, Advanced Mathematical Analyses, 2nd Edition.
- Walter, R. 2009, Principal of Mathematical Analyses, 3rd Edition McGraw Hill Inc.

MTH-716 3(3-0) LINEAR ALGEBRA

Learning objectives

Study some of the fundamental rules of linear algebra and show analogies with tensor analysis. Study of Matrices, determinants, systems of linear equations, and eigenvalues and eigenvectors.

Course Contents

Euclidean spaces, Vector spaces, Subspaces, Linear independence and dependence, Basis and dimensions Rank and nullity of matrices, Inner product spaces, Angle and Orthogonally in Inner product spaces, Orthogonal basis, Gram-Schmidt process. Orthogonal matrices, change of basis, Eigenvalues and eigenvectors, Diagonaliation, Orthogonal diagonalization.

Linear transformations, Linear functional and dual spaces. Kernel and range, Inverse linear transformation. Matrices of general linear transformation, Rank and nullity of linear transformation, Applications to relevant problems.

Suggested readings:

- Glazman, I. M. and T. Ljubic, 2006, Finite-Dimensional Linear Analysis, 1st edition Publications Dover N. Y.
- McMahon and David 2005, Linear Algebra Demystified, 1st edition , : McGraw–Hill Professional. N.Y
- Poole and David 2010, A Modern Introduction to Linear Algebra, 3rd Edition : Cengage – Brooks/Cole,
- Ricardo and Henry 2010, A Modern Introduction To Linear Algebra ,1st Edition : CRC Press.
- Thomas, S. and Shores 2006, Applied Linear Algebra and Matrix Analysis, 1st Edition : Springer.N. Y.
- Zhang and Fuzhen 2009, Linear Algebra (Challenging Problems for Students), 1st Edition : The Johns Hopkins University Press.

MTH-717 3(3-0) CLASSISICAL MECHANICS

Learning objectives

The main goal of the course is to introduce students to classical mechanics and its applications and for them to learn the fundamentals of this important topic.

Course Contents

Change of Coordinate System and the Transformation Matrix, Center of Mass, Moment of Inertia, and the Planar Motion of Rigid Bodies , Products of Inertia, the Inertia Tensor, Principal Axes, and the 3-d Motion of Rigid Bodies Euler an Angles, Gyroscopic Precession, Nutation, the Gyrocompass, and the Rolling Wheel , Lagrangian Mechanics, Forces of Constraint, and the Hamiltonian Function , Equilibrium, Stability, and the Dynamics of
Oscillating Systems.

Suggested readings:

- Daniel, K. and K. J. Robert 2010, An Introduction to Mechanics, : Cambridge University Press.
- Finn, F. J. 2009, Classical Mechanics, 1st Edition. : Jones & Bartlett Learning.
- John, T. R. 2005, Classical Mechanics 1st Edition : University Science Books.
- David, D. 2008, Introduction to Classical Mechanics: With Problems and Solutions, 1st Edition, : Cambridge University Press.

MTH-718 3(3-0) ELEMENTRY FLUID MECHANICS

Learning objectives

The course main object to learn the fundamentals of viscous incompressible flows, the basics of non-viscous potential flows, the fundamentals of computational fluid mechanics, the fundamentals of compressible flows.

Course Contents

Fluid and continuum, Physical properties and types of fluids, Classification of fluid flows, Methods of describing fluid motion, Material derivative, Equation of continuity, Boundary surface, Boundary condition, Streamlines, Path lines and Streak lines, Stream tubes, Vortices vector , vortex lines, velocity potential, Irrational motions, Translation, rotation and deformation of a fluid element. Two dimensional motion. Stream function, Relationship between velocity potential and stream function. Complex velocity potential, Irrational vertex. Euler's equation of motion, Impulsive motions, Bernoulli's equations. Flow past a circular cylinder without and with circulation, Application of conformal transformation to fluid flow, Flow past an elliptic cylinder, Flow past a sphere, Blasius theorem, Aero foil, Theorem of Kutta and Joukowski, Sources, Sinks and doublets, Superposition of elementary plane potential flows, Circle theorem, Method of images, Axi-symmetic flows, Stokes' stream function, Flow and circulation, Stokes ' Theorem, Kelvin's theorem on circulation, Kelvin's minimum energy theorem, Mean value of the velocity potential Uniqueness theorems.

Suggested readings:

- Bansal, R. K. 2005, A Text Book of Fluid Mechanics and Hydraulic Machines, 1st Edition : Firewall Media.
- Bansal, R. K. 2010, Textbook of Fluid Mechanics, 9th Edition, : Firewall Media.
- Genick, M. B. 2011, Basics of Fluid Mechanics, 4th Edition, Tata McGraw-Hill Education.

- Merle, P. C. , W. C David and R. H Bassem 2011, Mechanics of Fluids, 4th Edition : Cengage Learning.
- Yunus, C. A. 2010, Fluid Mechanics, 2nd Edition, : Tata McGraw-Hill Education.

MTH -719 1(1-0) SPECIAL PROBLEM

MTH-720 1(1-0) SEMINAR

MTH-721 3(3-0) PARTIAL DIFFERENTIAL EQUATIONS

Learning objectives

the structure of linear partial differential equations and how they relate to engineering situations, how analytical solutions are obtained, the general principles of how to construct a Green's function for a given linear differential equation, and how to use it to solve the inhomogeneous problem.

Course Contents

Modeling of two-and three-dimensional partial differential equations, Multiple Fourier series solutions of boundary value problems, Solutions using Fourier integrals, Solutions of Wave and heat equation s in unbounded domains, Laplace equation in two 0and three-dimensional polar coordinates, Solution of Laplace equation on a semi Infinite strip and on a circular region, Solution of boundary value problems using Bessel functions and Legendre functions. The Strum Liouville system. Solutions of boundary value problems using Laplace transforms and Fourier transforms, Green's function method, Reduction of partial differential equation into canonical forms.

Suggested readings:

- Dennis, Z. G. and C. R. Michael 2008, Differential Equations with Boundary-Value Problems, 7th Edition : Cengage Learning.
- John, P. C, B. Albert and A. David 2002, Differential equations with boundary value problems, 1st Edition, : Pearson Education.
- Paul, B. , D. L. Robert and H.R. Glen 2006, Differential Equations, 3rd Edition, : Cengage Learning.
- Stephen, G. W and A. A. Scott 2007, Differential Equations and Linear Algebra, 3rd Edition, : Pearson Prentice Hall.

MTH-722 3(3-0) DIFFERENTIAL GEOMETRY

Learning objectives

This course introduces to student major ideas of differential geometry and its applications to physics. Upon completion of this course students will have knowledge of the geometry of curves and surfaces, understand how calculus, topology and linear algebra contribute to studying geometrical objects and will be able to solve typical problems associated with this theory.

Course Contents

Space curves, Moving trihedral, Curvature, Torsion, , Serret-Frenet formulae, Osculating plane, circle and sphere, Helices, Indicatrices and their curvature and torsion, Fundamental theorem of space curve, Involutes, Evolutes, The theory of surfaces, Tangent and normal planes, Envelops and characteristics related to one parameter family of surfaces, Edge of regression, Developable surfaces and developable associated with a space curve, Parametric curves, Two fundamental forms of curves on a surface ,

Meunier's theorem, Lines of curvatures, Principal directions and principal curvature, Euler's theorem, Geodesics and Geodesic equations.

Suggested readings:

- Barrett, O. B 2006, Elementary Differential Geometry, 2nd Edition, : Academic Press .
- Pressley, A. N 2010, Elementary Differential Geometry, 2nd Edition, : Springer .
- Thomas, B. F and L.T. Stephen 2010, Differential Geometry of Curves and Surface , 1st edition, : A K Peters.
- Willmore, T. J. 2012, Introduction to Differential Geometry, : Dover Publications.

MTH-723 4(0-4) RESEARCH REPORT/THESIS

MTH-724 3(3-0) SPECIAL THEORY OR RELATIVITY

Learning objectives

To be able to use Lorentz transformations to solve a variety of problems and understand the Minkowski model for space-time and the concepts of interval and null-cone etc. Their physical interpretation to understand the relativistic conservation law of energy-momentum and its applications to particle collisions etc.

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Course Contents

Fundamental concepts, Lorentz transformations, Length contraction, Time dilations, Relativistic kinematics, Velocity and acceleration, Transformation of velocities, Mass, Force, Momentum, Relativistic dynamics, Relativistic equations of motion, Relativistic kinetic energy, Relativistic mass and its derivation, Energy-mass relations, Energy-momentum relation, Maxwell's equations in special relativity, Vector calculus and Lorentz transformation.

Suggested readings:

- Ajoy, G. 2009, Special Theory of Relativity Physics, 1st Edition : S. Anshan
- Albert, E. 2011, Relativity (The Special and General Theory),1st edition, : Create Space Independent Publishing .
- Alber,t E, 2012, Relativity (The Special and General Theory), : Empire Books .
- David, B. 2006,: The Special Theory of Relativity Rout ledge Classics, 1st Edition, : Complete Series Bundle RC.

MTH-725 ANALYTICAL DYDNAMICS 3(3-0)

Learning objectives

The course aim is familiarize with the peculiar characteristics in Analytical, Dynamics, expose to the need for and demands of mathematics in the Science/ Technology and Engineering world and prepare for the contemporary Science/Technology and Engineering world.

Course Contents

Generalized coordinates, Holonomic and non-holonomic systems, D, Alembert's principles, D delta rule, Lanrainge's theory of holonomic systems, Equations of Lagrange, Quasi coordinates and Lagrange equations in quasi-coordinates, first integrals of Lagrange equations of motkion, Energy integral and Whitaker,s equations, Ignorable coordinates and Routhian function, Noether's theorem, Hamilton';s theory Hamailton's principlel, Generalized momenta dnd phase space, Hamiltlon';s equation, Ganomical transformations, Generating functions, Hamilton Jascobi theorem.

Suggested readings:

- Eugeniu, M. A. Yu. and Y. A. Ryabov 2004, Asymptotic Methods in Resonance Analytical Dynamics Stability and Control: Theory, Methods and Applications; Volume 21, 1st Edition : CRC Press
- Firdaus, U. E. and K. E. Robert 2007, Analytical Dynamics: A New Approach 1st Edition, : Cambridge University Press
- Leoard, M. 2010, Methods of Analytical Dynamics (Dover Civil and Mechanical Engineering), : Dover Publications N.Y.
- Walter, D. and R. Martin 2001, Classical and Quantum Dynamics: From Classical Paths to Path Integrals, 3rd Edition, : Springer

MTH-726 3(3-0) DISCRETE MATHEMATICS

Learning objectives

The general objective is to give basic knowledge in Discrete Mathematics, especially in the solution of combinatorial problems, the knowledge of some important algebraic structures and basic knowledge of graph theory. Also the ability to perform a stringent mathematical discussion is trained.

Course Contents

Introduction to logic, propositional calculus, Sets, Sequences and functions, Growth of functions, Algorithms, Complexity of algorithms, Integers and division, Applications of number theory, Matrices, Mathematical reasoning, Methods of proof, Mathematical induction, Recursive definitions, Advanced counting techniques, Recurrence relations, Solving recurrence relations, Generating functions, inclusion exclusion, Applications of inclusion – exclusion, Relations and their properties, Representing relations, Closure of relation Equivalence relations, Partial orderings, Introduction to graphs, Graph terminology, Representing graphs and graph Isomorphism, Connectivity, Euler and Hamilton paths, Shortest path problems, Planner graphs, Graphs, Graph coloring, Instruction to trees, Spanning trees, Minimum spanning trees.

Suggested readings:

- Edgar, G. G. and P.M. Michael 2005, Discrete Mathematics with Graph, 3rd Edition
- Kenneth, R. and S. Susanna 2006, Discrete Mathematics and Its Applications, 6th Edition, : McGraw-Hill Science/Engineering/Math.
- Kenneth, R. 2011, Discrete Mathematics and Its application, 7th Edition : McGraw-Hill Science/Engineering/Math
- Mark, W.A. 2006, Data Structures and Algorithm Analysis in C++ , 3rd Edition : Prentice Hall

MTH-727 3(3-0) ADVANCED FLUID MECHANCICS

Learning objectives

Identify the significance of each term in the governing equations. Simplify the governing equations for problems involving symmetry, and negligible terms. Specify appropriate mathematical boundary conditions given a complete physical description of a flow. Obtain dimensionless forms of the Navier-Stokes equations, and identify relevant dimensionless parameters. Perform similarity transformations for Stokes first and second problems, and obtain the exact solutions.

Course Contents

Vortex motion, Helmholtz theorem, Helmoholtz's verticity equation, Rectilinear vortices, Karman's vortex street, Circular vortex, Analysis of stress and strain rate tensor, Stress-strain rate relationship for a Newtonian fluid, Reynold's transport theorem, Navier-Stokes'equations, Exact solutions of Navier-Stokes' equations Dimensional analysis, Dynamical similarity, Concepts of thermodynamics, Energy equation. Exact solutions for the problem of temperature distribution in a viscous flow. Boundary layer concept and its governing equations. Exact solutions of boundary layer equations. Ven Karman momentum integral equations and its application, energy integral equation, Approximate Solutions of steady boundary layer equations; Von Kamran –pohlhausen method, Waiz method, Thwaite's method introduction to turbulent boundary layer flow.

Suggested readings:

- Bansa, R. K. 2005 , Textbook of Fluid Mechanics, 9th edition, : Firewall Media,
- Genick, M. B. 2011, Basics of Fluid Mechanics, 4th edition, : Firewall Media.
- Merle, P. C. 2011, Mechanics of Fluids, 4th edition, : Cengage Learning,.
- Yunus, C. A. 2010, Fluid Mechanics, 2nd edition, : Tata McGraw-Hill Education.

MTH-728 3(3-0) QUANTUM MECHANICS

Learning objectives

Familiar with the notions of Hilbert space, self-adjoint operators, unitary operators, commutation relations, understand their relevance to the mathematical formulation of quantum mechanics and be able to use the notions to formulate and solve problems. Moreover understand the probabilistic interpretation of quantum states, and basic aspects of the relation between classical and quantum mechanics.

Course Contents

Review and difficulties of Classical Mechanics, Black body radiation, Photoelectric effect, Compton effect, Bohrs theory of atomic structure, Wave particle duality, De Broglie's postulate, Uncertainty principle, Uncertainty of position and momentum, Energy time uncertainty, Linear operators, Formalism in Quantum mechanics, Orthonormal system, Hermitian operators and their properties, Parity operators Postulates of Quantum mechanics, Schrodinger wave equation. Three dimensional Schrödinger equations, Step potential , potential barrier, potential well, Harmonic oscillator, Scattering theory, Scattering amplitude, Scattering equation, Born approximation, partial wave analysis, Perturbation theory, Time independent perturbation of non-degenerate and generate cases, Time dependent perturbations.

Suggested readings:

- Alastair R. 2005, Quantum Physics (Beginners Guide) 1st edition, : One world Publications
- Andrew H. T. H. 2012, In Plain Sight: The fundamental link between relativity and quantum mechanics, 2nd edition : Create Space Independent Publishing Platform .
- David G. J. 2004, Introduction to Quantum Mechanics, 2nd edition : Addison-Wesley.
- Kenneth F. W. 2005, The Quantum World Quantum Physics for Everyone, 1st edition : Harvard University Press.
- Steven W. 2012, Lectures on Quantum Mechanics Weinberg 1st edition, : Cambridge University Press.

MTH-729 3(3-0) ELECTROMAGNETIC THERORY

Learning objectives

Obtain an understanding of Maxwell's equations and be able to apply them to solving practical electromagnetic fields problems. Fundamental concepts covered will include, laws governing electrodynamics, plane wave propagation in different media, power flow, polarization, transmission and relection at an interface, transmission lines, microwave networks, waveguides, radiation and antennas andwireless systems design

Course Contents

Maxwell's equation in free space and material media , Solution of Maxewell's equations, Constitutive equations, Ohm,s law and currents, Potentials, Wave equations, Plane elect magnetic waves in homogeneous and Isotropic media, Reflection and Reflection of Plane waves, Wave Guides, Boundary conditions, Maxwelll's equations and constitutive equations for moving media, Lorentz transformations Maxwell stress tensor, Poying's theorem, Integral form of Maxwell's equations,.Convariant formulation of Maxwell's equations, Energy relationships for the electromagnetic field.

Suggested readings:

- Bhag, G. S. and H. R. Huseyin 2009, Electromagnetic Field Theory : 2nd Edition : Cambridge University Press
- John, R. R. , M. J. Frederick and W.C. Robert 2008. Foundations of Electromagnetic Theory 4th Edition : Addison-Wesley
- Stratton, A. J. 2008, Electromagnetic Theory. 1st edition : Adams Press
- Stratton, A J. 2010, Electromagnetic, 1st edition,: Swedenborg Press

MTH-730 3(3-0) THEORY OF ELASTICITY

Learning objectives

The course will provide a basic treatment of the formulation of linear elasticity theory and its application to problems of stress and displacement analysis.

Course Contents

Analysis of stress and strain, Stress – strain relationships, Hook's law; Plain strain, Plain stress, Relationships between elastic constants, Equations of equilibrium, Boundary conditions, Compatibility equations; Stress function in two – three dimensions, Two dimensional problems in rectangular and polar coordinates, Torsion of rods and beams, Wave propagation, Theory of thin plates.

Suggested readings:

- Atkin, R. J. 2005, An Introduction to the Theory of Elasticity, 1st Edition : Dover Publications.
- Love, A. E. H. 2011, A Treatise on the Mathematical Theory of Elasticity, 4th Edition : Dover Publications .
- Martin, S. H. 2009, Elasticity (Theory, Applications, and Numerics) 2nd Edition , : Academic Press .
- Stephen, T. P. and G. M. James 2009, Theory of Elastic Stability, 2nd Edition, : Dover Publications .

MTH-731 3(3-0) INTEGRAL EQUATIONS AND VARIATIONAL CALCULUS

Learning objectives

Learn the analyse and solve the fundamental problem with prescribed or free boundary conditions in simple cases, solve extensions of the fundamental problem, including that for double integrals and use the canonical theory, Poisson brackets and associated invariants.

Course Contents

Basic concepts, Classification of linear integral equations, Relationships between differential and integral equations, Green's function, Resolvent kennel, Neumann series, Separable kernel, Eigenvalues and Eigen functions, Methods of successive approximation, Iterative methods, Integral equations of convolution type, Classical Fredholm theory, Hilbert-Schmidt theory.

Functional, Fundamental lemma, Euler-Lagrange equations, Constrained maxima and minima, Extrema of functions of several variables, Generalization of Euler's equations, Extremizing multiple integrals, Hamilton's principal, Use of Lagrange multipliers, Sturm Liouville and Rayleigh-Ritz methods.

Suggested readings:

- Mariiano, G. 2007, Cartesian Currents in the Calculus of Variations II, 1st Edition : Dover Publications.
- Charles, F. 2010, An Introduction to the Calculus of Variations, :Dover Publications.
- Mariano, G. , M. Guiseppe and S. Jiri 2010, A Series of Modern Surveys in Mathematics 1st Edition : Springer .
- Shilov, G. E. and B. L. Gurevich 2012 Integral, Measure and Derivative: A Unified Approach 1st edition, : Dover Publications .

MTH-732 3(3-0) FUNCTIONAL ANALYSIS

Learning objectives

Learn the metric spaces, completeness, banach spaces, Hilbert spaces, and dual spaces. This course develop the analysis of the functions in research.

Course Contents

Fundamental Properties of Metric Spaces, Convergence and Completeness , Holder and Minkowski's Inequalities .,Sequence spaces, Separable spaces, Normal spaces, Basic properties, Equivalent norms, Convergence and completeness, Banach spaces, Finite dimensional normed spaces, Compactness. Bounded linear mappings and Bounded linear functional, Dual spaces. Inner product spaces, Parallelogram law, Schwarz inequality, Hilbert spaces, Orthogonality, Orthonormal sequences, Gram-Schmidt process, Representation of functional on Hilbert spaces.

Suggested readings:

- Elias, S. M and S. Rami .2011, Functional Analysis: Introduction to Further Topics in Analysis, 1st Edition : Princeton University Press.
- Haim, B. 2011, Functional Analysis, Sobolev Spaces and Partial Differential Equations, 1st Edition : Springer.
- John, C. B 2010, A Course in Functional Analysis, 1st Edition : Springer.
- Yuli, E. , M. Vitali and T. Antonis 2004, Introduction to Functional Analysis, 1st Edition, : American Mathematical Society.

MTH-733 3(3-0) ADVANCED NUMERICAL ANALYSIS

Learning objectives

To learn numerical methods for data analysis, optimisation,linear algebra and ODEs. learn MATLAB skills in numerical methods, programming and graphics. To present these solutions in a coherent manner for assessment.

Course Contents

Gaussian quadrature using a system of orthogonal, polynomials (Legendre and Leaguer Polynomials, Numerical Differentiation, Difference Equations, Differential Equations, Euler's Method, Improved Euler's Methods. Mid-point Formula, Heun's Method. Hyperbolic Partial Differential Equation. Analyses of Finite Difference Scheme. Well-Poses and Stable Initial Value problem. Elliptical Partial Differential Equation and difference Scheme.

Suggested readings:

- Antia, H. M. 2002, Numerical Methods for Scientists and Engineers, 2nd edition : Birkhäuser;
- Ascher, C . 2011, A First Course on Numerical Methods, 1st edition Published: Society for Industrial and Applied Mathematics (SIAM).
- Quarteroni, A. R. and S. Fausto 2010, Numerical Mathematics, 1st edition Published by :Springer..
- Sauer, T. 2010, Numerical Analysis, 2nd Edition : Pearson.