SCHEME OF STUDIES

M.Sc.

MATHEMATICS

(Under Annual System)
For the year 2012 and onward

More Light

2002

DEPARTMENT OF MATHEMATICS
GC UNIVERSITY, FAISALABAD

Curriculum and Syllabus

Master of Science in Mathematics

For External and Annual Examination System from 2012 & onwards

List of Courses

PART-I (All Courses are compulsory)

Course Code	Sr. No.	SCHEME OF STUDIES	MARKS
MTH-C11	1.	Real Analysis	100
MTH-C12	2.	Algebra	100
MTH-C13	3.	Complex analysis and Differential Geometry	100
MTH-C14	4.	Mechanics	100
MTH-C15	5.	Topology and Functional Analysis	100
		Total Marks M.Sc. Part-I	**500**

PART-II

Sr. No.	SCHEME OF STUDIES	MARKS
	Compulsory Courses	
1.	Fluid Mechanics	100
2.	Mathematical Methods & Partial Differential Equations	100
	OPTIONAL Courses (Choose any four optional courses out of six)	
1.	Mathematical Statistics	100
2.	Numerical Analysis	100
3.	Operational Research & C++	100
4.	Analytical Dynamics & Theory of Relativity	100
5.	Theory of Modules & Theory of Optimization	100
6.	Quantum Mechanics	100
	Compulsory	
1.	Viva Voce (This Paper will be from all paper Part-I)	100
	Total Marks M.Sc. Part-II	**600**
	Grand Total Marks of M.Sc. Degree	**1200**

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CONTENTS

Paper I: REAL ANALYSIS   Code = MTH- CII

Note: Five questions to be attempted. Question # 1 is Compulsory, select 2 questions from each section.

QUESTION 1 (1/9)

a)   Five short answers, Each question carries two marks
b)   Ten Column matching, each carries one mark.

SECTION 1   (4/9)

Algebraic and ordered properties of Real Number, Absolute values, inequalities (Cauchy's, Minkoski's, Benoulli's) properties and concepts of supremum and infimum, ordered set, Fields, Field of Real, The extended real number systems, Euclidean spaces.

Sequences, Subsequences, Cauchy Sequence, Series, of Non Negative terms and their convergence. The comparison, Root, Ratio and Integral tests. Absolute and conditional Convergence of Infinite series.

Limits of a function, Continuous functions. Types of discontinuities.

The Derivative of a real funcation. Continuity of derivatives.

SECTION 2   (4/9)

Partial Derivatives and differentiability. Derivative and differentials of composite functions. Implicit functions, Jacobians. Maxmima and minima (With and without side conditions).

The Riemann-Stieltjes (R-S) Integral. Properties and Riemann (R-S) integrals. Functions of bounded variation.

Point wise and uniform convergence of sequences and series of functions, Weierstrass M-Test, Uniform convergence and continuity. Uniform Convergence and differentiation, Uniform convergence and integration.

Convergence of improper integrals. Beta and Gamma functions and their properties.

BOOK RECOMMENDED:

1. R.G. Sherbert Bartle *Introduction to Real Analysis,* 1999 John wiley New York.
2. W. Rudin *Principles of Mathematics Analysis,* 1986 McGraw-Hill New York.
3. W. Kaplan *Advance Calculus* 1984 Addison-Wesley Publishing Company.
4. Apostol, *Mathematical Analysis*, 1974 Addison-wesley Publication Company.

Code = MTH-C12

Paper II: ALGEBRA

Note: Five question to be attempted. Question # 1 is compulsory, select 2 questions from each section.

QUESTION 1 (1/9)

c) Five short answers, Each question carries two marks
d) Ten Column matching, each carries one mark.

SECTION 1   (4/9)

Groups and subgroups, Cyclic group, Coset decomposition of a group, Lagrange's theorem and its consequences, conjugacy classes, centralizers and normalizers, normal subgroup.

Homomorphisms of groups Cayley's theorem, Quatient groups, fundamental theorem of Homomorphism, isomorphism theorems, endomorphisms and automorphisms of groups, Characteristic and fully invariant subgroups.

SECTION 2   (4/9)

Definition and example of rings, types of rings, fields and its characteristics, ideals, Ring homomorphisms, Quotient ring, Prime and maximal ideals. Vector spaces, subspaces, Bases & Dimension of a vector space, Homomorphism of vector spaces, quotient spaces, Dual spaces, linear transformation. Rank and Nullity of linear transformation. Algebra of linear transformation and representation of linear transformations as matrices. Change of bases. Linear functional eigenvalues and eigenvectors, similar matrices, diagonalization of matrices. Orthogonal matrices.

BOOK RECOMMENDED:

1. J.J. Rottman, *The theory of groups: An introduction*, Allyn & Bacon, Boston, 1965.
2. J. Rose, *A course on group theory*, C.U.P 1978.
3. I.N. Herstein, *Topics in Algebra,* Xerox publishing Company, 1964.
4. G. Birkhoff and S. Maclane, *A Survey of Modern Algebra* Macmillan, New York.
5. Macdonald, *The Theory of Group,* Oxford University Press, 1968.
6. P.M. Cohn, *Algebra*, Vol. I, London: John Wiley, 1974.
7. D. Burton, *Abstract and linear algebra*, Addison-Wesley Publishing Co.
8. P.B. Battacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract algebra, C.U.P.1986.
9. J.B, Fraleigh, *Abstract Algebra*, Addision-Wesley.
10. N. Jacobson, *Basic Algebra*, Vol.II Freeman 1974.
11. K.H. Dar, *First step to abstract algebra*, Feroze Sons Pvt.
12. A. Majeed, *Theory of group*, Ilmi Kitab Khana.

Code = MTH-C13

Paper III: COMPLEX ANALYSIS AND DIFFERENTIAL GEOMETRY

Note:-   Five question to be attempted. Question # 1 is compulsory, select 2 questions from each section.

Question 1   (1/9)

    (e)   Five short answers, each question carries two marks.
    (f)   Ten Column matching, each carries one mark.

SECTION 1   (4/9)

The complex number, functions of a complex variable, Analytic functions, Cauchy-Riemann equations. Power series, Radius of convergence. Cauchy's theorem, Cauchy's Gourset theorem, Liouvilles Theorem, Chauchy's integral formula and related theorems. Contour integration. Singularities, Branch points. Taylor's and Laurent's series. Analytic continuation. Residues, Residue theorem. Fundamental theorem of Algebra. Conformal Mappings.

SECTION 2   (4/9)

The moving trihedron, Arc length paramater representions, Curvature and torsion of unit speed and non unit speed curves, The frenet-Serret Theorem, Helices, Spherical indicatericies, involutes & Evolutes. Simple surface and coordinate patches. The tangent plane and the normal planes, the first fundamental form and the metric, coordinate transformations. Surface Curves: The angle between two curves on a surface; Normal curvature and geodesic curvature, the second fundamental form, christoffel symbols. Mean and Gaussain Curvatures. Principal curvatures, Riemannain Curvature, Gauss's Theorema Egregium, Dupin's indicaterix. Weingarten Map, Guass-codazzi equations.

BOOKS RECOMMENDED:

1. L. Pennisi, L. Gordon and S. Lasher, Elements of Complex Variables, Holt Rinehart and Winston.
2. R. Churchill, Complex Variables and Application (1996) McGraw Hill.
3. R.A. Silverman, *Complex Analysis with Applications*, Prentice Hall, Englewood Cliffs, N.Jersey.
4. J. Paliouras, Complex Variables for scientists and Engineers McMillan.
5. H.R. chillingworth, *Complex variables*, Pergamon Press, Oxford.
6. L.V. Ahlfors, *Complex Analysis* McGraw Hill.
7. M. Iqbal, *Complex Analysis* (1996).Ilmi Kitab Khana.
8. K. Kodaira, *Introduction to complex Analysis*, Cambridge.
9. S. Lang, *Complex Analysis*. 4th Edition, 2001, Springer.
10. R. Millman and G.Parker. *Elements of differential Geometry* Prentice Hall.
11. B. O'Neill, *Elementary Differential Geometry*.
12. D.J. Struik, *Lectures on Classical Differential Geometry* Addison- Wesley.
13. A. Goetz, *Introduction to differential Geometry* Addison-Wesley.
14. F. Chorlton. *Vector and Tensor Methods* Ellis Harwood.

Code = MTH - C14

Paper IV: MECHANICS

Note:-   Five questions to be attempted, Question # 1 is compulsory, select 2 questions
              from each section.

QUESTION # 1   (4/9)

(g)   Five short answers, each question carries two marks

(h)   Ten Column matching, each carries one mark.

SECTION 1

Vector and Tensor Analysis   (4/9)

Vector Analysis

Gradient, Divergence and curl of point functions, expansion formulas, curvilinear, line, surface and volume integrals, Gauss's, Green's and stokes's theorems and their applications.

Cartesian Tensors

Tensors of different ranks, Addition and Subtraction of tensors, inner and outer products, contraction theorem, Kronecker tensor and Levi-Civita tensor, relation between these two special tensors, Applications to vector Analysis.

SECTION 2   (4/9)

Mechanics

General Motion of a Rigid Body, Euler's Theorem and Chasles' Theorem, Euler's angles, Moments and products of inertia, intertie tensor, principal axes and principal moments of intertie, Kinetic energy and angular momentum of a rigid body. Momental ellipsoid and Equimomental systems. Parallel axis and perpendicular axis theorem, Equilibrium of a rigid body, General Conditions of equilibrium, and deduction of conditions in special cases.

BOOK RECOMMENDED:

1. H. Heffrey, *Cartesian Tensors*, Combridge University Press.
2. F. Chorlton, *Vector and Tensor Methods*, Ellis Horwood Publiher, Chichester,U.K, 1977.
3. K. L. Mir *Theortical mechanics* Ilmi Kitab Khana Lahore.
4. Nawzish Ali Shah *vector and Tensor Analysis*.
5. R.A. Becher, *Introduction to theoretical Mechanics*, McGraw Hill Book Company, Inc. New York.
6. Synge & Griffith, *Principles of mechanics*, McGraw Hill book company Inc., New York.

Code = MTH-C15 *for M.Sc. Mathematics*

Paper V: TOPOLOGY AND FUNCTIONAL ANALYSIS

Note: -   five questions to be attempted. Question # 1 is compulsory, select 2 questions form each section.

SECTION # 1

  i)   Five short answers each carry two marks
  ii) Ten Columns matching each carries one mark.

SECTION 1   (4/9)

Topological spaces; subspaces and relative topology, open sets, closed sets, neighborhood, interior, Exterior and limit points, base and sub base, product spaces. Continuous and open mappings. Homeomorphism. First and second axioms of countability. Separation axioms, T_0, T_1, T_2, T_3, T_4 spaces. Regular and normal spaces. Connectedness, Local connectedness, components. Compact spaces and their characterization.

SECTION 2   (4/9)

Definition & examples of metric space, open and closed sets, convergences, Cauchy sequence and examples, completeness of a metric space, normed linear spaces, Banach spaces, Quotient spaces, continuous and bounded linear operators, linear functional, linear operator and functional on finite dimensional spaces. Inner product spaces, Hilbert spaces (definition and examples), Orthogonal complements, Orthonormal set & sequences, conjugate spaces, representation of linear functional on Hilbert space, reflexive spaces.

BOOKS RECOMMENDED:

1. G.F. Simon, Introduction to topology and Modern Analysis, McGraw Hill book. Company New York, 1963.
2. J. Willard, General Topology, Addison-Wesley Publishing Company, London.
3. E. Kreyszig, Introduction to functional Analysis with application, John wiley and Sons, 1978
4. W. Rudin, Functional Analysis, McGraw Hill Book Company, New York.
5. N. Dunford and J. Schwartz, Linear operators (part-I General Theory), interscience
6. K.R. Muners, Topology, A first course (Prentice Hall, Inc)
7. J. Dugundji: Topology;(Prentice Hall, Inc)
8. A. Majeed, Elements of Topology and functional Analysis Ilmi Kitab Khana Lahore.

Paper VI: FLUID MECHANICS

Note: Five questions to be attempted. Question # 1 is compulsory; Select 2 questions from each section.

QUESTION # 1   (1/9)

a)   Five short answers, Each question carries two marks

b)   Ten Column matching, each carries one mark.

SECTION 1   (4/9)

Real fluids and ideal fluids, Velocity of a fluid at a point, Streamlines and path lines, Steady and unsteady flows, Velocity potential, Vorticity vector, Local and Particle rates of change, Equation of continuity. Acceleration of fluid, Conditions at a rigid boundary, General Analysis of fluid motion, Euler's equations of motion. Bernoulli's equation steady motion under conservative body forces, some potential theorems, impulsive motion. Sources, Sinks and doublets, Images in rigid infinite plane and solid spheres, AXi-symmetric flows, Stokes's stream function.

Stream function, complex potential for two-dimensional, irrational, Incompressible flow, complex velocity potential for uniform stream. Line source and line sinks, line doublets image systems, Miline-Thomson circle theorem, Blasius's theorem.

SECTION 2   (4/9)

Vortex motion, line Vortex, Vortex row image System, Kelvin's minimum energy theorem, Uniqueness theorem, fluid streaming pass a circular cylinder, Irrational motion produced by a vortex filament. The HelmholtZ vorticity equation, Karman's vortex-street.

Constitutive equations; Navier-Stoke's equations; Exact solution of Navier-stoke's equations; steady unidirectional flow; Poiseuille flow; Couette flow; Unsteady Unidirectional flow, sudden motion of a plane boundary in a fluid at rest ; flow due to an oscillatory boundary; Equation of motion relative to rotating system; Ekman flow; Dynamical similarity of turbulent motion.

BOOKS RECOMMENDED:

1. F. Chorlton, Text book of fluid Dynamics D. Van No Strand Co. Ltd. 1967.
2. M. Thomson, Theoretical Hydrodynamics, Macmillan Press 1979.
3. W. Jaunzemics, continuum Mechanic, Macmillan Company, 1967.
4. L.D Landau and E.M, Lifshitz, Fluid Mechanics, Pergamon press 1966.
5. G.K. Batchelor, An introduction to fluid Dynamics, Cambridge University Press,1969.
6. Brvce R. Munson and Donald F. Young, Fundamentals of Fluid Mechanics, Department of Engineering Science and Mechanics, Department of Mechanics Engineering Lowa State University Amos Lowa USA.
7. L.D. Landan & E. M. Lifshitz, Fluid Mechanics, Pergamon press,1966.
8. G.K. Batchelor, An Introduction to Fluid Dynamics, Cambridge University Press, 1969.
9. Walter Jaunzemis, Continuum Mechanics, McMillan Company, 1967.
10. Milne-Thomas, Theoretical Hydrodynamics, McMillan Company,1967.
11. D.J. Tritton, Physical Fluid Dynamics 2nd edition oxford.

PAPER VII: MATHEMATICAL METHODS & PARTIAL DIFFERENTIAL EQUATIONS   Pap

Note: Five questions to be attempted. Question # 1 is compulsory; Select 2 questions   Note from each section.

QUESTION # 1   (1/9)   QUE
a)   Five short answers, Each question carries two marks
b)   Ten Column matching, each carries one mark.

SECTION 1   (4/9)

Theory of Sturm-Liouville Problems. Linear Homogeneous differential equations of order. Fundamental set of solutions. Linearly dependent and independent solutions.Wronskian determinant. Adjoint and self-adjoint Equations. Self –adjoint operator. Symmetric operator. Lagrange's identity. Green's identity. Eigenvalue problem Eigenfuncations and eigenvalues. Self-adjoint eigenvalue problem.

Orthogonality of eigenfunctions. Real eigenvalues. Regular, Periodic and singular sturm-liouvill systems. Orthogonal sets of functions. Expansion of functions in terms of eigenfunctions. Pewer Series, Solutions of Legendre's Equation, Legendre's polynomials Generating function; Rodrigue's formula, Recurrsion relations. Orthogonality and normality of legendre's Polynomials, Legendre's Series Bessel's equation, Bessel's functions, Generating functions, Recurring relations, orthogonality of Bassel's function, Bessel's series Green's function methods applied to ODEs. Green's function in one and two dimensions.

Integral Equations formulation and classification of integral equations Degenerate Kernels. Methods of Successive Approximations.

SECTION 2   (4/9)

Basic concepts and definitions, formation and classification of partial differential equations (PDEs). Partial differential equations of the first order. Nonlinear PDEs of first order. Applications of first order PDEs. Partial Differential equations of second order; Mathematical formation of heat, Laplace and wave equations. Classification of second order PDEs. Boundary and initial conditions. Characteristics. Method of Characteristics. Reduction to various Canonical (Normal) forms. And the general solutions of DPDEs. Method of separation of variables (Product Method) for solving PDes like elliptic,parabolic and hyperbolic equations. The Cauchy Problem. Cauchy's Problem form hyperbolic system in two independent variables with application to wave equations. Laplace, Fourier and Hankel Transorm for the solution of PDEs and their application to boundary value problems.

BOOKS RECOMMENDED:

1. *Stakgol, Boundary value problems of Mathematical physics, Vol. I,II Macmillan.*
2. *Lal Din Baig Methods of Mathematical Physics 2000.*
3. *H. Sagan, Boundary and Elgenvalue problems in Mathematical Physics.*
4. *E.L.Butkov, Mathematical Physics, Addision-Wesley.*
5. *G.Arfken, Mathematical Physics*
6. *R.P Kanwal, Linear Integral Equations.*
7. *My-Tung & Debnath, partail Differential Equation.*

Paper VIII: MATHEMATICAL STATISTICS

Note: Five questions to be attempted. Question # 1 is compulsory; Select 2 questions from each section.

QUESTION # 1   (1/9)

     a)   Five short answers, Each question carries two marks

     b)   Ten Column matching, each carries one mark.

SECTION 1   (4/9)

Interpretations of probability, Experiments and events, Definition of probability, finite sample spaces. Counting methods, the probability of a Union of events. independent events. Definition of conditional probability. Bay's theorem. Random variables and discrete distributions. Continuous distributions. Probability function and probability density function. The distribution function. Bivariate distributions. Marginal distributions. Conditional distribution. Multivariate distributions. Functions of random variables. The expectation of a random variable. Properties of expectations. Variance, Moments. The mean and the median. Covariance and correlation. Conditional expectation. The sample mean and associated inequalities. The multivariate normal distribution.

SECTION 2   (4/9)

Statistical inference. Maximum likelihood estimators. Properties of maximum likelihood estimators. Sufficient statistics. Jointly sufficient statistics. Minimal Sufficient statistics. The sampling distribution of a statistic. The chi square distribution. Joint distribution of a the sample mean and sample variance. The t distribution, confidence intervals. Unbiased estimators. Fisher information. Testing simple hypotheses. Uniformly most powerful tests. The F distribution. Comparing the means of two normal distributions. Test of goodness of fit. Contingency tables. Equivalence of confidence sets and tests. Kolmogorov-Smirnov test. The Wilcoxon signed-ranks tests. The Wilcoxon-Mann-Whitney Ranks test.

BOOKS RECOMMENDED:

1. A.M. Mood, F.A Graybill, D.C Boes, introduction to the theory of statistics, 3rd Edition, (MaGraw-Hill Book Company New York, 1974).
2. M.H.Degroot, Probability and statistics, (2nd Edition). Addison-Wesley publishing Company, USA,1986.
3. K.V Mardia, Kent, J.T Bibby, J.M.Multivariate Analysis. Academic press New York, 1979
4. Mood, A.M. Graybill, F.A. Boes, D.C Introduction to the theory of statistics, (2nd Edition), McGraw -Hill Book Company New York,1986.
5. Degroot, M.H. Probability and statistics, (2nd Edition) Addison Wesley Company New York 1986.
6. Walpole-Myers.Myers. Ye Probability and Statistics (7th Edition)
7. K.V.Mardia, Kent, J.T.Bibby, J.M.Multivariate Analysis Academic Press New York 1979.
8. Allen. T Craig, Robert V. Hogg, Introduction to Mathematical Statistics 5th Edition Publish by pearson Education Singapore (Pvt.) Ltd.

Paper IX: NUMERICAL ANALYSIS

Note: Five questions to be attempted. Question # 1 is compulsory; Select 2 questions from each section.

QUESTION # 1   (1/9)

     a)   Five short answers, Each question carries two marks
     b)   Ten Column matching, each carries one mark.

SECTION 1   (4/9)

Introduction, Computation error and error analysis, study of various iterative methods to solve non-linear equations with analysis of error, Convergence and stability of Bisection, False position, Secant, Newton-Rephson and fixed point methods, acceleration of convergence by Aitken method, Solution of system of linear equations by LU decomposition method, Cases of Failure, Iterative methods, (Jacobi, Gauss Seidel, SOR, SUR) and their convergence analysis, Ill conditioned systems and condition number, Interpolation: Review of simple interpolation for equally spaced data, Interpolation by Gauss forward/ backward method, Bessel and stirling method with error analysis, Interpolation by spline functions (up to cubic spline), Methods of Jeast Squares Numerical differentiation, Numerical integration for equally Spaced data (Newton cotes formula and its special cases e.g. Trapezoidal Rule and simpson's rules and for unequally spaced data, (using Lagrange and divided difference formula of interpolation) Gaussian quadrature usinga system of orthogonal polynomials (Legendre and Laguere Polynomials).

SECTION 2   (4/9)

Methods of least squares, Numerical Integration for equally spaced data, Newton cotes formula and its special cases e.g. Trapezoidal Rule Simson's Rules, Gaussian quadrature using a system of orthogonal, polynomials (Legender and Laguere Ploynomials, Numerical Differentiation, Difference Equations, Differential Equations, Differential Equations, Euler's Method, Improved Euler's Methods. Mid point formula, Heun's Methods.

BOOKS RECOMMENDED:

1.   Johnson L., and Dean, R.; Numerical Analysis, Addison Wesley.
2.   James, M.L., Smith, G.M. & Woford, J.C., Applied Numerical Methods for Digital Computation, Harper and Row, Publications.
3.   Ralston, A & Philips, R.A First Course in Numerical Analysis, McGraw Hill.
4.   Froeberg, C.E. Introduction to Numerical Analysis , Addison Wesley.
5.   Scarborough, J.B., Numerical Mathematical Analysis, John Hopkins Press.
6.   M.Iqbal, Numerical Analysis, National Book Foundation.
7.   J.H.Wilkinson, Eigenvalue problems, Oxford University Press.
8.   Aitkinson, Elementary Numerical Analysis.

Paper X: OPERATIONAL RESEARCH & C++

Note: **Five questions to be attempted. Question # 1 is compulsory; Select 2 questions from each section.**

QUESTION # 1   (1/9)

a)   Five short answers, Each question carries two marks
b)   Ten Column matching, each carries one mark.

SECTION 1   (4/9)

LINEAR PROGRAMMING

Mathematical modeling. Formulation and graphical soluation. Analytical solution simplex method. Twp-phase and M-technique for Linear programs Duality. Duality simplex method. Sensitivity Analysis.

TRANSPORTATION PROBLEMS

Definition. Various methods including North-West corner method. Least-cost method and vogel's approximation. The Assignment model. Application to Networks Shortest-Route Algorithm for acyclic and cyclic networks. Maximal-flow problems.

INTEGER PROGRAMMING

Definition and formulation –cutting –plane Algorithm and Branch-and Bound method, Application. The mixed Algorithm, Zero-one polynomial Programming.

SECTION 2   (4/9)

Object oriented Programming using C++. Declaring variable, Designing functions, Designing classes, Using Built in functions and Libraries.

Introduction 1:- History of C++, Writing C++ Program, Structure, Preprocessor, Header file, Main function, Increment operators++, Data types, Declaration of the variable, Initialization of a the variable, Arithmetic operators, Arithmetic expression, order or precedence of operation.

Introduction 2:- Basis input / output, cout<< object, the escape sequence, the end line, setw manipulator, Assignment operator, the cin>> operator. Compound Assignment, increment and decrement operator, functions part I and Part II, Pointers, Inheritance, and polymorphism part I and II, Files graphics, bit wise operators.

BOOKS RECOMMENDED:

1. *Hamdy A Taha An introduction to operation Research Macmillan Publisher and distributors, New Delhi, 1974.*
2. *S Kalavathy Operations Research Vikas publishing House (P) Ltd.*
3. *F.S Hiller and G.J Liebraman, Operational Research CBS Publisher House (P) Ltd.*
4. *C.M Harvey, Operation Research, North Holland , New Delhi*
5. *Prof.Sr.Saeed Akhtar Bahtti operation Research: An introduction.*
6. *Krejewsky and Ritzman Operation Management Strategy and analysis.*
7. *Object Oriented Programming Using C++ by Robert Lafore 3rd Edition.*
8. *Aikman series. C.M. Aslam T A Qurashi.Urdu Bazaar Lahore.*

Paper XI: ANALYTICAL DYNAMICS & SPECIAL THEORY OF RELATIVITY

Note: Five questions to be attempted. Question # 1 is compulsory; Select 2 questions from each section.

QUESTION # 1   (1/9)
- a)   Five short answers, Each question carries two marks
- b)   Ten Column matching, each carries one mark.

SECTION 1   (4/9)

Generalized – Coordinates, Holonomic and Non-holonomic Systems, D' Alembert's Principals, D-delta Rule, Lagrange's theory of holonomic – Systems. Equations of Lagrange, Generalization of Lagrange equations. First integrals of Lagrange equations of motion, Energy integraland Whitaker's equations, ignorable coordinates and Routhian function, Noeater's Theorem. Lagrange's theory of Non-Holonomic systems Equations of lagrang of Non-Holonomic system with and without Lagrance multipliers, chaplygin's quations. Hamilton's theory hamilton's principals generalized momenta ad phase space, Hamiltion's equations. Canonical transformation, Generating functions, the lagrange and poisson bracket, bilinear covariant infinitestimal exat transformations. Hamilton's Jacobi theorem.

SECTION 2   (4/9)

Historical background and fundamental concepts of special theory of relativity. Lorentz transformaton (for motin along axis) . Lengh contraction. Time dilation and simultaneity. Velocity addition formulae. 3-dimensional Lorentz transformations. Introductin to 4-vector formalism.Lorentz transformations in the 4 vector formalism. The lorentz and poincare groups. Introduction to classical Mechanics. Minkowski spacetime and null cone. 4-velocity, 4 acceleration 4-momentum and 4-force. Application of Special Relativity to Doppler shift and Compton Effect. Particle Scattering. Binding energy, Particle production and decay. Electromagnetism in Relativity. Electric current. Maxwell's euations and electromagnetic wave. The 4-vector formulation of maxwell's equations. Special Relativity with small acceleration.

BOOKS RECOMMENDED:

1.   *M. saleem and M.Rafique, Special Relativity, (Ellis Harwood 1992)*
2.   *Rosser, Special Relativity.*
3.   *W. Ringler, Introduction to Special Relativity, (Oxford)*
4.   *D.T. Greenwood, Classical Dynamics, Prentice Hall, Inc.*
5.   *H. Godstein, Classical Mechanics, Addision-Wesley.*
6.   *L.A Pars, Treatise of Analytical Dynamics, Heinemann Press, London*
7.   *Classical Mechanics for M.Sc Students Prof Mohammad Yar Khan.*
8.   *Theoretical Mechanics By K.L Mir.*
9.   *A. Qadir Relativity: An Introduction to the Special Theory, World Scientific,1989.*
10. *R.D Inverno, Introduction Einstein's Relativity, Oxford University Press. 1992*
11. *H. Goldstein, Classical Mechanics, Addison Wesley, New York, 1962.*
12. *J.D. Jackson, Classical Relativity, Springer-Verlag, 1977.*
13. *J.G. Taylor, Special Theory of Relativity.*

PAPER XII: THEORY OF MODULES & THEORY OF OPTIMIZATION

Note: Five questions to be attempted. Question # 1 is compulsory; Select 2 questions from each section.

QUESTION # 1 (1/9)

e) Five short answers, Each question carries two marks
f) Ten Column matching, each carries one mark.

SECTION 1 (4/9)

Definition and examples, Sub modules, Homeomorphisms and quotient modules. Direct sums of modules. Finitely Generated modules. Torsion Modules. Free modules. Basis, Rank and endomorphism of free modules. Matrices over Rings and their connections with the basis of free modules. A module. A Module as the direct sum of a free and a torsion module. Exact sequence and elementary notions of homological algebra. Noetherian and modules, Radicals, Semi simple rings and modules.

SECTION 2 (4/9)

Introduction to optimization. Relative and Asolute extreme. Convex. Concave and unimodal functions Constants. Mathematical programming Problems. Optimization of one, two and several variables functions and necessary and sufficient conditions for their optima.

OPTIMIZATION BY EQUALITY CONSTRAINTS

Direct substitution method and Lagrange multiplier method, necessary and sufficient conditions for an equality-constrained optimum with bounded independent variables. Inequality constraints and Lagrange multipliers. Kuhn-Tucker Theorem. Multidimensional optimization by Gradient method. Convex and concave programming. Calculus of variation and Euler Lagrange equations, Functions depending on several independent variable. Variational Problems in parametric form. Generalized mathematical formulation of dynamics Programming. Non-Linear Continuous models dynamics Programming and Variational Calculus. Control Theory.

BOOKS RECOMMENDED

1. T.S. Blyth, Module theory, Oxford University Press, 1977.
2. B. Harley, and Hawkes, T.O.Rings, Modules and Linear Algebra, Chapman and Hall,1980.
3. I.N. Herstein, I.N.Topics in Algebra, John Wiley and Sons, 1975.
4. B.S Gotfried and Weismn, J. Introduction to optimization theory (Prentice.Inc. New Jersey,1973.
5. L. Elsgolts, Differential Equations and the Calculus of variations (Mir Publishers-Moscow, 1970.
6. D.A Wismer and chattergy R. Introduction to Nonlinear Optimization (North –Holland, New York, 1978.

Paper XIII: QUANTUM MECHANICS

Note: Five questions to be attempted. Question # 1 is compulsory; Select 2 questions from each section.

QUESTION # 1   (1/9)

g) Five short answers, Each question carries two marks
h) Ten Column matching, each carries one mark.

SECTION 1   (4/9)

Inadequacy of Classical Mechanics

Black body radiation, photoelectric effect, Compton effect, Bohr's theory of atomic structure, Wave-particle duality, the de Broglie Postulate.

The Uncertainty Principle

Uncertainty of Position and momentum, Statement and proof of the uncertainty principle. Energy-time uncertainty. Eigenvalues and eigenfunctions, Operators and eigenfuntions, Linear Operators, Operator formalism in Quantum Machanics, Orthonormal Systems, Hermitian operators and their properties. Simultaneous eigenfunctions. Parity operators, Postulates of quantum mechanics, the Schrödinger wave equation.

SECTION 2   (4/9)

Motion in one dimension

Step potential, potential barrier, Potential well Oscillator, Motion in three dimensions, Angular momentum, commulation relations of between components of angular momentum, and their representation in spherical polar coordinates, simultaneous eigenfuncations of L_z and L_2. Spherically symmetric potential and the hydrogen atom.

Scattering Theory

The scattering cross-section, scattering amplitude, scattering equation. Born approximation, Partial wave analysis.

Perturbation theory

Time independent perturbation of non-degenerate and degenerate cases. Time-dependent Perturbation.

Identical Particles Symmetric and antisymmetric eigenfunctions. The Pauli Exclusion Principle.

BOOKS RECOMMENDED:

1. J.G. Taylor, Quantum Mechanics, George Allen and Unwin, 1970.
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