

GC UNIVERSITY, FAISALABAD



Scheme of Studies

BS Honors in Mathematics

8 Semesters / 4 years Degree Program
for the year 2012 and onwards

Department of Mathematics

Scheme of Studies

BS Honors in Mathematics

Semester 1

Course Code	Course Title	Credit Hours
ISL-302	Islamic Studies	2(2-0)
ENG-321	English-I	3(3-0)
MTH-301	Calculus-I	4(4-0)
MTH-303	Mathematical Method-I	4(4-0)
PHY-325	Physics-I	4(3-1)

Semester 2

Course Code	Course Title	Credit Hours
PST-322	Pakistan Studies	2(2-0)
ENG-322	English-II	3(3-0)
STT-322	Statistics-I	4(4-0)
MTH-302	Calculus-II	4(4-0)
MTH-304	Mathematical Method-II	4(4-0)

Semester 3

Course Code	Course Title	Credit Hours
MTH-401	Vector Calculus	2(2-0)
MTH-403	Mechanics I	4(4-0)
MTH-405	Mechanics II	4(4-0)
STT-421	Statistics-II	3(3-0)
PHY-425	Physics-II	3(3-0)

Semester 4

Course Code	Course Title	Credit Hours
MTH-402	Metric and Topological Spaces	4(4-0)
MTH-404	Differential Equations	4(4-0)
MTH-406	Numerical Analysis	2(2-0)
MTH-408	Operations Research	2(2-0)
CSI-422	C++	4 (4-0)

Semester 5

Course Code	Course Title	Credit Hours
MTH-501	Real Analysis I	4(4-0)
MTH-503	Complex Analysis	4(4-0)
MTH-505	Vector and Tensor Analysis	4(4-0)
MTH-507	Algebra-I	4(4-0)
MTH-509	Point Set Topology	4(4-0)

Semester 6

Course Code	Course Title	Credit Hours
MTH-502	Real Analysis-II	4(4-0)
MTH-504	Algebra-II	4(4-0)
MTH-506	Mechanics	4(4-0)
MTH-508	Functional Analysis	4(4-0)
MTH-510	Differential Geometry	4(4-0)

Semester 7

PURE MTHEMATICS

Course Code	Course Title	Credit Hours
MTH-601	Advanced Group Theory	4(4-0)
MTH-603	Advanced Set Theory	4(4-0)
Optional Paper (3 out of Following)		
MTH-605	Mathematical Statistics-I	4(4-0)
MTH-607	Continuous Groups	4(4-0)
MTH-609	Theory of Modules	4(4-0)
MTH-611	Algebraic Topology	4(4-0)
MTH-613	Advanced Topology	4(4-0)
MTH-615	Numerical Analysis-I	4(4-0)
MTH-617	Linear Algebra	4(4-0)
MTH-619	Rings and Fields	4(4-0)

APPLIED MTHEMATICS

Course Code	Course Title	Credit Hours
MTH-621	Fluid Mechanics-I	4(4-0)
MTH-623	Advanced Mathematical Methods	4(4-0)
Optional Paper (3 out of Following)		
MTH-605	Mathematical Statistics-I	4(4-0)
MTH-625	Special Theory of Relativity	4(4-0)
MTH-627	Operations Research	4(4-0)
MTH-629	Quantum Mechanics	4(4-0)
MTH-631	Soft Ware Engineering	4(4-0)
MTH-615	Numerical Analysis-I	4(4-0)

Semester 8

PURE MTHEMATICS

Course Code	Course Title	Credit Hours
MTH-602	Measure Theory	4(4-0)
MTH-604	Advanced Functional Analysis	4(4-0)
Optional Paper (2 out of Following)		
MTH-606	Rings & Modules	4(4-0)
MTH-608	Theory of Numbers	4(4-0)
MTH-610	Mathematical Statistics-II	4(4-0)
MTH-612	Numerical Analysis-II	4(4-0)
MTH-614	Special Functions	4(4-0)
MTH-616	Theory of Optimization	4(4-0)
MTH-628	Project	4(4-0)

APPLIED MTHEMATICS

Course Code	Course Title	Credit Hours
MTH-618	Fluid Mechanics-II	4(4-0)
MTH-620	Partial Differential Equations	4(4-0)
Optional Paper (2 out of Following)		
MTH-622	Theory of Elasticity	4(4-0)
MTH-624	Electromagnetism	4(4-0)
MTH-610	Mathematical Statistics-II	4(4-0)
MTH-612	Numerical Analysis-II	4(4-0)
MTH-614	Special Functions	4(4-0)
MTH-616	Theory of Optimization	4(4-0)
MTH-628	Project	4(4-0)
MTH-626	C ++	4(4-0)

The Project of BS (H) Mathematics will be offered as an optional paper to not more than 50 % of the class strength and only to those who obtain at least 65 % marks on the basis of their performance in V & VI Semesters.

Course Number	Title	Credit Hours	Marks
ISL-302	Islamic Studies	2(2-0)	40

Course Number	Title	Credit Hours	Marks
ENG-321	English-I	3(3-0)	60

ENGLISH-I**MID EXAM**

Sentence, Article, Auxiliary Verbs, Moods of verb, Tenses, Parts of speech, Types of sentences, Sentence *Structure* (Subject + Predicate), Phrase, Clause, Infinitives, Sequence of Sentences, Transitive and Intransitive verb.

FINAL EXAM

Conditional Sentences, Comprehensive, Précis, Translation (U to E), Tenses, Letters, Application (For Jobs)

RECOMMENDED BOOKS

A.J. Thomson and A.V. Martinet, *A Practical English Grammar*, Oxford University Press

A.J. Thomson and A.V. Martinet, *Exercise Book I*, Oxford University Press.

Course Number	Title	Credit Hours	Marks
MTH-301	Calculus-I	4(4-0)	80

CALCULUS-I

The Real Number System. Axiom of Addition, Subtraction and Multiplication. Existence of Irrational Numbers. The Order Properties of R. Absolute Value of a Real Number. The Real Line Inequalities. Functions Limits of Functions, Continuity and Derivability. Notation and Geometrical Interpretation of the Derivative, Derivatives of Trigonometric, Inverse Trigonometric, Logarithmic, Exponential, Hyperbolic, Inverse Hyperbolic and Implicit Functions, Approximation, Related Rates, Higher Derivates, Leibniz Theorem and its Application, Rolle's Theorem, Mean Value Theorem, Maclurin's and Taylor's Expansion series with application. Cauchy's Mean Value Theorem their Geometrical Interpretation. Increasing and Decreasing Functions. Indeterminate forms. Anti-Derivates, Integration by Substitution, Integration by Parts. Integration of Rational, Irrational and Trigonometric Functions. The Definite Integrals and their Properties. Improper Integrals. Reduction Formulas

RECOMMENDED BOOKS

George B. Thomas, *Calculus and Analytic Geometry*.

Spiegel M. P; *Advance Calculus New York*. Mc Graw Hill Book Company

Dr. S. M. Yousaf and Muhammad Amin Ch, *Calculus with Analytic Geometry* Ilmi Kitab Khana Urdu Bazar Lahore.

Course Number	Title	Credit Hours	Marks
MTH-303	Mathematical Method-I	4(4-0)	80

MATHEMATICAL METHOD-I

Complex Numbers, Addition, Multiplication, Modulus, Conjugate and Argument of a Complex Number, the Argand's Diagram, Polar Form of A Complex Number, DeMoivre's Theorem and its Application, Exponential, Trigonometric, hyperbolic, Logarithmic, Inverse Hyperbolic and Inverse Trigonometric Functions. Complex Powers, Simple case of Summation of Series. Algebra of Matrices. Inverse of a Matrix. Elementary Row and Column operations. System of Linear Equations. Gaussian and Gauss Jordan Elimination Methods. Consistency Criterion. Determinant of Square Matrices Properties of Determinants. Determinate of the Transpose Matrix Sequences, Basic Theorems on sequences, Infinite series P-Test, the divergence Test, The Basis Comparison Test, The Integral Test, The Cauchy's Root test. The D'e Alembert Ratio Test, Alternating series, Absolute and conditional Convergence. Convergence of Power Series. Differentiation, Integration, Addition and Multiplication Power Series.

RECOMMENDED BOOKS

Murphy R. Spegal *Complex Variables* Mc. Graw-Hill book Company New York.

Aitken A.C Determinant and Matrices Edinburgh: Olevier and Boyd.

Spiegel M.R; *Advance Calculus* Mc Graw-Hill Book Company New York,

S.M. Yousaf and M. Amin, *Mathematical Methods*, Ilmi Kitab Khana latest edition Urdu Bazar Lahore.

Course Number	Title	Credit Hours	Marks
PHY-325	Physics-I	4(3-1)	80

PHYSICS-I

VECTOR ANALYSIS: Vector Operations, Gradient of a Scalar field, Divergence of a vector field, Curl of a vector Field, Divergence theorem, Stoke's theorem.

Suggested Level: Ch # 1 of Mechanics by Tirmizi, 2nd Edition

SOUND WAVES: Wave motion and Sound with Beats, Doppler Effect and its application

Suggested Level: Ch # 1 of Wave & Oscillation by Dr. Tahir Hussain T.I New Edition

FLUID DYNAMICS: Bernoulli's Equations, Applications, of Bernoulli's Equation,

Suggested Level: Ch # 15 of Physics by R.H.K, 4th Edition

WORK AND ENERGY: Introduction, Work-Energy Theorem,

Suggested Level: Ch # 11 of Physics by R.H.K, 4th Edition

ELECTROMAGNETIC SPECTRUM: Radio waves, Microwaves (terrestrial Microwaves & Satellite Microwave)

Suggested Level: Ch # 41 of Physics by R.H.K, 4th Edition

LASER: Principal of Laser, Characteristics and use of laser

Suggested Level: Ch # 52 of Physics by R.H.K, 4th Edition

FIBER OPTICS: Principals and working of fiber optic, Advantages and Disadvantages, Computer Networks and Fiber Optic
Suggested Level: Ch # 42 of Physics by R.H.K, 4th Edition

Course Number	Title	Credit Hours	Marks
PST-322	Pakistan Studies	2(2-0)	40

PAKISTAN STUDIES

The main objective of this paper is to familiarize the students with the freedom movement, Pakistan history and the foreign policy of Pakistan

Alighrah movement with special reference to its Educational and Political Activities, Formation of Muslim League and its role in the creation of Pakistan, Khilafat Movement and its impact upon the political culture of the sub-continent, Comparative study of Nehru Report and 14 points of Jinnah, Iqbal's Allahabad Address, and its Significance, A brief overview of constitutional development in Pakistan, Pakistan Resolution and the creation of Pakistan, Quaid-i-Azam, as a political leader and founder of Pakistan, Pakistan's geo-strategic position and its importance, Constitutional development in Pakistan: A brief analysis, Pakistan's political culture and problems of democracy, Human rights in Pakistan, Major determinants of the foreign policy of Pakistan

RECOMMENDED BOOKS

M Ikram Rabbani, *Pakistan Studies*

M Ikram Rabbani, *Current Affairs*

Ahmed Saeed, *Track to Pakistan*

Safdar Mahmood, *Political Roots and Development*

Waheed-uz-Zaman, *Towards Pakistan*

Dr. M Imtiaz Shahid, *An advance study in Pakistan Affairs.*

Course Number	Title	Credit Hours	Marks
ENG-322	English-II	3(3-0)	60

Course Number	Title	Credit Hours	Marks
STAT-322	Statistics-I	4(4-0)	80

STATISTICS

Meanings of Statistics, Main branches of Statistics (Theoretical and Applied), Meanings of Descriptive and Inferential Statistics, Population and Sample, Types of Variables, Measurement Scales. Sources of statistical data in Pakistan. Description of data by frequency Tables and Graphs. Stem and Leaf display and Box Plots.

Measures of central tendency: Arithmetic Mean, Geometric Mean, Harmonic Mean, Mode, Median and Quantiles. Properties of Arithmetic mean with proofs. Weighted arithmetic mean. Empirical Relation between Mean, Median and Mode. Relative Merits and Demerits of Various Averages.

Measures of Dispersion. Absolute and Relative Measures, Range, Semi-inter Quartile Range, Mean Deviation, Variance, Standard Deviation. Coefficient of Variation. Coefficient of Mean Deviation, Coefficient of Quartile Deviations, Properties of Variance and Standard Deviation with Proofs. Standardized Variables, Moments, Moment Ratios, Sheppard's Correction, Kurtosis and Skewness.

RECOMMENDED BOOKS

Wonnacott, T.H and Wannacott, R.J (1990). *Introductory Statistics*. Jhon Wily & Sons. New York.

Walpole, R.E (2001). *Introduction to Statistics*. Macmillan Publishing Company.

Rauf, M (2001). *Polymers Modern Statistics*. Polymer Publication, Urdu Bazar, Lahore.

Chaudhray, S.M and Kamal, S. (2002). *Introduction to Statistical Theory*. Ilmi Kitab Khana, Urdu Bazar, Lahore.

Mood, A.M. Gray-bill, F.A. Boes, D.C. Introduction to the theory of statistics (2nd edition) 1986, McGraw-Hill book company New York.

Course Number	Title	Credit Hours	Marks
MTH-302	Calculus-II	4(4-0)	80

CALCULUS-II

General Conics, Tangents and Normal, Polar Coordinates Conic in Polar Coordinates, Relationship between Rectangular and polar system. Simple curve tracing, in polar and Cartesian coordinates. Tangents and Normal in Cartesian and polar Coordinates, Parametric representation of Curve. Asymptotes (Rectangular and polar Curves) Maxima, Minima, Singular points (Node, Cups, Isolated pts), Quadrature, Lengths of Arcs, Intrinsic Equations, Curvature, Circle of Curvature, Envelopes and Evolutes, Straight Line in R^3 Angle between two Straight lines, Distance of a pt. form a line, Equations for planes. Angle between two planes Straight Lines and Planes. Shortest Distance between two Straight Lines. Functions of several Variables partial Derivatives. Homogeneous Functions, Differentials, tangent Plane and the Normal Line. Exterma of Functions of two Variables. Double Integrals, Triple integrals Area and volume by double integrals, Volume and Area of Surface of Revaluation.

RECOMMENDED BOOKS

George B. Thomas, Calculus And Analytic Geometry

Spiegel M.R; *Advance Calculus* Mc Graw Hill Book Company New York.

S.M. Yusuf and M. Amin, *Calculus with Analytic Geometry*, Ilmi Kitab Khana Urdu Bazar Lahore.

Course Number	Title	Credit Hours	Marks
MTH-304	Mathematical Method-II	4(4-0)	80

MATHEMATICAL METHOD-II

Groupoid, Semi Group, Groups, Properties of Groups, order of Group, Order of an element, Subgroups, Cyclic Groups, Cyclic Subgroup, Cossets and Lagrange's Theorem. Permutations, Cycles, Transpositions, Order of a permutation, Introduction of Rings and Fields. Definition, Example and Elementary Properties of a vector space, Subspaces, Linear Combination, Linear Dependence, Basis of Vector spaces. Linear Transformation. Matrix of Linear Transformation. Inner Product Spaces (Definition and Example) Orthogonality, Orthogonal Matrices, Eigen Values and Eigen Vectors, Similar Matrices, Digitalization of Matrices.

RECOMMENDED BOOKS

Murrsy R.Spegal *Complex Variables* Mc. Graw-Hill book Company New York.

Aitken A.C Determinant and Matrices Edinburgh: Olevor and Boyd.

Spiegel M.R; *Advance Calculus* Mc Graw-Hill Book Company New York,

S.M. Yousaf and M. Amin, *Mathematical Methods*, Ilmi Kitab Khana latest edition.

Course Number	Title	Credit Hours	Marks
MTH-401	Vector Calculus	2(2-0)	40

VECTOR CALCULUS

Scalars and vectors. Representation of Vectors. Types of vectors. Addition & Subtraction of Vectors. Properties of vector addition. Multiplication of a Vector by a Scalar. The unit Vectors $i, j,$ and $k.$

Vector or Cross Product of two Vectors. Vectors Area of a Triangle. Product of three Vectors. Geometrical Interpretation of Scalar Triple Product, Condition for four points to be Coplanar. Vector Triple Product, Scalar and vector Products of Four Vectors.

Scalar point function, Vector point function, Continuous Function, Differentiation of Vector Function. Geometrical Meaning of $dr/dt.$ Derivative of a vector function in terms of its components. Integration of Vector Functions. Partial Derivatives and Differentials. Differential Operator $\nabla,$ Gradient, Divergence and Curl of a Vector Point Function, Vector Perpendicular to Level Surface. Directional Derivatives.

RECOMMENDED BOOKS

Smith G.D. Vector Analysis Oxford University Press, Oxford.

Spiegel M. R, Vector Analysis 1974, McGraw Hill New York.

Dr. Munawar Hussain *Elementary Vector Analysis*, 5th Edition 2006, Caravan Book House Lahore.

Dr. Nawazish Ali Shah, *Vector and Tensor Analysis*, A-One Publishers Lahore.

Dr. S. M. Yousaf *Vector Analysis* Ilmi Kitab Khana Urdu Bazar Lahore.

Course Number	Title	Credit Hours	Marks
MTH-403	Mechanics-I	4(4-0)	80

MECHANICS-I

Components of Force. Composition of Concurrent forces, the (λ, μ) Theorem Equilibrium of a Particle. Moment of a force about a point. Varignon's Theorem. Couples. Equivalent Couples. Composition of Couples Resolution of a Force into a force and a couple. Resolution of a system of Force into a force and a couple. Resolution of a system of Parallel Force Condition of Equilibrium of Coplanar force system. Types of forces. Direction of Forces of Constraints. Equilibrium of 3 coplanar forces. Laws of Friction, Cone of Friction. Role of Friction. Equilibrium of a Particle on a rough inclined plane. Equilibrium of a particle on a rough Horizontal Plane. Definition of Virtual Work Applied Forces and Forces of Constraints. Virtual Displacement and virtual Work. Workless constraints Principle of Virtual Work, for Single particle, set of Particles and for a Rigid Body.

BOOKS RECOMMENDED

Syngé & Griffith, *Principles of Mechanics*, McGraw Hill Book Company Inc., New York.

D.T. Greenwood, *Principles of Dynamics*, Prentice Hall, Inc.

W. Huser, Introduction to Principles of Mechanics, Addison Wesley, New York.

R.A Becker, *Introduction to Theoretical Mechanics*, McGraw Hill Book Company, Inc., New York.

F. Chorlton, A Text Book of Dynamics.
 K .L. Mir, *Theoretical Mechanics* Ilmi Kitab Khana.

Course Number	Title	Credit Hours	Marks
MTH-405	Mechanics-II	4(4-0)	80

MECHANICS-II

Velocity and Acceleration. Cartesian components of velocity and acceleration. Tangential and Normal Components of Velocity and Acceleration. Transverse and Radial Components of Velocity and Acceleration. Motion with constant Acceleration. Motion with Variable Acceleration. Graphical Methods. Motion of a Free Particle along the vertical Line, Simple Harmonic Motion. The Nature of Simple Harmonic Motion. Geometrical Representation. Speed of the Projectile Parabola of Safety. Range on the Inclined Plane. Maximum range on horizontal and Inclined Plane. Time Period, Maximum Height. Motion under a Central Force. Elliptic Orbit Under a central force. Polar form of the orbit. Apse and apsidal distance. Planetary orbits. Kepler's Laws. Damped Harmonic Oscillator, Damped force oscillations, Vertical motion with air Resistance

RECOMMENDED BOOKS

Synge & Griffith, *Principles of Mechanics*, McGraw Hill Book Company Inc., New York.
 D.T. Greenwood, *Principles of Dynamics*, Prentice Hall, Inc.
 W. Huser, Introduction to Principles of Mechanics, Addison Wesley, New York.
 R.A Becker, *Introduction to Theoretical Mechanics*, McGraw Hill Book Company, Inc., New York.
 F. Chorlton, A Text Book of Dynamics.
 K .L. Mir, *Theoretical Mechanics* Ilmi Kitab Khan

Course Number	Title	Credit Hours	Marks
STT-421	Statistics-II	3(3-0)	60

STATISTICS-II

Introduction of Simple Linear Regression. Scatter Diagram. Simple Linear Regression Model. Assumptions of Linear regression model. Least Squares Estimators. Properties of the Least Square Regression Line. Standard Errors of Estimates.
 Correlation, Pearson's Product Moment Correlation Coefficient with its application in daily life. Properties of Correlation Coefficient, Coefficient of Determination, Correlation Coefficient for group data. Rank Correlation and its properties. Spearman's Rank Correlation Coefficient and its derivation. Tied ranks.
 Multiple Linear Regression with two Regressors, Coefficient of Multiple Determination, Standard Error of Estimate. Coefficient of Partial and Multiple Correlations. Relation between Partial and Multiple Correlation Coefficients.

Curve Fitting by Method of Least Squares. Fitting a straight line, fitting of a Second and third degree Parabola, Change of Origin and Unit, Exponential Curves, Criteria for a Suitable Curve, Finding Plausible Values by LS Method.

BOOKS RECOMMENDED

Wonnacott, T.H and Wannacott, R.J (1990). *Introductory Statistics*. Jhon Wily & Sons. New York.

Walpole, R.E (2001). *Introduction to Statistics*. Macmillan Publishing Company.

Rauf, M (2001). *Polymers Modern Statistics*. Polymer Publication, Urdu Bazar, Lahore.

Chaudhray, S.M and Kamal, S. (2002). *Introduction to Statistical Theory*. Ilmi Kitab Khana, Urdu Bazar, Lahore.

Course Number	Title	Credit Hours	Marks
PHY-425	Physics-II	3(3-0)	40

PHYSICS-II

Coulomb’s law. Electric field with different charges. Electric flux. Gauss’s law and its applications. Magnetic field. Magnetic flux. Faraday’s law and its applications. Biot-Savart law and its applications. Ampere’s circuit law and its applications. Electromagnetic inductions. Motional electromotive force. Self-inductance with solenoid and toroid. Growth and Decay of current, in an (R-l and R-C) series circuit. Electromagnetic oscillators. (A-C and D-C) voltage applied to “inductors and capacitors) Phaser concept. A sinusoidal voltage applied to an (L-R, R-C, R-l-C) series circuits. Frequency response of (R-L-C) series circuits. Semi conductors with (P-Type and N-Type) material. Pn-Junction. Resistance. Capacitance. Inductance. Diodes. Rectifiers. Multi-vibrators. Logic-gates. Generators. Motors. Transformers.

Course Number	Title	Credit Hours	Marks
MTH-402	Metric and Topological Spaces	4(4-0)	80

METRIC AND TOPOLOGICAL SPACES

Distance in R^2 metric, definition of metric and metric space, examples, balls, diameters, open & closed ball, open set & close set. interior points and interior of a set, exterior points and exterior of a set, closure of a subset, limit points, neighborhood points, boundary points, sequences and their convergence complete space,

Basic notions of set theory, set operations, extended set operations and indexed families of sets. relations, equivalence relations, partition, ordering relations, function as relations, topological spaces; subspaces and relative topology, open sets, closed sets, neighborhood, interior, exterior boundary and limit points, base and sub base.

RECOMMENDED BOOKS

G.F. Simon, *Introduction to Topology and Modern Analysis*, 1963, McGraw Hill Book Company, New York.

J. Willard, *General Topology*, Addison-Wesley Publishing Company, London.

E. Kreyszig, *Introduction to Functional Analysis with Applications*, 1978, John Wiley and Sons.

W. Rudin, *Functional Analysis*, McGraw Hill Book Company, New York.

N. Dunford and J. Schwartz, *Linear Operators (Part-I General Theory)*, Interscience Publishers, New York.

Course Number	Title	Credit Hours	Marks
MTH-404	Differential Equations	4(4-0)	80

DIFFERENTIAL EQUATIONS

Differential Equations and their classification, Formation of Differential Equations, Initial values and boundary values Problem, Separation of Variables. Homogenous Differential Equations, Exact Differential Equations, Differential equations reduceable to homogenous form, Linear Differential Equations of 1st Order, Bernonlli's Equations. Orthogonal Trajectories, Homogenous linear equations, Non-Homogenous Differential Equations with constant Coefficient, D & Inverse D^{-1} , Operators, General & Particular Integrals. Cauchy-Eluer's equations, Reduction of order, Method of Variation of Parameter's, Exact Linear Equations, System of Linear Differential Equations, Power Series Solutions of first order Differential Equations. Laplace and Inverse Transformations with simple Application to Differential Equation.

RECOMMENDED BOOKS

Zill D G, Cullen M.R. *Differential Equations with Boundary-Value Problems* (3rd Edition), 1997, PWS Publishing Co.

Eisgolts L, *Differential Equations and the Calculus of Variations*, 1970, Mir Publishers Moscow.

Jerri A.J *Introduction to Integral Equations with Applications*, 1985, Marcel Dibber New York.

Muhammad Amin, *Mathematical Methods*, 2007, Ilmi Kitab Khana Lahore.

Course Number	Title	Credit Hours	Marks
MTH-406	Numerical Analysis	2(2-0)	40

NUMERICAL ANALYSIS

Introduction, Computation 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-Raphson and fixed point methods, acceleration of convergence by Aitken method, solution of system of linear equation 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 methods, Bessel and Stirling method with error analysis, Lagrange Interpolation and Newton divided differences formula with error analysis.

RECOMMENDED BOOKS

Robert-W. Horn *Numerical Methods*.

Alestairs Wood *Introduction to Numerical Analysis*.

M. Iqbal *Numerical Analysis* Nation Book of Foundation

S.A. Bhatti, N. A Bhatti, *Numerical Methods*.

Ch. Muhammad Saleem *Numerical Analysis*.

Course Number	Title	Credit Hours	Marks
MTH-408	Operations Research	2(2-0)	40

OPERATIONAL RESEARCH

Introduction, Brief History, Optimization Techniques, System models and Modeling, Classification of OR Models, Phases of an OR study. Hungarian Method (Assignment Problem). Transportation Problem. Classification of Mathematical Programming. Linear Programming (LP), Formulation of LP problems. Simplex Method, The M-Method and the Two phase Technique for starting Optimization. Duality and Sensitivity Analysis, Critical Path Method (CPM), Program Evaluation and review Technique (PERT).

RECOMMENDED BOOK

Hamdy A Taha *An Introduction to Operations Research* Macmillan Publishing Company Inc, New York, 1987.

S Kalavathy *Operations Research* Vikas Publishing House (P) Ltd.

F. S Hiller and G. J Liebraman, *Operational Research* CBS Publisher and distributors, New Delhi, 1974.

C. M Harvey, *Operation Research*, North Holland, New Delhi

Prof. Sr. Saeed Akhtar Bhatti *Operations Research: An Introduction*

Krajewsky and Ritzman *Operations Management Strategy and Analysis*.

Course Number	Title	Credit Hours	Marks
CSI-422	C++	4(4-0)	80

C++

History of Computer Languages, Building Blocks of C++. Control Structures. Functions, Arrays, Pointers, Strings, Object Oriented Concepts e.g. Operator Over loading, Inheritance, Overriding, Polymorphism & Virtual Functions. Introduction to Java.

RECOMMENDED BOOKS

Herbet Schildt, *Turbo C/C++*

Eric P. Bloom, *The Turbo C++*

Robert Lafore, *Turbo C*

Deitel & Deitel *C++ How to Programme*

Course Number	Title	Credit Hours	Marks
MTH-501	Real Analysis -I	4(4-0)	80

REAL ANALYSIS-I

Algebraic and ordered properties of Real Numbers, Absolute values, Inequalities (Cauchy's, Minkowski's, Bernoulli's) Properties and concepts of supremum and infimum, Ordered sets, Fields, Field of Real, The extended real number system, Euclidean spaces, Sequences, Subsequences, Cauchy sequence, Series of Numbers and their convergence. The Comparison, Root, Ratio and Integral tests. Absolute and Conditional convergence of infinite series. Limits and Continuity. Properties of continuous functions. Types of discontinuities. Differentiable functions. Mean-value theorems, Continuity of derivatives. Partial Derivatives and Differentiability. Derivative and differentials of Composite functions. The Directional Derivative, the Laplacian in polar cylindrical and Spherical coordinates.

BOOKS RECOMMENDED

- Bartle R G and Sherbert DR, *Introduction to Real Analysis*, 1999 John Wiley New York.
 Rudin W. *Principles of Mathematics Analysis*, 1986 McGraw-Hill New York.
 Brabence RL *Introduction to Real Analysis*, 1997 PWS Publishing Company.
 Gaughan ED. *Introduction to Analysis (5th Edition)* 1997 Brooks/Cole
 Kaplan W. *Advance Calculus* 1984 Addison-Wesley publishing Company.

Course Number	Title	Credit Hours	Marks
MTH-503	Complex Analysis	4(4-0)	80

COMPLEX ANALYSIS

Analytic functions, Cauchy-Riemann equations. Power series, Radius of convergence. Cauchy's theorem. Cauchy'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. Application of calculus of residues to infinite products. Conformal transformations and their applications.

BOOKS RECOMMENDED

- L. Pennisi, L. Gordon, and S. Lasher, *Elements of Complex Variables*, Holt Rinehart and Winston.
 R.Churchill, *Complex Variables and Application* (1996). McGraw Hill.
 R.A.Silverman, *Complex Analysis with Applications*, Prentice Hall, Englewood Cliffs, N.Jersey.
 J. Paliouras, *Complex Variables for Scientists and Engineers* McMillan
 H.R.Chillingworth, *Complex Variables*, Pergamon Press, Oxford.
 L.V. Ahlfors, *Complex Analysis* McGraw Hill.
 M. Iqbal, *Complex Analysis* (1996). Ilmi Kitab Khana.
 K. Kodaira, *Introduction to Complex Analysis*, Cambridge.
 S. Lang, *Complex Analysis*. 4th Edition, 2001, Springer.

Course Number	Title	Credit Hours	Marks
MTH-505	Vector & Tensor Analysis	4(4-0)	80

VECTOR AND TENSOR**VECTOR ANALYSIS**

Curvilinear Coordinates, Scale Factors, Arc length, Area and volume in curvilinear coordinates. Spherical and Cylindrical coordinates, Expansion formulas of Gradient, Divergence and Curl of point in curvilinear coordinate, Relation between orthogonal bases, Curvilinear Coordinates, Spherical and cylindrical coordinates and their applications, Line, Surface and volume integral. Gauss's, Green's and Stokes theorem with their application.

CARTESIAN TENSORS

Cartesian Tensor, Law of transformation, from one coordinates system to another coordinates system. Algebra of Tensor, Sum, Difference, Quotient, Inner product, Contraction, Contraction theorem with their application, Symmetric Tensor and Skew Symmetric Tensor, Kronecker Tensor and Levi Civita Tensor, Relation between these Tensors, Isotropic Tensor, First and Second order Differential Operators in Tensor. Application of Tensors in Vector Analysis, Proof of Expansions formulae using tensor formalism.

BOOKS RECOMMENDED

H. Jeffrey, *Cartesian Tensors*, Cambridge University Press.

F. Charlton, *Vector and Tensor Methods*, Ellis Harwood. Publisher, Chichester, U.K. 1997.

Schaum Series Vector and Tensor Analysis Mc Graw Hill Company.

K. L. Mir *Vector and Tensor Analysis* Ilmi Kitab Khana.

Dr. Nawzish Ali Shah Vector and Tensor Analysis

Course Number	Title	Credit Hours	Marks
MTH-507	Algebra-I	4(4-0)	80

ALGEBRA –I

Groups and subgroups. Generators and relations. Cyclic group, Cosets and Lagrange's theorem. Normalizers and centralizers. Center of a group. Subgroups. Factor groups, Isomorphism theorems and automorphisms. Commutators. Permutation groups and Cayley's theorem, Introduction to Rings, Types of Rings, Integral domains. Field and its characteristic.

BOOKS RECOMMENDED

I.D. Macdonald, *Theory of Groups* Oxford University Press

I.N., Herstein, *Topics in Algebra*, Addison-Wesley.

J.B, Fraleigh, *Abstract Algebra*. Addison-Wesley.

K.H. Dar, First Step to Abstract Algebra, (2nd edition 1998). Feroz Sons, 1998.

J.T. Scheik, *Linear Algebra with Applications*, 1997, McGraw Hill.

A Majeed, *Theory of groups*, Ilmi Kitab Khana.

Q. Mushtaq, *A course in Group Theory*, (1993). University Grants Commission, Islamabad.

Course Number	Title	Credit Hours	Marks
MTH-509	Point set Topology	4(4-0)	80

POINT SET TOPOLOGY

Set, countable and uncountable sets, partially and totally ordered sets and lattices with examples, axiom of choice. 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 , $T_3^{1/2}$, T_4 , spaces, regular and normal spaces, connectedness various characterizations of connectedness, local connectedness, components, open covers, compact spaces and their characterization, continuity, uniform continuity and their relationship with compactness in metric spaces, limit points sequential compactness. equivalence of different notions of compactness.

BOOKS RECOMMENDED

G.F. Simon, *Introduction to Topology and Modern Analysis*, 1963, McGraw Hill Book Company, New York.

J. Willard, *General Topology*, Addison-Wesley Publishing Company, London.

E. Kreyszig, *Introduction to Functional Analysis with Applications*, 1978, John Wiley and Sons.

W. Rudin, *Functional Analysis*, McGraw Hill Book Company, New York.

N. Dunford and J. Schwartz, *Linear Operators (Part-I General Theory)*, Interscience Publishers, New York.

A. Majeed, *Elements of Topology and Functional Analysis*, Ilmi Kitab Khana Lahore

Course Number	Title	Credit Hours	Marks
MTH-502	Real Analysis - II	4(4-0)	80

REAL ANALYSIS-II

The Riemann – Stieltjes (R-S) Integrals. Properties of R-S integrals. Functions of bounded variations. 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. Implicit functions, Jacobians, Functional dependence. Taylor's theorem for a function of two variables. Maxmima and minima of functions of two and three variables. Method of Lagrange Multipliers.

Book Recommended

Bartle RG Sherbert DR, *Introduction to Real Analysis (3rd edition)* 1999, John Wiley New York.

Rudin W. *Principles of Mathematics Analysis (3rd edition)* 1986, McGraw-Hill New York.

Brabence RL *Introduction to Real Analysis*, 1997, PWS Publishing Company.

Gaughan ED. *Introduction to Analysis (5th edition)* 1997, Books/Cole.

Kaplan W. *Advance Calculus (3rd edition)* 1984 Addison-Wesley publishing Company.

Apostol, *Mathematical Analysis 6th* Prenteng Addison-Wesley Publishing Company.

Course Number	Title	Credit Hours	Marks
MTH-504	Algebra-II	4(4-0)	80

ALGEBRA –II

Review of elementary concepts of vector spaces. Linear dependence and independence of vectors. Vector spaces and subspaces. Quotient spaces. Direct sum of spaces. Linear transformation. Rank and Nullity of linear transformations. Algebra of linear transformations and representation of linear transformations as matrices. Change of bases. Linear functional. Dual spaces and Annihilators. Eigenvectors, eigenvalues and Cayley–Hamilton theorem. Diagonalization of Matrices. Inner product spaces. Bilinear, quadratic and Hermit forms.

BOOKS RECOMMENDED

- A.M., Tropper, *Linear algebra*, Thomas Nelson & Sons.
 S. Lang, *Linear Algebra*, Addison-Wesley.
 K.R. Hoffman, and Kunze, R., *Linear Algebra* Prentice –Hall.
 I. N., Herstein, *Topics in Algebra*, Addison- Wesley.
 P.R, Halmos, *Finite Dimensional Vector Spaces*, Von Nostrand.
 K.H. Dar, *First Step to Abstract Algebra*, 2nd Edition 1998. Feroze Sons Pvt.
 J.T. Scheick, *Linear Algebra with Applications*, 1997. McGraw Hill.
 P.M. Chon, *Algebra-I and Algebra-II*.

Course Number	Title	Credit Hours	Marks
MTH-506	Mechanics	4(4-0)	80

MECHANICS

General Motion of a rigid body, Euler’s Theorem and Chasles Theorem. Euler’s Angles, Moments and Products of Inertia, Inertia Tensor, Euler’s Principal Axes and Principal Moments of Inertia , Kinetic Energy and Angular Momentum of a Rigid Body, Momental Ellipsoid and Equipomental Systems, Euler’s dynamical Equations and their solution in special cases. Heavy asymmetrical Top, Equilibrium of a Rigid Body, General Conditions of Equilibrium, and Deduction of Conditions in Special Cases.

BOOKS RECOMMENDED

- Synge & Griffith, *Principles of Mechanics*, McGraw Hill Book Company Inc., New York.
 D.T. Greenwood, *Principles of Dynamics*, Prentice Hall, Inc.
 W. Huser, *Introduction to Principles of Mechanics*, Addison Wesley, New York.
 R.A Becker, *Introduction to Theoretical Mechanics*, McGraw Hill Book Company, Inc., New York.
 F. Chorlton, *A Text Book of Dynamics*.
 K .L. Mir, *Theoretical Mechanics* Ilmi Kitab Khana.

Course Number	Title	Credit Hours	Marks
MTH-508	Functional Analysis	4(4-0)	80

FUNCTIONAL ANALYSIS

Metric Spaces Definition & examples, Open and closed sets, Convergences, Cauchy sequence and examples, completeness of a metric space, completeness proofs. Definition and examples of Normed spaces. Banach spaces. Convergence in Normed space. Basis of Normed Space. Convex sets. Quotient spaces. Equivalent Norms. Compact Normed space. Characterization of Banach spaces. Linear operators. Bounded linear operators, Various characterizations of bounded (continuous) Linear operators. The space of all bounded linear operators. Linear Functional and their examples. Dual Space and Reflexive space. Inner product spaces and their examples, The Cauchy-Schwarz inequality. Polarization Identity. Hilbert spaces, Bessel's inequality. Gram-Schmidt orthogonalization Process. Minimizing Vector. Direct Sum of spaces. The Riesz representation theorem. Annihilators and Orthogonal complements. Direct Decomposition.

RECOMMENDED BOOKS

- E. Kreyszig, *Introductory Analysis with Applications*, John Wilsy, 1978.
 J Maddox, *Elements of Functional Analysis*, Cambridge, 1970.
 G.F. Simmon, *Introduction to Topology and Modern Analysis*, McGraw-Hill- N. Y, 1983.
 W. Rudin, *Functional Analysis*, McGraw-Hill. N.Y. 1983.
 A. Majeed, *Elements of Topology and Functional Analysis* Ilmi Kitab Khana Lahore.

Course Number	Title	Credit Hours	Marks
MTH-510	Differential Geometry	4(4-0)	80

DIFFERENTIAL GEOMETRY

The moving trihedron, Arc length; The osculating plane, Curvature and torsion of unit speed and non unit speed curves, Serret-Frenet formulae. Helices, Spherical indicatrices, Evolutes & Involutives. 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 Analysis and geodesic curvature, The second fundamental form, Christoffel symbols. Gauss's theorem Egregium. Mean and Gaussian curvatures, Principal curvatures, Euler's theorem, Dupin's indicatrices. Weingarten Map. Gauss-Codazzi equations.

BOOKS RECOMMENDED

- R. Millman, and G. Parker. *Elements of differential Geometry* Prentice Hall Inc.
 B., O' Neill. *Elementary Differential Geometry*.
 D.J. Struik. *Lectures on Classical Differential Geometry* Addison- Wesley.
 A. Goetz, *Introduction to Differential Geometry* Addison- Wesley.
 F. Chorlton. *Vector and Tensor Methods* Ellis Harwood.

Course Number	Title	Credit Hours	Marks
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MTH-651	Advanced Group Theory	4(4-0)	80
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ADVANCED GROUP THEORY

Introduction to Sets and Structures. Examples of groups. Finite groups. Subgroups. Permutations and cyclic groups. Isomorphism's and Homomorphism with separate reference to Abelian groups. Cosets, Normal groups, Factor groups and Simple groups. Series of group ,s. The Sylow theorems. Groups actions, Free groups and group presentations, Geometric, Analytic and dynamical applications. A brief introduction to continuous groups and group representations.

RECOMMENDED BOOKS

- J.B. Fraleigh, *A First Course in Algebra*, Addison-Wesley 1982.
M. Hamermesh, *Group Theory*, Addisossn-Wesley 1972.
I.N. Herstein, *Topics in Algebra*, John Wiley 1975.

Course Number	Title	Credit Hours	Marks
MTH-653	Advanced Set Theory	4(4-0)	80

ADVANCED SET THEORY

Equivalent sets, Countable and uncountable sets, The concept of cardinal number, Addition and multiplication of cardinals, Cartesian products as sets of function, Addition and multiplication of ordinals. Partially ordered sets axiom of choice, statement of lemma.

BOOKS RECOMMENDED

- Frankal, *Abstract Set Theory*, North-Holland Publishing Company Amsterdam.
Patrick Suppes, *Axiomatic Set Theory*, Dover Publications, Inc., New York.
P.R. Halmos, *Naïve Set Theory*, New York, Van Nostrand.
B.Rotman & G.T. Kneebone, *The Theory of Sets and Transfinite Numbers*, Old bourne London.
P.R. Halmos, *Measure Theory*, Von Nostrand, New York.
W. Rudin, *Real and Complex Analysis*, Mcgraw Hill, New York.
R.G. Bartle, *Theory of Integration*.
H.L. Royden, *Real Analysis*.

Course Number	Title	Credit Hours	Marks
MTH-655	Mathematical Statistics –I	4(4-0)	80

MATHEMATICAL STATISTICS-I

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. Baye's' theorem. Random variables and Discrete

Distributions. Continuous distributions. Probability function and probability density function. The distribution function, Bivariate distributions, Marginal distributions. Conditional distributions. 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.

RECOMMENDED BOOKS

A.M. Mood, Graybill, F.A, Boes, D.C. *Introduction to the Theory of Statistics, 3rd Edition*,(McGraw-Hill Book Company New York, 1974).
 M. H Degroot,. *Probability and Statistics, (2nd edition)*, Addison-Wesley Publishing Company, USA, 1986.
 K.V. Mardia, Kent, J.T. Bibby, J.M. *Multivariate Analysis*. Academic Press New York,1979.

Course Number	Title	Credit Hours	Marks
MTH-607	Continuous Groups	4(4-0)	80

CONTINUOUS GROUPS

Continuous Groups; $Gl(n,r), Gl(n,c), So(p,q), Sp(2n)$; generalities on Continuous Groups; Groups of isometrics; Introduction to Lie groups with special emphasis on matrix Lie groups; Relationship of isometrics and Lie group; Theorem of Cartan; Correspondence of continuous groups with Lie algebras; Classification of groups of low dimensions; Homogeneous spaces and orbit types; Curvature of invariant metrics on Lie groups and homogeneous spaces.

RECOMMENDED BOOKS

Bredon,G.E, *Introduction to compact Transformation groups* Academic Press,- 1972).
 Eisenhart, L.P. *Continuous Groups of Transformations* (Princeton U.P.1933).
 Pontrjagin ,L. S., *Topological groups*.(Princeton University Press, 1939).
 Hussain Taqdir. *Introduction to Topological Groups*.(W.B.Saunders- Company,1966).
 Miller Willard, Jr., *Symmetry groups and their application*;(Academic Press- New York and London 1972).

Course Number	Title	Credit Hours	Marks
MTH-609	Theory of Modules	4(4-0)	80

THEORY OF MODULES

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

sequences and elementary notions of homological algebra. Noetherian and modules, Radicals, Semi simple rings and modules.

BOOKS RECOMMENDED

Blyth, T.S., *Module theory*, Oxford University Press, 1977.

Hartley, B. and Hawkes, T.O. *Rings, Modules and Linear Algebra*, Chapman and Hall, 1980.

Herstein, I.N. *Topics in Algebra*, John Wiley and Sons, 1975.

Adamson, J. *Rings and Modules*.

Course Number	Title	Credit Hours	Marks
MTH-611	Algebraic Topology	4(4-0)	80

ALGEBRAIC TOPOLOGY

Path wise connectedness; Notion of homotopy, Homotopy classes. Path homotopy. Path homotopy classes; Fundamental groups, Covering maps. Covering spaces. Lifting properties of covering spaces, Fundamental group of a circle.

RECOMMENDED BOOKS

Kosniowski, C. *A first course in Algebraic Topology* (Cambridge University Press)

Greenberg, M.J. *Algebraic Topology. A first Course* (Benjamin. 1976).

Wallace, A. H. *Algebraic Topology. Homology and Cohomology*. (Benjamin, 1968).

Course Number	Title	Credit Hours	Marks
MTH-613	Advanced Topology	4(4-00)	80

ADVANCED TOPOLOGY

Compactness in metric spaces, Limit point, Compactness, Sequential compactness and their various characterizations, Equivalence of different notions of compactness. Connectedness, various characterizations of connectedness, Connectedness and T()spaces, Local connectedness, Path-connectedness, Components. Homotopic maps, Homotopic paths, Loop spaces, Fundamental groups, Covering spaces, the lifting theorem, Fundamental groups of the circle () etc. Chain complex, Notion of homology.

RECOMMENDED BOOKS

Greenberg, M.J. *Algebraic Topology, A first Course*, The Benjamin/Commings Publishing Company, 1967.

Wallace, A.H. *Algebraic Topology, Homology and Cohomology*. W.A. Benjamin, Inc New York, 1968.

Gemignani, M.C., *Elementary Topology*, Addison-Wesley Publishing Company, 1972.

Course Number	Title	Credit Hours	Marks
MTH-615	Numerical Analysis-I	4(4-0)	80

NUMERICAL ANALYSIS- I

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- Raphson 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 methods, Bessel and Stirling method with error analysis, Lagrange Interpolation and Newton divided differences formula with error analysis, Interpolation by Spline functions (up to Cubic spline), methods of Least 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 differences formula of interpolation), Gaussian quadrature using a system of orthogonal polynomials (Legendre and Laguerre polynomials).

BOOKS RECOMMENDED

- C. Gerald, *Applied Numerical Analysis*, Addison-Wesley Publishing Company, 1978.
 A. Balfour & W.T. Beveridge, *Basic Numerical Analysis with Fortran*, Heinemann Educational Books Ltd. (1977).
 Shan and Kuo, *Computer Applications of Numerical Methods* (Addison – Wesley) National Book Foundation, (1972), Islamabad.
 R. L. Burden and J. D. Faires, *Brooks /Cole Publishing Company*, New York.

Course Number	Title	Credit Hours	Marks
MTH-617	Linear Algebra	4(4-0)	80

LINEAR ALGEBRA

Review of elementary concepts of Vector spaces. Linear dependence and Independence of vectors. Vector spaces and subspaces. Quotient spaces. Direct sum of spaces. Linear transformation. Rank and Nullity of linear transformations. Algebra of linear transformations and representation of linear transformations as matrices. Change of bases. Linear functional. Dual spaces and Annihilators. Eigenvectors, Eigenvalues and Cayley–Hamilton theorem. Digitalization of matrices. Inner product spaces. Bilinear, Quadratic and Hermitian forms.

BOOKS RECOMMENDED

- K.H. Dar, *First Step to Abstract Algebra*, (2nd Edition 1998). Feroze Sons Pvt.
 J.T. Scheick, *Linear Algebra with Applications*, 1997. McGraw Hill.
 K.R. Hoffman, and Kunze, R., *Linear Algebra* Prentice –Hall.
 A.M., Tropper, *Linear algebra*, Thomas Nelson & Sons.
 S. Lang, *Linear Algebra*, Addison-Wesley.
 I. N., Herstein, *Topics in Algebra*, Addison- Wesley.
 P.R, Halmos, *Finite Dimensional Vector Spaces*, Von Nostrand.
 P.M. Chon, *Algebra-I and Algebra-II*.

Course Number	Title	Credit Hours	Marks
MTH-619	Rings & Fields	4(4-0)	80

RINGS AND FIELDS

Definitions and basic concepts, homeomorphisms, homomorphism theorems. Polynomial rings. Unique factorization domain, factorization theory. Euclidean domain, arithmetic in Euclidean domains, Extension fields, Algebraic and transcendental elements, simple extension, Introduction to Galois theory.

RECOMMENDED BOOKS

Hartley, B. and Hawkes, T.O. *Rings, Modules and Linear Algebra*, Chapman and Hall, 1980.

Herstein, I.N. *Topics in Algebra*, John Wiley and Sons, 1975.

Blyth, T.S., *Module theory*, Oxford University Press, 1977.

Adamson, J. *Rings and Modules*.

Course Number	Title	Credit Hours	Marks
MTH-621	Fluid Mechanics- I	4(4-0)	80

FLUID MECHANICS -I

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 a fluid, Conditions at a rigid boundary, General Analysis of fluid motion Euler's equations of motion, Bernoulli's equations 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 sources and line sinks, Line doublets image systems, Milne-Thomson circle theorem, Blasius's Theorem.

BOOKS RECOMMENDED

Chorlton, F., *Text Book of fluid Dynamics* D. Van Nostrand Co. Ltd. 1967.

Thomson, M., *Theoretical Hydrodynamics*, Macmillan Press, 1979.

Jaunzemis, W., *Continuum Mechanics*, Macmillan Company, 1967.

Landau, L.D, and Lifshitz, E.M., *Fluid Mechanics*, Pergamon Press, 1966.

Batchelor, G.K., *An Introduction to Fluid Dynamics*, Cambridge University Press, 1969.

Brvce R. Munson and Donald F. Young, *Fundamentals of Fluid Mechanics*, Department of Engineering Science and Mechanics, Department of Mechanics Engineering Iowa State university Ames Iowa USA.

Course Number	Title	Credit Hours	Marks
MTH-623	Advanced Mathematical Methods	4(4-0)	80

Advanced Mathematical Methods

Theory of Sturm-Liouville Problems. Linear homogeneous differential equations of order n . 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. Eigenfunctions and eigenvalues. Self-adjoint eigenvalue problem..

Orthogonality of eigenfunctions. Real eigenvalues. Regular, Periodic and singular Sturm-liouville systems. Orthogonal Sets of functions. Expansion of functions in terms of eigenfunctions.

Power Series, Solutions of Legendre's Equation, Legendre's polynomials Generating function; Rodrigue's formula, Recursion relations. Orthogonality and normality of Legendre's Polynomials, Legendre's Series. Bessel's equation, Bessel's Functions, Generating function, Recurring relations, Orthogonality of Bessel'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.

BOOKS RECOMMENDED

I. Stakgold, Boundary Value Problems of Mathematical Physics, Vol. I, II. Macmillan.

Lal Din Baig Methods of Mathematical Physics 2000.

H.Sagan, Boundary and Eigenvalue problems in Mathematical Physics.

E.L Butkov, *Mathematical Physics*, Addison-Wesley

G. Arfken, *Mathematical Methods for Physics*, Academic Press.

R.P kanwal, *Linear Integral Equations*.

My-Tung & Debnath, *Partail Differential Equations*

MTH-625	Special Theory of Relativity	4(4-0)	80
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SPECIAL THEORY OF RELATIVITY

Historical background and fundamental concepts of Special Theory of Relativity. Lorentz transformations (for motion along axis). Length contraction. Time dilation and simultaneity. Velocity addition formulae. 3-dimensional Lorentz transformations. Introduction 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 equations and electromagnetic waves. The 4-vector formulation of Maxwell's equations. Special Relativity with small acceleration.

BOOKS RECOMMENDED

A. Qadir, *Relativity: An Introduction to the Special Theory*, World Scientific, 1989.

R. D' Inverno, *Isntroduction Einstein's Relativity*, Oxford University Press. 1992.

H. Goldstein, *Classical Mechanics*, Addison Wesley, New York, 1962.

J.D. Jackson, *Classical Relativity*, Springer-Verlag, 1977.

J.G. Taylor, *Special Theory of Relativity*

Course Number	Title	Credit Hours	Marks
MTH-627	Operations Research	4(4-0)	80

OPERATIONS RESEARCH**LINEAR PROGRAMMING**

Mathematical modeling. Formulation and graphical solution. Analytical solution. Simplex method. Two- 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.

BOOKS RECOMMENDED

Hamdy A Taha *An Introduction to Operations Research* Macmillan Publishing Company Inc, New York, 1987.

S Kalavathy *Operations Research* Vikas Publishing House (P) Ltd.

F. S Hiller and G. J Liebraman, *Operational Research* CBS Publisher and distributors, New Delhi, 1974.

C. M Harvey, *Operation Research*, North Holland, New Delhi

Prof. Sr. Saeed Akhtar Bhatti *Operations Research: An Introduction*

Krajewsky and Ritzman *Operations Management Strategy and Analysis*.

Course Number	Title	Credit Hours	Marks
MTH-629	Quantum Mechanics	4(4-0)	80

QUANTUM MECHANICS

Basic postulates of Quantum mechanics. State vector. Formal properties of quantum mechanical operators. Eigenvalues and Eigenstates, Simple harmonics oscillator, Schrodinger representation. Heisenberg equation of motion Schrodinger equation. Potential step, Potential hydrogen atom. Matrix representation of angular momentum an spin. Time independent perturbation theory, Degeneracy. The Stark effect. Introduction to relativistic Quantum Mechanics.

RECOMMENDED BOOKS

Fayyazuddin and Riazuddin, *Quantum Mechanics* (World Scientific 1990).

Merzbache, E. *Quantum Mechanics*, John Wiley (2nd edition) 1970.

Liboff, R.L *Introductory Quantum Mechanics*, Oxford University Press.

Course Number	Title	Credit Hours	Marks
MTH-631	Soft Ware Engineering	4(4-0)	80

SOFT WARE ENGINEERING

Introduction to Software. Designing phases of Software, Different Phase used in Software Development Process. Applying UML (Unified Modeling Language) & Patterns. Software Types, Different kinds of Development Cycles. Iterative , Water Fall, Big Bang Techniques. Software Testing, Black Box Testing, White Box Testing. Concepts of Object Oriented Programming. Difference Between Structured Programming & Object Oriented Programming. Advancements of OOPS.

RECOMMENDED BOOKS

Applying UML & Patterns By Grasp

Practitioner's approach towards Software Engineering by Pressman

Applying UML & Patterns by Craig Larman

Course Number	Title	Credit Hours	Marks
MTH-606	Rings & Modules	4(4-0)	80

RINGS & MODULES

Definition and examples, Submodules, Homomorphisms 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 sequences and elementary notions of homological algebra. Noetherian and modules, Radicals, Semi simple rings and modules.

BOOKS RECOMMENDED

Blyth, T.S., *Module theory*, Oxford University Press, 1977.

Hartley, B. and Hawkes, T.O. *Rings, Modules and Linear Algebra*, Chapman and Hall, 1980.

R. B. J. E. Allenly, *Rings Fields and Groups, An Introduction to Abstract Algebra*, Edward Arnold, 1985.

Herstein, I.N. *Topics in Algebra*, John Wiley and Sons, 1975.

Lal Din Baig *Methods of Mathematical Physics* 2000.

Adamson, J. *Rings and Modules*.

Course Number	Title	Credit Hours	Marks
MTH-608	Theory of Numbers	4(4-0)	80

THEORY OF NUMBERS

Algebraic Numbers and integers, Units and Primes in $R(v)$. Ideals. Arithmetic of Ideals congruences. The norm of a Ideal. Prime Ideals. Units of Algebraic number field.

APPLICATION TO RATIONAL NUMBER THEORY

Equivalence and class number. Cyclotomic field K Fermat's equation. Kummer's theorem, the q equation $X^2 + 2=Y^3$, pure cubic fields. Distribution of Primes and Riemann Zets function, the prime number theorem.

BOOKS RECOMMENDED

W.J. Leveque, *Topics in Number Theory, Vol. I and II* Addison-Wesley Publishing Co, 1956.

Shailesh Shirali, C. S Yogananda, Number theory Universities press.

Steven Miller Ramin Takloo-Bighash, An Introduction to modern Number Theory Publishing Princeton

Neville Robbins, Beginning Number Theory (2nd edition), Jones and Bartlett.

Course Number	Title	Credit Hours	Marks
MTH-610	Mathematical Statistics- II	4(4-0)	80

MATHEMATICAL STATISTICS- II

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

RECOMMENDED BOOKS

- Mood, A.M. Graybill, F.A . Boes, D.C. *Introduction to the Theory of Statistics*, (2nd edition), McGraw-Hill Book Company New York ,1986.
- Degroot, M.H. *Probability and Statistics*, (2nd edition) Addison Wesley Company New York 1986.
- Walpole-Myers. Myers. *Ye Probability and Statistics* (7th edition)
- K. V. Mardia, Kent, J. T. Bibby, J. M. *Multivariate Analysis* Academic Press New York 1979.
- Allen. T Craig, Robert V. Hogg, *Introduction to Mathematical Statistics* 5th edition publish by Pearson education Singapore (Pvt) Ltd

Course Number	Title	Credit Hours	Marks
MTH-612	Numerical Analysis-II	4(4-0)	80

NUMERICAL ANALYSIS-II

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 Laguerre Ploynomials, Numerical Differentiation, Difference Equations, Differential Equations, Euler’s Method, Improved Euler’s Methods. Mid point Formula, Heun’s Method,

BOOKS RECOMMENDED

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

Course Number	Title	Credit Hours	Marks
MTH-614	Special Functions	4(4-0)	80

SPECIAL FUNCTIONS

Sturm-Liouville theory of DEs, Basic properties of a SL System, Orthogonality, Reality and uniqueness, Sturm’s comparison theorem, completeness of Eigenfunctions Via Rayleigh quotient, Bessel functions, Legendre Polynomial and their Generating functions and properties, Hermite equation and functions and their properties, Laguerre Equation and functions and their properties, chibeicif function, Hypergeomtric Differential Equations and Functions, Gamma and Beta Functions

RECOMMENDED BOOKS

G.B. Arfken And H. J. Weber, *Mathematical Methods for Physicists*, CUP New York.
 B. G. Korenev, *Bessel Functions and their Applications*
 R. E. Attar, *Special Functions and Orthogonal Polynomials*
 G. N. Watson, *A Treatise on the Theory of Bessel Functions*

Course Number	Title	Credit Hours	Marks
MTH-616	Theory of Optimization	4(4-0)	80

THEORY OF OPTIMIZATION

Introduction to optimization. Relative and absolute 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 Language equations, Functions depending on several independent variables. Variational problems in parametric form. Generalized mathematical formulation of dynamics programming. Non-Linear continuous models, Dynamics programming and Variational calculus. Control theory.

RECOMMENDED BOOKS

Gotfried B.S and Weisman, J. *Introduction to Optimization Theory* (Prentice-Inc. New Jersey,1973).
 Elsgolts. L. *Differential Equations and the Calculus of Variations* (Mir Publishers-Moscow,1970).
 Wismer D.A and Chattergy R. *Introduction to Nonlinear Optimization* (North - Holland, New York,1978).
 Intriligator M.D. *Mathematical Optimization and Economic Theory*(Prentice-Hall, Inc, New Jersey,1971).

Course Number	Title	Credit Hours	Marks
MTH-619-P	Project	4(4-0)	80

The Project of BS (H) Mathematics will be offered as an optional paper to not more than 50 % of the class strength and only to those who obtain at least 65 % marks on the basis of their performance in V & VI Semesters.

Course Number	Title	Credit Hours	Marks
MTH-618	Fluid Mechanics -II	4(4-0)	80

FLUID MECHANICS -II

Vortex motion, Line Vortex, Vortex row Image System, Kelvin's minimum energy theorem, Uniqueness theorem, Fluid streaming past 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; Equations of motion relative to a rotating system; Ekman flow; Dynamical similarity of turbulent motion.

BOOKS RECOMMENDED

L.D. Landan & E. M. Lifshitz, *Fluid Mechanics*, Pergamon Press, 1966.

Batchelor, G.K. *An Introduction to Fluid Dynamics*, Cambridge University Press, 1969.

Walter Jaunzemis, *Continuum Mechanics*, McMillan Company, 1967.

Milne-Thomas, *Theoretical Hydrodynamics*, McMillan Company, 1967.

D. J Tritton, *Physical Fluid Dynamics* 2nd edition Oxford

Course Number	Title	Credit Hours	Marks
MTH-620	Partial Differential Equations	4(4-0)	80

PARTIAL DIFFERENTIAL EQUATIONS

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 PDEs. Methods of separation of variables (Product Method) for solving PDEs like elliptic, parabolic and hyperbolic equations. The Cauchy Problem. Cauchy's Problem for hyperbolic system in two independent variables with application to wave equations. Laplace, Fourier and Hankel transform for the solution of PDEs and their application to boundary value problems.

RECOMMENDED BOOKS

E.I. Butkov, *Mathematical Physics*, Addison-Wesley.

H. Sagan, *Boundary and Eigenvalue Problems in Mathematical Physics*.

My-Tung & Debnath, *Partial Differential Equations*.

G. Arken, *Mathematical Methods for Physics*, Academic Press.

I. Stakgold, *Boundary Value Problems of Mathematical Physics*, Vol. I, II Macmillan.

Sneddon, I.N., *Elements of Partial Differential Equations*, McGraw-Hill Book Company, 1987.

Dennemyer, R., *Introduction to Partial Differential Equations and Boundary Value Problems*, McGraw-Hill Book Company, 1968.

Himi, M And Millerl, W.B., *Boundary Value Problems and Partial Differential equations* PWS-Kent Publishing Company, Boston, 1992.

Chester, C. R., *Techniques in Partial Differential equations* McGraw-Hill Book Company, 1971.

Haberman, R., *Elementary Applied Partial Differential Equations*, Prentice Hall, Inc. New Jersey, 1983.

Zauderer E., *Partial differential Equations of Applied Mathematics*, John Wiley & Sons, Englewood Cliff, New York, 1983

J. D. Logan, *Partial Differential Equations*, Second Edition, Springer-Verlag, 2004

Course Number	Title	Credit Hours	Marks
MTH-622	Theory of Elasticity	4(4-0)	80

THEORY OF ELASTICITY

Cartesian tensors, Analysis of stress and strain, Generalized Hooke's law; crystalline structure, Point groups of crystals, Reduction in the number of elastic moduli due to crystal symmetry; Equations of equilibrium; Boundary conditions, ompatibility equations; Plane stress and plane strain problems; Two dimensional problems in rectangular and polar co-ordinates; torsion of rods and beams.

RECOMMENDED BOOKS

S. P. Timoshenko And J.N. Goodier, *Theory of Elasticity*, 3rd edition, McGraw Hill Book Company, 1970, 1987.

A. P. Boresi And K. P. Chong, *Elasticity iri Engineering Mechanics*, 2nd edition, John Wiley & Sons, 2000.

A.C. Ugural And S.K. Fenster, *Advanced Strength and Applied Elasticity*, 2nd edition Elsevier Science Publishing Co., Inc., 1987.

Adel S. Saada, *Elasticity: Theory and Applications*, Second Edition, Krieger Publishing, Malabar, Florida, 1993.

Abdel-Rahman Ragab & Salah Eldin Bayoumi, *Engineering Solid Mechanics: Fundamentals and Applications*, CRC Press, Boca Raton, Florida, 1999.

Course Number	Title	Credit Hours	Marks
MTH-624	Electromagnetism	4(4-0)	80

ELECTROMEGNETISM

Electrostatics and the solution of electrostatics problems in vacuum and in media, Electrostatic energy, Electro currents, The magnetic field of steady currents. Magnetic properties of matter. Magnetic energy, Electromagnetic Introduction, Maxwell's equations, Boundary Value Potential Problems in two dimensions, Electromagnetic Waves, Radiation, Motion of electric charges.

RECOMMENDED BOOKS

- Reitz, J. R. & Milford, F. J., *Foundation of Electromagnetic Theory*, Addison-Wesley 1969.
- Panofsky, K.H. and Philips, M., *Classical Electricity and Magnetism*, Addison Wesley, 1962.
- Corson, D. and Lerrain, P., *Introduction to Electromagnetic Fields and Waves*, Freeman, 1962.
- Jackson, D.W., *Classical Electrodynamics*, John-Wiley.
- Ferraro, V.C.A., *Electromagnetic Theory*, the Athlone Press, 1968.

Course Number	Title	Credit Hours	Marks
MTH-615	Mathematical Statistics- II	4(4-0)	80

MATHEMATICAL STATISTICS- II

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

RECOMMENDED BOOKS

- Mood, A.M. Graybill, F.A . Boes, D.C. *Introduction to the Theory of Statistics*, (2nd edition), McGraw-Hill Book Company New York ,1986.
- Degroot, M.H. *Probability and Statistics*, (2nd edition) Addison Wesley Company New York 1986.
- Walpole-Myers. Myers. *Ye Probability and Statistics* (7th edition)
- K. V. Mardia, Kent, J. T. Bibby, J. M. *Multivariate Analysis* Academic Press New York 1979.

Allen. T Craig, Robert V. Hogg, *Introduction to Mathematical Statistics* 5th edition
publish by Pearson education Singapore (Pvt) Ltd

Course Number	Title	Credit Hours	Marks
MTH-616	Numerical Analysis-II	4(4-0)	80

NUMERICAL ANALYSIS-II

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 Laguerre Ploynomials, Numerical Differentiation, Difference Equations, Differential Equations, Euler's Method, Improved Euler's Methods. Mid point Formula, Heun's Method,

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M. Iqbal, *Numerical Analysis* , National Book Foundation.

J.H. Wilkinson, *Eigenvalue Problems*, Oxford University Press.

Aitkinson , *Elementary Numerical Analysis*.

Course Number	Title	Credit Hours	Marks
MTH-617	Special Functions	4(4-0)	80

SPECIAL FUNCTIONS

Sturm-Liouville theory of DEs, Basic properties of a SL System, Orthogonality, Reality and uniqueness, Sturm's comparison theorem, completeness of Eigenfunctions Via Rayleigh quotient, Bessel functions, Legendre Polynomial and their Generating functions and properties, Hermite equation and functions and their properties, Laguerre Equation and functions and their properties, chibeicif function, Hypergeomtric Differential Equations and Functions, Gamma and Beta Functions

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R. E. Attar, *Special Functions and Orthogonal Polynomials*

G. N. Watson, *A Treatise on the Theory of Bessel Functions*

Course Number	Title	Credit Hours	Marks
MTH-618	Theory of Optimization	4(4-0)	80

OPTIMIZATION THEORY

Introduction to optimization. Relative and absolute 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 Language equations, Functions depending on several independent variables. Variational problems in parametric form. Generalized mathematical formulation of dynamics programming. Non-Linear continuous models Dynamics programming and Variational calculus. Control theory.

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Elsgolts. L. *Differential Equations and the Calculus of Variations* (Mir Publishers-Moscow,1970).

Wismar D.A and Chattergy R. *Introduction to Nonlinear Optimization* (North - Holland, New York,1978).

Intriligator M.D. *Mathematical Optimization and Economic Theory*(Prentice-Hall, Inc, New Jersey,1971).

Course Number	Title	Credit Hours	Marks
MTH-628	Project	4(4-0)	80

The Project of BS (H) Mathematics will be offered as an optional paper to not more than 50 % of the class strength and only to those who obtain at least 65 % marks on the basis of their performance in V & VI Semesters.

Course Number	Title	Credit Hours	Marks
MTH-626	C++	4(4-0)	80

PROGRAMMING LANGUAGE C++.

Object Oriented Programming using C++. Declaring Variable, Designing Functions, Designing Classes, Using Built in Functions and Libraries.

Introduction I:- History of C++, writing C++ Program, structure, preprocessor, Header file, Main function, Increment operators++, data types, Declaration of the variable, Initialization of the variable, Arithmetic operators, arithmetic Expression, order of 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, the comment statement, the conditional statement, loops statement, arrays, structures, functions part I and part II, pointers, inheritance, and polymorphism part I and II, Files graphics, bit wise operators.

RECOMMENDED BOOKS

Object Oriented Programming Using C++ by Robert Lafore 3rd Edition.

Aikman Series. C.M Aslam T A Qurashi. Urdu bazaar Lahore.

Course Number	Title	Credit Hours	Marks
MTH-508	Advanced Functional Analysis	4(4-0)	80

ADVANCED FUNCTIONAL ANALYSIS

Hahn-Banach theorem, adjoint operator, uniform boundedness theorem, strong and weak convergence, convergence of sequences of operators and functionals, open mapping theorem, closed graph theorem, Banach fixed point theorem and its applications, spectral theory in finite dimensional normed spaces, spectral properties of bounded linear operators, compact linear operators and their properties, spectral properties of compact linear operators on normed spaces.

RECOMMENDED BOOKS

E. Kreyszig, Introductory Analysis with Applications, John Wiley, 1978.

J Maddox, Elements of *Functional Analysis*, Cambridge, 1970.

W. Rudin, *Functional Analysis*, McGraw-Hill. N.Y. 1983.

N. L. Carothers, *Banach Space Theory*, Cambridge University Press, 2004.

The End