DEPARTMENT OF MATHEMATICS
UNIVERSITY OF PESHAWAR
KHYBER PAKHTUNKHAWA, PAKISTAN

COURSE CONTENTS FOR THE DEGREE OF M.PHIL IN MATHEMATICS APPROVED BY THE ACADEMIC COUNCIL ON 16.05.1996 & SYNDICATE ON 31.07.1996 AND SUBSEQUENTLY UPDATED ON DIFFERENT DATES.

RULES AND REGULATIONS ARE AS GIVEN IN THE UNIVERSITY <u>OF PESHAWAR</u> <u>STATUTES FOR THE DEGREE OF M.PHIL</u>.

<u>M.Phil</u>

S.#	Course No	Title	Credit Hours
01	Math-601	Introduction for Mathematical Logic	3
02	Math-602	Mathematics for Scientists-I	3
03	Math-603	Mathematics for Scientists-II	3
04	Math-604	Introduction to C/C++	3
05	Math-605	Seminar and Lectures	3
06	Math-701	Advance Calculus	3
07	Math-702	Group Theory-I	3
08	Math-703	Group Theory-II	3
09	Math-704	Advance Measure Theory-I	3
10	Math-705	Advance Measure Theory-II	3
11	Math-706	Advance Topology	3
12	Math-707	Algebraic Topology	3
13	Math-708	Field Theory	3
14	Math-709	Rings and Categories of Modules	3
15	Math-710	Partial Differential Equations	3
16	Math-711	Advance Topics in Differential Equations	3
17	Math-712	Math-712 Functional Analysis	3
18	Math-713	Elementary Knot Theory	3
19	Math-730	Boundary Layers Theory	3
20	Math-731	Gas Dynamics	3
21	Math-732	Astronomy-I	3
22	Math-733	Astronomy-II	3
23	Math-734	Theoretical Astrophysics	3
24	Math-735	Math-735 Mathematical Statistics	3
25	Math-736	Math-736 Regression Analysis	3
26	Math-737	Math-737 Numerical Analysis-I	3
27	Math-738	Math-738 Numerical Analysis-II	3
28	Math-739	Math-739 Operation Research-I	3
29	Math-740	Math-740Operation Research-II	3
30	Math-742	Math-742 Topological Vector Spaces	3
31	Math-743	Math-743 Spectral Theory in Hilbert Spaces	3
32	Math-744	Math-744 Banach Algebras	3
33	Math-760	Directive Study	3

Math-601   Introduction to Mathematical Logic

Introduction, Propositional Calculus, Methods of Proof, Analysis of Arguments, Predicate Calculus and Quantifiers, Boolean Algebra to Logic, Boolean Functions, Boolean Algebra and Propositional Logic, Logic Gates, Combinational Circuits.

Recommended Books:

1. Irving M.Copi, Symbolic Logic, Collier MacMillan Publishers, 1973.
2. Patric J.Hurley, A concise Introduction to Logic, Ward Worth Publishing Company, 1991.
3. Elliott Mendelson, Boolean Algebra and Switching Circuits, McGraw Hill Book Company, 1970.

Math-602   Mathematics for Scientists-I

Topics to be covered:

1. Linear Algebra and Theory of Matrices with its Applications.
2. Itterative Methods for System of Linear Equations.
3. Vector Analysis.

Recommended Books:

1. M.C. Potter and J. Goldberg, Mathematical Methods, Prentice-Hall, 1991.
2. E.Kreyszig. Advance Engineering Mathematics, John Wiley & Sons, Inc., 2000.

Math-603   Mathematics for Scientists-II
Topics to be covered:
1. Ordinary Differential Equations.
2. Special Functions.
3. Laplace Transform and its Application to Differential Equations.

Recommended Books:

1. M.C. Potter and J. Goldberg, Mathematical Methods, Prentice-Hall, 1991.
2. E.Kreyszig. Advance Engineering Mathematics, John Wiley & Sons, Inc., 2000

Math-604   Introduction C/C++

Math-605   Seminar & Lectures

Math-701   Advance Calculus

Matric space, Limits & continuity. Derivatives, applications of the derivatives and Mean Value theorems. Applications of Mean value theorems, differential.

Definite Integral, elementary properties, improper integrals. Gamma and Beta functions. Some elementary applications of definite integral (Buffon, S. Neddle Problem, Arc length, picard existence theorem), Weierstrass approximation theorem.

Differentiation of functions of several variables, partial & directional derivative, differential and differentiability, differentiability in a complex setting, differentiation under integral sign, implicit function theorems and its application, Lagrange multipliers, Brochistochrone problem, vibrating string.

Infinite series of numbers, infinite series of functions, Taylor pronominal and Taylor expansion, power series, divergent series. Infinite series of matrices.

Recommended Books:

Advance Calculus (An Introduction to Modern Analysis) by W.L. Voxman & R.H. Goestrchel, Jr. Marcel Dekker, Inc. N.Y.

Math-702   Group Theory-I

Survey of group theory, (Elementary concepts) symmetric and alternating groups of finite degree, orbit of symmetric and alternating groups, transitive group. Group action on sets, group action of groups, periodic torsion free and mixed abelian groups free abelian groups. Finitely generated groups. Definition of a modular lattice and distributive lattices. The lattices of all sub-groups of a group. The lattice of admissible out-groups. The lattice of normal subgroups.

Recommended Books:

1. Kurosh, A.G. Theory of Groups. Vo. 1&II 2nd Edition Charlsea Publishing Company N.Y. 1960.
2. Kochendorffer, R. Group theory, McGraw Hill, London 1970.
3. Burrow, M. Representation Theory of finite groups. Academic Press, London 1982.
4. Grazer G Lattice Theory W,H. freeman and Comp. N.Y. 1971.

Math-703   Group Theory-II

1. Free groups, words, laws verbal sub groups, relatively free groups varieties, varieties as closed classes groups. The n-generater groups and the n-veriable laws of a variety, product varities, nilpotent. And metabelian varieties.
2. Free presentation of groups abelian groups. Tieze transformations and Van-Kampen diagrams, coset enunsation, presentations of sub group. Finite or infinite Minimal presentation of groups, minimal presentation of wreath products. Cyclically presented groups.

Recommended Books:

1. Hanna Neumaun "Varieties of Groups" Springer Verlage Berline Heidel berg N.Y. 1967.
2. H.S.M. Caxbter, W.O.J. Moser Gensators and relations for discrete groups. Springer verlage Berline Heidelberg N.Y. 1972.

Math-704   Advance Measure Theory-I

Lebesque integral for bounded, unbounded function some important results. The Leb. Integral on an infinite interval. Lebesque integration in the plane R^2, iterated integration, Fubini's theorem, Tonelli Hobson Theorem.
Differentiation and integration

Monotonic ftns. Differentiation of monotonic ftns. Vitall's cover of sets. Vitalis's Lemma. Derivative of a ftn. Functions of bounded variation, positive and negative variation, fundamental properties of ftns. of bounded variation. Absolute continuouis ftn. Indefinite integrals, Lipschutz conditions. Fundamental theorem of integral calculus. Integration by parts for Lebesque integra. First mean value theorem. Generalized F.M.V. second M.v.T (Bonnet form), relation between stieltjes and lebesque integra. L^P spaces. The class L^P (a,b) square integrable, norm of an element of L^P space. Inequalities. Metric on an L^P space. Convergence and completeness of L^P space.

Cauchy seq. complete space. Riesz Fischer theorem. L^P spaces an normed linear space. Approximation by continuous ftn.

Recommended Books:

1. Measure theory, Halmos
2. Measure and integration, Streling K. Berberian
3. Real Analysis, Royden.

Math-705   Advance Measure Theory-II

Measure Spaces and Signed Measures.

Measurable spaces, Measure Space, examples of measure space, properties of measure, finite and infinite measures, semi-finite measures, complete measure space, signed measure, positive and negative sets, Hahn decomposition Theorem, Hahn decomposition Jordan decomposition, singular measure, Jordan decomposition theorem, finite signed measures, total variation of a signed measure. Absolutely continuous measure, random Nikodym theorem, Random Nikodym derivative, Lebesque decomposition Theorem.

Product Measure.

Cartesian product of sets, dies of rectangle, measurecable rectangle, sections, product measure, double integral and iterated integrals, Fubini's theorem.

Books Recommended:

1. Measure Theory, Halmos
2. Measure and Integration, Sterling K. Berberian
3. Real Analysis, Royden

Math-706   Advance Topology

Product Topology, Point-open Topology, Compact-open Topology, Weak Topology-I, weak Topology II, Quotients topology, identifications, identification maps, fundamental group (first homotopy group), elementary properties of the fundamental group, Continuous functions and homorphisms, categories and functors, seifert-van kampan theorem, direct limits, lifting theorems, regular covering spaces, map liftings, universal covering spaces. 1-manifld, on contractibility of S^1, Jordan curve theorem.

Books Recommended:
Aspects of Topology, C.O. Christenson, W.L. Voxman. Marcel Dekker, Inc. N.Y.

Math-707   Algebraic Topology

Simplices, simplicial complexes and simplicial maps abstract simplicial complexes, review of abelian groups, homology groups, homology groups of surfaces, zero dimensional homology, homology of a cone, relative homology, homology with arbitrary coefficient, computability of homology group. Homorphisms induced by simplicial map, chain complexes and acyclic carrier.

Simpicial approximations, barycentric subdivision, simplicial approximation theorem, homorphism induced by homotopic maps, review of quotient spaces. Exact homology sequence, zig-zag lemma, Mayer-Victoris sequences, singular homology groups, axioms for singular theory, excision in singular homology, acyclic models, Mayer-Victoris sequence, Jordan corve theorem, more on quotient spaces, CW complexes homology of CW complexes, projective and lens spaces.

Recommended Book:

Elements of Algebraic Topology, J.R. Munkres, Addison Wesley.

Math-708   Field Theory

Introduction, field extensions, ruler and compass constructions, foundations of Galois theory, Normality and stability, splitting fields, Radicals extensions, the trace and norm therorems, finite fields, simple extensions, cubic and quartic equations.

Separability, Miscellaneous results on radical, extensions, infinite Algebraic extensions.

Recommended Book:

Fields and Rings, Irving Kaplansky, University of Chicago press.

Math-709   Rings and Categories of Modules

Rings and subrings, ring homorphism, Ideals and Factor Rings, some special rings, polynomial rings, products and functions ring, centre of a ring. The opposite ring of a ring, Matrix ring, Endomorphism rings, Idempotents, Nilpotent elements.

Modules and submodules: Linear combinations and submodules, factor modules, change of rings, Annihilators, homomorphism of modules, epimorphisms and monomorphisms, factor theorem, isomorphism theorem, exactness, categories of modules; endomorphism rings, direct summands, split homomorphisms, projections, idempotent endomorphisms, essential and superfluous submodules., directsum and product of modules.; direct sums-coproduct, internal direct sums, decomposition or rings.

Simple modules, semisimple modules, socle, radical, finitely generated modules, role of radical and socle, artinian, noetherian ring.

Recommended Book:

Rings and categories of Modules, F.W.Anderson and K.R. fuller, Springer Verlag.

Math-710　Partial Differential Equations

Ordinary differential equations with three variables. Total differential equation. Partial Differential Equations of first, second and higher order. Applications. Transformations and canonical forms. Elliotic, parabolic and hyperbolic equations. Laplace, Fourier and other transformations. Laplace's equation. Diffusion equation, wave equation and Helmholtz equation.

Recommend Books:

1. Partial Differential Equations. By Parry Moon and Domina Eberle spencer 1989 edition.
2. Elements of Partial Differential Equations by Ian N.Sneddon McGraw Hill book company Inc 1980 edition.
3. Partial Differential Equations by E.T. Copson. Cambridge University Press 1990 edition.
4. Methods of Mathematical Physics Vol II Partial Differential Equations by R.Courant and D.Hilbert Inter Science 1970 edition.

Math-711　Advance Topics in Differential Equations

Inverse differential operators. Laplace transform. Application of Gamma function. Inverse transform. Step function. Initial value problems. Linear system of equations. Non-linear equations. Power series solutions. Ordinary and singular points. Solutions near regular singular points.

Recommended Books:

1. Differential Equations by E.D. Rain Ville and Phillip E. Bedient MacMillan Publishing company inc.
2. Differential Equations. By W.E. Boyce and R.C. Diprima Wiley.

Math-712　Functional Analysis

Review of Normed and Banach Spaces. The Stone-Weierstrass Theorem and the Ascoli-Arzela Theorem. Review of Hilbert spaces. Dual Spaces. The Hahn-Banach Theorem. The representation Theorem. Reflexive Spaces. Strong and Weak Convergence, Convergence of Sequences of Operators and functional. Bair's theorem. The Principle of Uniform Boundedness. The open Mapping Theorem and The Closed Graph Theorem.

Recommended Books:

1. A.L. Brown and A Page, Elements of functional analysis. Van Nostrand and Reinholt Company, London 1970.
2. E.Kreyzig. Introductory Functional Analysis with Applications, John Wiley & Sons. N.Y. 1978.
3. A.E. Taylor and D.C. Lay, Introduction to Functional Analysis. John Wiley & Sons Inc. 1980.

Math-713　Elementary Knot Theory

Introduction, type of Knot links. Projection (regular), projection of Knot. Linking numbers and Reidemeister moves. Universe of Knot. Unknot discussion, examples and Skein theory, tangle theory. Elementary invarlants of Knots. Knots and groups. Wirtinger presentation. Knots and graphs, L and F Polynomials of Knots. Keuffmen polynomial. Jones polynomial. Generalized polynomials and a state model for jones polynomial. Knots and matrices.

Recommended Books:

1. On knots, L.H. Kauffman, Princeton University Press.

2. Knots and Links, Dale Rolfsen, Publisher perish, Inc.
3. Knot Theory, K. Reidemeister, B.C.S. Associates Moscow, Idaho, U.S.A.
4. Introduction to Knot Theory, R.H. Crowell & R.H. Fox Springer Verlag.

Math-730   Boundary Layers Theory

Viscous flow of incompressible fluid. Navier-Stokes equations. Small Reynolds number solutions. The laminar boundary layers in incompressible fluids. Turbulant flows. Turbulent boundary layers. Boundary layers in compressible fluids.

Recommended Books:

1. Boundary Layer Theory, by Hermann Schlichting. McGraw Hill Book Co. 1989 edition.
2. Laminar Boundary Layers by L.Rosenhead. Oxford Clarendon Press 1986 edition.
3. The Theory of Lominar Boundary Layers in Compressible Fluids by K.Stewartson Oxford Clarendon Press 1984 edition.
4. Modern Fluid Dynamics by S.N. Curle and H.J. Davies. Vol. I&II. Van Nostrand Reinhold co. 1986 edition.
5. Fluid Mechanics by L.D. Landau and E,M. Lifshitz Pergamon Press. 1979 edition.
6. Theoretical Hydrodynamics by L.M. Milne Thomson MacMillan and Co. 1982 edition.
7. Modern Developments in Fluid Dynamics by L. Howarth. Oxford Clarendon Press. 1984 edition.

Math-731   Gas Dynamics

Compressible flows. Mathematical and Thermodynamic Methods of Gasdynamics. Supersonic, Subsonic and Hypersonic flows. Shock Waves. Method of Characteristics. One dimensional gas flow. The intersaction of surfaces of discontinuity. Interactions. Two limensional gas flow. Fluid Dynamics of Combustion. Detonation and deflagration waves.

Recommended Books:

1. Unsteady Motio of Continuous Media by K.P. Stanyukovich. Pergmon Press 1986 edition.
2. Supersonic flow and Shock Waves by R. Courant and K.O. Friedrichs Springer Verlag 1988.
3. Modern Fluid Dynamics by S.N. Curle and H.J. Davies. Vol. II. Van Nostrand Reinbold co 1986 edition.
4. Fluid Mechanics byL.D. Landau and E.M. Lifshitz. Pergmon press 1979 edition.
5. Modern Developments in Fluid Dynamics by L. Howarth Oxford Clarendon Press 1984 edition.
6. The Dynamics of Real Gases by J.F. Clarke and M.MGChesney. Butterworths London 1984 edition.

Math-732   Astronomy-I

Spehrical Tironometry. The Calestial Spehere. Contents of the Universe. Tools of the astronomer. Refraction.   The meridian circle. The hertzsprung-russell diagram. Stellar evolutions. Planetary motions. Time. Planetary phenomena and Heliographic co-ordinates. Aberration. Parallax. Galaxies and their evolution. Cosmology.

Recommended Books:

1. Frontiers of astronomy by Fred Hoyle
2. Spherical Astronomy by W.M.Smart (Cambridge University Press) 1982 edition
3. Outline of Astronomy Vol. I & II by H.H. Voigt 1983 edition.
4. Astronomy: Fundamentals

Math-733   Astronomy-II

The solar system. Earth, moon and appollo findings. Venus, mars, Jupiter and Saturn. Precession and Nutation. The Proper motions of the stars. Astronomical photography. Binary star orbits. Occulations and eclipses. Life in the cosmos. Cosmic evoluation.

Recommended Books:

1. Frontiers of Astronomy by Fred Hoyle Cambridge University Press 1984 edition.
2. Spherical Astronomy by W.M. Smart Cambridge University Press 1982 edition.
3. Outline of Astronomy Vol: I&II by H.M.Veigt 1983 edition.
4. Astronomy: Fundamentals and Frontiers. By Robert Jastrow and M.H. Thompson. John Wiley & Sons. 1985 edition.

Math-734   Theoretical Astrophysics

An approach to astrophysics. The cosmic distance scale. Dynamics nd masses of astronomical bodies. Central force. Two body problem with attractive force. Kepler's laws. The concept of mass. The equivalence principle. Random processes. Boltzmann equation and liouville's theorem. Photons and fast particles. Electromagnetic processes in astrophysics. Quantum processes in astrophysics. Stars. Mathematical formulation of the theory. Equation of state. Cosmic gas and dust. Shock fronts and Ionization fronts. Structure of the Universe. Dynamics on a cosmic scale. The flow of time. Life in the Universe. Thermodynamics of biological system.

Recommended Books:

1. Astrophysical Concepts by Martin Harwit John Wiley & Sons. 1983 edition.
2. Theoretical Astrophysics by V.A. Ambartsumyan Pergamon Press. 1988 edition.
3. Astrophysics by L.H. Aller Ronald press co. 1983 edition.

Math-735   Mathematical Statistics

Point and internal estimation: Introduction.Properties of a good estimator: Unbiasedness. Consistency, sufficiency and officiency. Completeness and minimal sufficiency. Fisher information. Cramerprao-Inequality. Minimum variance bound unbiased estimators. Rao-Blackwell theorem. Lehmann-Seheffe's theorem. Uniformly Minimum varience unbiased estimators. Confidence intervals for means Confidence intervals for variances.

Mothods of extimation: Maximum: Liklihood estimation and propertiesof the corresponding estimaters. Moment equations Method. Minimum chi-square method. Bayen and minimax estimators.

Statistical hypotheses: Introduction. Most powerful tests. Neyman-pearson lemma, randomized tests. Uniformly most powerful tests. Likelihood ratio tests and its properties. Chi-square tests.

Recommended Books:

1. Rohatqi, V.E. 1976 An introduction to Probability Theory and Mathematical Statistics. John Wiley and Sons, Inc. N.Y.
2. Hogg, R.V. and Craiq, A.T. 1978 Introduction to Mathematical Statistics. MacMillan Publishing Co. Inc. N.Y.
3. Roussas, G.G. 1973. A first course in Mathematical Statistics. Addison Wesley publishing company.

Math-736   Regression Analysis

Simple linear regression analysis: The two variable linear model and assumptions. The ordinary least squares estimators and their properties. Inference in the linear model.

The General linear Model: Introduction. Assumption and their role. The ordinary least squares estimators. Gauss-markov's theorem. Inference in the ordinary least squares model. Use of extraneous information in linear regression model. Least squares method subject to linear restrictions. Inference about the set of linear hypotheses. Problems in the general linear model.

Multicollinearity and its consequencies: detection and its remedies. Ridge Regression. Heteroscedasticity and its sources. The generalized least squares estimator and its properties. Testing for Heteroscedasticity. Autocorrelation and its consequences for ordinary least squaresestimator. Durbin-Watson test for autocorrelation. Dummy variables and their role. Distributed lage models and difficulties involved in estimation. Specification error. Exclusion of relevant variables and inclusion of irrelevant variables. Erross in variables.

System of simultaneous linear relationships: Introduction to simultaneous equation system. Problems of indentification.

Methods of estimation: Instrumental variable, indirect least squares and two-stage least squares.

Recommended Books:

1. Searle, S.R. 1971. Linear Models. Johnwiley and Sons, Inc. New York.
2. Draper, N.R. and Smith, H. 1961. Applied Regression Analysis. John Wiley and Sons, Inc. New York.
3. Montgomery, C.D. and Peck A.E. 1982 Introduction to Linear regression Analysis. John Wiley and Sons, Inc. New York.

Math-737   Numerical Analysis-I

1. **LINEAR ALGEBRA.**

    i.   **SOLUTION OF EQUATIONS OF THE FORM _f(x)=0._**

        Simple interation. The theory of interation. Aitken's Δ^2- process. Newton-Raphson interation. Other interative process of the form $x_{n+1} = \varphi(x_n)$ Birge-Vieta method. Secont method.

ii. **NUMERICAL SOLUTION OF SIMULTANCOUS LINEAR EQUATIONS.**

III conditioning. Methods for solving system of equations *AX=B*. Gaussian climination method. Gauss Siedel Method. Relaxation methods.

2. **CURVE-FITTING AND APPROXIMATION OF FUNCTIONS.**

Least squares approximations. Fitting Non-|Linear curves by least squares. Chebyshev polynomials. Approximation of Functioneconomized power series. Approximation with rational function. Approximation of functions with trigonometric series and Fast Fourier Transforms.

3. **NUMERICAL SOLUTION OF FIRST ORDER DIFFERENIAL EQUATIONS.**

Introduction. Existence Theorems for a single Order Differential Equations. Systems of first order equations. Euler's method. Modified Euler method. Taylor's series method. Runge-Kutta methods. Reliability of Numerical Solutions of Differential Equations.

Recommended Books:

1. Numerical Mathematical Analysis by James B. Scarborough The John Hopkins Press 1986 edition.
2. Computational Methods by K.A. Redish The English University Press 1981 edition.
3. Applied Numerical Analysis by C.F. Gerald Addison Wesly 1984 edition.
4. Afirst course in Numerical Analysis by C.F. Gerald Addison Wesly 1984 edition.
5. Theory and Applications of Numerical analysis by D.G. Moursund and C.S. Duris. McGraw Hill Inc. 1967 edition.
6. Numerical Analysis by R.L. Burden, J.D. Faires and A.C. Reynolds Prindle, Weber and Schmidt, Boston 1981 edition.

Math-738   Numerical Analysis-II

1. **FIRST AND SECOND ORDER DIFFERENTIAL EQUATIONS.**

Introduction. Euler's method. The modified Euler's method. Runge-Kutta methods. Milne's method. Hamming's methods. Initial value problems. The special case when the first derivative is missing. Boundary value problems.

2. **PARTIAL DIFFERENTIAL EQUATIONS.**

Classification and numerical solution of linear second order partial differential equations in two variables:

$$\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0$$

$$\frac{\partial^2 u}{\partial u} = c^6 \frac{\partial^2 u}{\partial x^2}$$

$$\frac{\partial u}{\partial t} = c^2 \frac{\partial^2 u}{\partial x^2}$$

Recommended Books:

1. Applied Numerical Analysis by C.F Gerald Addison Wesley 1984.
2. Numerical Solution of Ordinary and Partial Differential Equations by L.Fox Pergamon Press 1982.
3. Numerical Solution of Partial Differential Equations by G.D. Smith 1984 Oxford University Press.
4. Numerical Methods. For Partial Differential Equations by William F. Ames 1989 Melson.
5. Numerical Mathematical Analysis by James B. Scarborough The John Hopkins Press 1986 edition.
6. Numerical Analysis by R.L. Burden, J.D. Faires and A.C. Reynolds. Prindle, Weber & Schmidt 1981 edition. Boston.

Math-739   Operation Research-I

i.   **INTRODUCTION:**

Definition. Development and Scope of Operation Research. Operation Research Models. Principal Components of Decision Problems. Types of Operation Research Models. Phases of Operation Research.

ii.   **LINEAR PROGRAMMING:**

Introduction and Graphical Solution of Linear Programming Probels. Examples. Of Linear Programming applications. Canonical and standard forms of linear programming. Basic solution. The simplex method. Examples on the application of simplex techniques.

iii.   **THE DUAL PROBLEM:**

Definition of the Dual Problem. Primal-Dual Relationship. Dual simplex Method. Sensitivity Analysis.

iv.   **TRANSPORTATION MODEL:**

Definition and Application. Solution of the Transportation Model. The Assignment Model. The Transhipment Model.

Recommended Books:

1. Operation Research: An Introduction, 3rd Edition Hamdy A. Taha. Collier MacMillon.
2. Operations Research by P.K. Gupta and D.S. Hira: Chand and Company Limited,Nagar, New Delhi, 1986.

Math-740   Operation Research-II

1. **LINEAR PROGRAMMING (ADVANCED TOPICS):**

   Matrix definition of the standard linear programming Problems. Foundation in linear programming. Revised simplex method.

2. **INTEGER PROGRAMMING:**

   Definition and applications of integer Programming. Methods of Integer programming. Branch and bound methods.

3. **DYNAMIC PROGRAMMING:**

   Elements of DP model. Definition of the state and stages. Examples of DP models and computations. Problem of Dimeninality in DP in Solution of linear programs by Dynamic Programming.

4. **INVENTORY MODELS:**

   A Generalized Inventory model. Types of Inventory models. Deterministic models.

Recommended Books:

1. Operation Research: An Introduction, 3rd Edition Hamdy A. Taha. Collier MacMillon.
2. Operations Research by P.K. Gupta and D.S. Hira: Chand and Company Limited,Nagar, New Delhi, 1986.

Math-742   Topological Vector Spaces

Vector Spaces, Convex Sets. Balanced Sets. Absorbent Sets, Linear Functionals, Linear Manifolds. Sublinear Linear Functionals and Extension of Linear Functionals. Topological Vector Spaces, Definitions and General Properties. Product and Quotient Spaces. Finite Dimensional Topological Vector Spaces, Closed Hyperplanes, Bounded Sets, Convex Sets and Compact Sets in topological Vector Spaces, Seminorms, Locally Convex Spaces, Minkowski Functionals, Normable Spaces. Metrizable Topological Linear Spaces.

Recommended Books:

1. A.P. Robertson & W.Robertson. Topological Vector Spaces, Cambridge University Press, 1966.
2. R. Cristesu, Topological Vector Spaces, Noordhof International Publishing Netherlands, 1977.
3. F.Treves, Topological Vector Spaces, Distribution and Kernels Academic Press, New York, 1967.
4. A.E. Taylor and D.C. Lay, Introduction to Functional Analysis, John Wiley & Sons Inc, 1980.

Math-743   Spectral Theory in Hilbert Spaces

The concept of Hilbert Spaces, Inner Product Spaces. Hilbert Spaces. Bounded Linear Operators, Bilinear Forms,Adjoint Operators, Projection Operators, The Fourier-Phincherl Operator. General Theory and Spectral Analysis of Linear Operators,Closed Linear Operatos, Invariant Subspaces of a Linear Operator, Eigenvalues and Spectrum of a Linear Operator. The Spectral Decomposition of a Bounded Self-Adjoint Operator.

Recommended Books:

1. G. Helmberrg, Introduction to Spectral Theory in Hilbert Spaces, Amsterdam London, 1969.
2. E.Kreyszing, Introductory Functional Analysis with Applications,John Wiley and Sons N.Y. 1978.
3. N.I. Akhiezer & I.M. Glazman, Theory of Linear Operators in Hilbert Spaces, Vol-I, Fredrik Ungar Publishing Co. N.Y 1963.
4. N.I. Akhiezer & I.M. Glazman, Theory of Linear Operators in Hilbert Spaces, Vol-II, Fredrik Ungar Publishing Co. N.Y 1963.
5. G.F. Simmons,Topology and Modern Analysis, McGraw Hill. Book Company, 1963.

Math-744   Banach Algebras

Banach Algebras, Ideals, Homomorphisms, Quotient Algebra,Wiener's Lemma, Gelfand's Theory of commutative Banach Algebras, The Notion of Gelfand's Topology, Radicals, Gelfand's Transforms,Basic Properties of Spectra, Gelfand-Mazur Functions, Normed rings, Gelfand-Niamark Theorem.

Recommended Books:

1. R.G. Douglas, Banach Algebra Techniques inOperator Theory, Academic Press, 1972.
2. M.A. Naimark, Normed Algebras, Wolters Noordhoff Pub. Netherland, 1972.
3. W.Zelazko, Banach Algebras, American Elsevier Pub. N.Y. 1973
4. C.E. Richart, Banach Algebras, D.Van Nostrand Pub. N.Y. 1960
5. G.F. Simmons, Topology and Modern Analysis, McGraw Hill Book Company 1967.

Math-760   Directive Study