SHRI MATA VAISHNO DEVI UNIVERSITY

Kakryal, Katra–182320 (J&K) INDIA

(A Statutory Technical University of J&K Legislature; recognized u/s 2(f) & 12(B) of UGC)

School of Mathematics

SMVDU/SOM/20/680

Minutes of Meeting of 8th Board of Studies (BoS) of School of Mathematics

Date: 16/03/2020

Meeting of Board of Studies (BoS) of School of Mathematics (SoM) was held on 06th March, 2020 in the Conference Hall (D-207), School of Mathematics at 03:30PM Onwards. During the meeting following were present.

S. No.	Name / BoS Participants	Affiliation
1.	Dr. Uday Pratap Singh	Associate Professor & Head Chairman, BoS
2.	Prof. V K Bhat	Professor & Dean, FoS
3.	Prof. R. K. Sharma	Professor, Department of Mathematics, IIT Delhi, *(External Expert member)*
4.	Dr. Manoj Kumar Gupta	Associate Professor and Head, School of Computer Science & Engineering *(Special Invitee)*
5.	Dr. Roop Lal Sharma	Assistant Professor, School of Economics
6.	Dr. A. K. Das	Associate Professor, SoM
7.	Dr. Kuldeep Raj	Assistant Professor, SoM
8.	Dr. Sandeep Bhougal	Assistant Professor, SoM
9.	Dr. Rakesh Kumar	Assistant Professor, SoM
10.	Dr. Surender Singh	Assistant Professor, SoM
11.	Dr. Sandeep Sharma	Assistant Professor, SoM

The following member(s) could not attend the meeting.

1.	Dr. Romesh Kumar	Professor & Head, Department of Mathematics, Jammu University, *(External Expert member)*

As per the agenda of BoS meeting, following items were discussed and recommended:

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The following member(s) could not attend the meeting.

1.	Dr. Romesh Kumar	Professor & Head, Department of Mathematics, Jammu University, *(External Expert member)*

As per the agenda of BoS meeting, following items were discussed and recommended:

Item: 8.1	To confirm the minutes of the 6thmeeting of Board of Studies (BoS), held on 29th April, 2016. **Head of School of Mathematics appraised the house about the compliance status of decisions taken during 7th BoS meeting and efforts made towards the same were appreciated.** **Minutes of 7th BoS meeting were confirmed.**
Item: 8.2	To discuss / review the programme structure of existing M.Sc. (Mathematics) programme. **Presently running scheme structure and curriculum of existing M.Sc. (Mathematics) programme was discussed and reviewed, and found upto standard in terms of model curriculum of UGC and in line with advancements in the field.**
Item: 8.3	To Review and finalize the Syllabus and Course Code for the proposed new Integrated B.Sc. (Honours) Mathematics-M.Sc. (Mathematics) programme. *(Syllabus with courses code of proposed programme is annexed as Annexure-I)* **A thorough discussion about the course structure and course codes for new Integrated B.Sc. (Honours) Mathematics-M.Sc. (Mathematics) programme were discussed and the course structure was approved. Moreover, the detailed syllabus of the above said courses of the programme was presented before the house and it was observed that the proposed syllabus will focus all areas of pure and applied mathematics. Therefore, the detailed syllabus for Integrated B.Sc. (Honours) Mathematics-M.Sc. (Mathematics) programme was also approved. The course structure and detailed syllabus are placed as Annexure-I**
Item: 8.4	**Any other item with the permission of chair**

The meeting ended with vote of thanks to Chair.

(Dr. Uday Pratap Singh)
Chairman, BoS

(Annexure-I)

DETAILS

OF

SCHEME AND SYLLABUS

FOR

INTEGRATED B.SC. (HONOURS) MATHEMATICS

M.SC. (MATHEMATICS) PROGRAMME

OFFERED

BY

SCHOOL OF MATHEMATICS

SHRI MATA VAISHNO DEVI UNIVERSITY, KATRA

(FOR APRROVAL OF BOS)

DATE: 6th March, 2020

SHRI MATA VAISHNO DEVI UNIVERSITY

Kakryal, Katra–182320 (J&K) INDIA

(A Statutory Technical University of J&K Legislature; recognized u/s 2(f) & 12(B) of UGC)

School of Mathematics

Course Structure with Corse Code of Integrated B.Sc. (Honours) Mathematics-M.Sc. Mathematics Programme

Semester I   **First Year**

Course Code	Course Title	L-T-P	Credits
MTL-1231	Differential Calculus	3-1-0	4
MTL-1241	Elements of Discrete Mathematics	3-1-0	4
MXX-XXXX	Basic Optics	3-0-2	4
MXX-XXXX	Conceptual Organic Chemistry/Basics of Biology	3-0-2	4
MXX-XXXX	Written Communication-I	2-0-2	3
	Total Credits	**14-2-6**	**19**

Semester II   **First Year**

Course Code	Course Title	L-T-P	Credits
MTL-1232	Integral Calculus	3-1-0	4
MTL-1233	Analytical Geometry of 3-D and Trigonometry	3-1-0	4
MXX-XXXX	Electromagnetics	3-0-2	4
MXX-XXXX	Chemical Bonding Transition Metal & Coordination Chemistry / Molecules and Basic Process of Life	3-0-2	4
MXX-XXXX	Professional Communication	0-0-2	1
	Total Credits	**12-2-6**	**17**

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School of Mathematics

Semester III

Course Code	Course Title	L-T-P	Credits
MTL-2231	Fundamentals of Algebra	3-1-0	4
MTL-2232	Real Analysis	4-0-0	4
MTL-2241	**Computer Programming**	4-0-2	5
MXX-XXXX	Heat and Thermodynamics / Fundamentals of Physical Chemistry / Nutrition and Health	3-0-2	4
MXX-XXXX	Metaphysics of Human Existence	4-0-0	4
	Total Credits	**18-1-4**	**21**

Semester IV

Course Code	Course Title	L-T-P	Credits
MTL-2242	Combinatorial Mathematics	3-1-0	4
MTL-2251	**Probability and Statistics**	4-0-2	5
MTL-2243	Vector Calculus	4-0-0	4
MXX-XXXX	Foundation of Modern Physics / Analytical Methods in Chemistry / Applications of Biology	3-0-2	4
MXX-XXXX	Studies on Environmental Biology	4-0-0	4
MXX-XXXX	Fallacies in Common Reasoning	4-0-0	4
	Total Credits	**22-1-4**	**25**

Semester V   **Third Year**

Course Code	Course Title	L-T-P	Credits
MTL-3231	Multivariable Calculus	4-0-0	4
MTL-3241	Coding Theory	3-1-0	4
MTL-3242	**Fuzzy Logic and Applications**	3-0-2	4
MTL-3243	Integral Transforms	3-1-0	4
MTE-3XXX	Elective-I	4-1-0	5
	Total Credits	**16-2-4**	**20**

Semester VI   **Third Year**

Course Code	Course Title	L-T-P	Credits
MTL-3244	**Ordinary Differential Equation**	3-0-2	4
MTL-3245	Number Theory & Cryptography	3-1-0	4
MTL-3232	Linear Algebra	4-0-0	4
MTL-3261	Linear Programming and Game Theory	3-1-0	4
MTE-3XXX	Elective-II	4-1-0	5
	Total Credits	**17-3-2**	**21**

Semester VII   **Fourth Year**

Course Code	Course Title	L-T-P	Credits
MTL-6231	Abstract Algebra	3-1-0	4
MTL-6232	Advanced Real Analysis	4-0-0	4
MTL-6241	**Partial Differential Equations**	**4-0-2**	**5**
MTL-6242	Advanced Calculus and Special Functions	4-0-0	4
MTE-6XXX	Elective-III	4-1-0	5
MTP-6243	MATALAB	0-0-4	2
	Total Credits	**20-2-6**	**24**

Semester VIII   **Fourth Year**

Course Code	Course Title	L-T-P	Credits
MTL-6233	Complex Analysis	4-0-0	4
MTL-6234	Advanced Linear Algebra	4-0-0	4
MTL-6244	Differential and Integral Equations	4-0-0	4
MTL-6245	**Numerical Methods**	**4-0-2**	**5**
MTE-6XXX	Open Elective-1	3-0-0	3
	Total Credits	**19-0-2**	**20**

Semester IX   **Fifth Year**

Course Code	Course Title	L-T-P	Credits
MTL-7261	**Optimization Techniques**	**4-0-2**	**5**
MTL-7231	Topology	4-0-0	4
MTL-7241	Calculus of Variations and Mechanics	4-0-0	4
MTL-7242	Modern Applied Algebra	4-0-0	4
MTE-7XXX	Open Elective-II	3-0-0	3
	Total Credits	**19-0-2**	**20**

Semester X   **Fifth Year**

Course Code	Course Title	L-T-P	Credits *
MTL-7251	**Statistical Inference**	**4-0-2**	**5**
MTL-7232	Differential Geometry	4-0-0	4
MTL-7233	Functional Analysis	4-0-0	4
MTE-7XXX	Elective-IV	4-1-0	5
MTD-7281	**Project/Research Article #**	-------	**8+2**
	Total Credits	**16-0-2**	**28**

LIST OF ELECTIVE AND OPEN ELECTIVE COURSES:

Course Code	Course Name	L-T-P **	Credits
ELECTIVE-I			
MTE-3231	Non-Linear Analysis	5-0-0	5
MTE-3241	Graph Theory	4-1-0	5
MTE-3242	Theory of Reliability	5-0-0	5
ELECTIVE-II			
MTE-3243	Information Theory	4-1-0	5
MTE-3244	Biomathematics	4-1-0	5
MTE-3281	Financial Mathematics	4-1-0	5
ELECTIVE-III			
MTE-6281	Decision Theory	5-0-0	5
MTE-6282	Intelligent Systems and Control	4-1-0	5
MTE-6283	Econometrics	4-1-0	5
MTE-6241	Algebraic Number Theory	5-0-0	5
MTE-6251	Stochastic Process	4-1-0	5
ELECTIVE-IV			
MTE-7241	Partial Differential Equations and Special Functions	4-1-0	5
MTE-7231	Advanced Topics in Algebra	4-1-0	5
MTE-7261	Queuing Theory	5-0-0	5
MTE-7232	Advanced Topics in Topology	5-0-0	5
MTE-7242	Fluid Dynamics	5-0-0	5

	OPEN ELECTIVES		
MTE-6242	Fuzzy Systems	3-0-0	3
MTE-6231	Complex Dynamics	3-0-0	3
MTE-6252	Statistical Techniques	3-0-0	3
MTE-6243	Techniques in Numerical Analysis	3-0-0	3
MTE-6284	Soft Computing	3-0-0	3
MTE-6231	Commutative Algebra	3-0-0	3

* Credit to be earned from seminar presentations on the project during the semester
** Depends on the choice of the electives
# Contact hours with the project supervisor

Differential Calculus

MTL-1231   **L-T-P: 3-1-0 (Credits=4)**

UNIT-I

The real line, geometrical representation of real lines, limit and continuity (ε and δ definition), properties of limit and classification of discontinuities, Differentiability of functions, Limits and continuity of functions of two variables, partial and total derivative of implicit and composite functions, successive differentiation, Leibnitz's theorem, Euler's theorem on homogeneous functions. Taylor and Maclaurin's series expansions, applications in business, economics and life sciences.

UNIT-II

Tangent and Normal, Curvature, Asymptotes, Singular points, Double point, inflection point, Concavity and Convexity, Envelopes and Evolutes, Tracing of curves. Parametric representation of curves and tracing of parametric curves, Polar coordinates and tracing of curves in polar coordinates.

UNIT-III

Rolle's theorem, Mean Value theorems, Taylor's theorem with Lagrange's and Cauchy's forms of remainder, Taylor's series, Maclaurin's series of some standard functions, Maxima and Minima for functions of two variables, Lagranges multipliers, Indeterminate forms.

Recommended Books:

1. R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
2. S.K. Berberian, A First Course in Real Analysis, Springer Verlag, New York, 1994.
3. T. Apostol, Mathematical Analysis, Narosa Publishing House
4. Courant and John, Introduction to Calculus and Analysis, Vol I, Springer
5. W. Rudin, Principles of Mathematical Analysis, Tata McGraw-Hill
6. H. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc., 2002.
7. G.B. Thomas and R.L. Finney, Calculus, Pearson Education, 2007

Elements of Discrete Mathematics

MTL-1241   **L-T-P: 3-1-0 (Credits=4)**

UNIT-I

Unary and Binary operations, partial order relation, chains and anti-chains, Structure theorem, Lattices, Boolean algebra, order relation in Boolean algebra, Boolean polynomials, Block diagrams for gating network, Connections with logic. Boolean subalgebra, Disjunctive Normal form, Direct products and Boolean morphisms.

UNIT-II

Basic concepts of graph theory: vertices, edges, degree, paths, circuits, cycles, complete graphs and trees. Multi-graphs, weighted graphs and directed graphs, Adjacency matrix of a graph, Connected and disconnected graphs, K-connected and K-edge connected graphs. Shortest path in weighted graphs, Eulerian path and circuits, Hamiltonian path and circuits, Planar graphs, chromatic number, edge colouring of graphs, Vizing's theorem. Trees and cut sets: Trees, spanning tree and cut set, minimum spanning tree.

UNIT-III

Pigeon hole Principle, Inclusion-Exclusion principle, Generating functions and Discrete numeric functions, manipulation of numeric functions, Asymptotic behaviour of numeric function, Recurrence relations, Linear recurrence relation with constant coefficients and their solutions, Homogeneous solution, particular solution & total solutions. Solution by the method of generating functions.

Recommended Books:

1. C.L. Liu, Elements of Discrete Mathematics, Mc Graw Hill International editions, 2006.
2. J.P Tremblay & R. Manohar, Discrete Mathematical Structures with applications to Computer Science, Tata Mc Graw Hill Book Co. 1988
3. N. Iyengar, Discrete Mathematics, Vikas Publishing House Pvt Ltd, 2003.
4. Richard Johnson Baugh, Discrete Mathematics, 7th ed., pearsons, 2009.
5. Narsingh Deo, Graph Theory, Prentice Hall of India, 2004.
6. K.D. Joshi, Foundations of Discrete Mathematics, Wiely Eastern Ltd., 1989

Integral Calculus

MTL-1232   **L-T-P: 3-1-0 (Credits=4)**

UNIT-I

Fundamental theorem of Integral calculus, Mean value theorems, Integration by parts, Trigonometric Integrals, Integration of rational functions by partial fractions, Reduction formula and derivation of different types of reduction formulas.

UNIT-II

Differentiation under integral sign by Leibnitz rule, Beta and Gamma functions and their properties, Differentiation under the integral sign, Leibnitz rule. Definite Integrals and their properties, rectifiability and length of a curve, quadrature and area between curves, change of order of integration, surface and volumes integrals of solids of revolution. Applications of definite integrals.

UNIT-III

Improper Integrals: Improper integrals of Type-I and Type–II, convergence and divergence of improper integrals. Double and triple integrals, Evaluation of integrals using change of order of integration, Jacobian transformations.

Recommended Books:

1. Maurice D. Weir, Joel Hass, Frank R. Giordano, Thomas' Calculus, Pearson, 14th Ed. 2018.
2. Hughes – Hallett et al., Calculus – Single and Multivariable, John-Wiley and Sons.
3. Robert T. Smith & Ronald B. Minton, Calculus, , McGraw-Hill, 4th Ed. 2011.
4. Shanti Narayan and P.K. Mittal, Integral Calculus, S. Chand & Company, Revised Edition.
5. R. K. Ghosh and K.C. Maiti, Integral Calculus, New Central Book Agency-Kolkata.
6. Joseph Edwards, Integral Calculus for Beginners, Arihant Publications; First edition (2016).

Analytical Geometry of 3-D and Trigonometry

MTL-1233   **L-T-P: 3-1-0 (Credits=4)**

UNIT-I

Review of concepts in two-dimensional geometry, Recapitulation of elements of three-dimensional geometry, Direction Cosine and direction Ratios, Different forms of equations of plane and straight line, angle between two planes, Line of intersection of two planes, Plane coaxal with given planes, Planes bisecting the angle between two planes, Angle between a line and a plane, Coplanarity of two lines, Shortest distance between two lines.

UNIT-II

Equation of the sphere in general and standard forms, equation of a sphere with given ends of a diameter, Plane section of a sphere, Tangent plane to a sphere, Intersection of two spheres, orthogonality of spheres, Sphere through a given circle, Intersection of a sphere and a line, Power of a point, Plane of contact, Polar plane, Angle of intersection of two spheres, Radical plane, Coaxial system of spheres.
Definition of cone, Enveloping cone of a sphere, Various equations of cone, Intersection of a line and a quadric cone, Tangent lines and tangent plane at a point of cone, Condition that a plane may touch a cone, Reciprocal cones, Intersection of two cones with a common vertex, Right circular cone.

UNIT-III

Definition of cylinder, cylinder whose generators intersect a given conic and are parallel to a given line, Equation of the right circular cylinder, cylinder with a given axis and radius, Different Conicoids.
Trigonometry: De-Moivre's theorem and applications. Direct and inverse, circular and hyperbolic, functions. Logarithm of a complex quantity. Expansion of trigonometric functions.

Recommended Books:

1. Loney, S. L., The Elements of Co-ordinate Geometry, MacMillan & Co., 1895.
2. Narayan, Shanti, Analytical Solid Geometry, S. Chand & Co., 12th Edition.
3. Chatterjee, Dipak, Analytical Solid Geometry, PHI Pvt. Ltd.
4. Hunt, Brian R., Lipsman, Ronald L., Rosenberg, Jonathan M., A Guide to MATLAB for Beginners and Experienced Users, Cambridge University Press, 1st Edition.

Fundamentals of Algebra

MTL-2231   **L-T-P: 3-1-0 (Credits=4)**

UNIT-I

Introduction of Set Theory, Cartesian Products of Sets, Injections, Surjections, Bijections Binary Operations on Sets, Identities, Inverses, and Closure, Equivalence Relations, Divisibility, Primes, GCDs, and the Euclidean Algorithm, Congruence, Division Modulo n and Linear Congruence Equations, Fermat's and Euler's theorems, Matrix Algebra.

UNIT-II

Introduction to Groups, Groups of transformations, General and special linear groups, Dihedral groups, Subgroups, Cyclic Groups, Homomorphisms, Isomorphism and homomorphism, Kernels, Permutation Groups, The alternating groups A_n, Normal Subgroups, Quotient Groups, Fundamental Theorem of Group Homomorphism, Coset decomposition, Lagrange's theorem and its consequences, Cayley's theorem.

UNIT-III

Introduction to Rings, Subrings, Integral Domains, Ideals, Prime and Maximal Ideals, Fields, Fields of Fractions and Quotient Rings, Fundamental Theorems of Ring Homomorphism, Finite Fields.

Recommended Books:

1. D. Dummit and R. Foote, Abstract Algebra, 3rd edition, Wiley, 2003
2. Thomas W. Hungerford, Abstract Algebra: An Introduction, Third Edition, 2014
3. Thomas Judson's Abstract Algebra: Theory and Applications, 2013 edition
4. Rajendra Kumar Sharma, Sudesh Kumari Shah and Asha Gauri Shankar, Alegebra I: A Basic Course in Algebra, Pearson Education, 2011
5. I.N. Herstein, Topics in Algebra, 2nd Edition, 1975

Real Analysis

MTL-2232   **L-T-P: 4-0-0 (Credits=4)**

UNIT-I

Idea of countable sets, uncountable sets and uncountability of R, Order Properties of Q and its order incompleteness, Order Completeness of R, The least upper bound property and equivalent conditions including the nested interval property, Archimedean property of R, Bounded sets and their properties, sup and inf of sets.

UNIT-II

Sequences, Bounded sequences, monotone sequences and their convergence, lim-sup and lim-inf and convergence criterion using them, subsequences, Cauchy sequences and their convergence criterion, Sandwich rule. Nested interval theorems, Cauchy's first and second limit theorems, tests for convergence: comparison test, limit comparison test, ratio test, Cauchy's n-th root test, Kummer's test and Gauss test (statements only), Alternating series, Leibniz test, Absolute and conditional convergence.

UNIT-III

Interior points and limit points, open, closed and perfect sets, Compact sets, Limit and continuity, Basic properties of continuous functions, sequential criterion for continuity & discontinuity, Algebra of continuous functions, Uniform continuity, Bounded functions, Continuous functions defined on a compact set: Their boundedness, attainment of bounds and uniform continuity, Intermediate Value Theorem.

Recommended Books:

1. T. Apostol, Mathematical Analysis.
2. R. Courant and F. John, Introduction to Calculus and Analysis, Volume I.

3. Goldberg, Methods of Real Analysis.
4. Rudin, Principles of Mathematical Analysis.
5. S. Narayan, A Course in Mathematical Analysis.

Combinatorial Mathematics

MTL-2242   **L-T-P: 3-1-0 (Credits=4)**

UNIT-I

Set identities, Relation and function, Composition of relations and functions, Partitions, Equivalence Relations with example of congruence modulo relation, Partial ordering relations,   binary and n-ary relations, Pigeonhole principle, Basic counting principles, Permutations and Combinations, Binomial and Multinomial theorems, Principle of Inclusion and Exclusion, Derangements, Inversion formulae, Pairing problems, Pairing within a set, Pairing between sets, an optimal assignment problem, Gale's optimal assignment problem.

UNIT-II

Generating functions: Generating function models, calculating generating functions, Exponential generating functions. Recurrence relations: Recurrence relation models Divide and conquer relations, Solution of recurrence relations, Solutions by generating functions. Integer partitions, Systems of distinct representatives.

UNIT-III

Polya theory of counting: Necklace problem and Burnside's lemma, cyclic index of a permutation group, Polya's theorems and their immediate applications. Latin squares, Hadamard matrices, combinatorial designs, Symmetric designs.

Recommended Books:

1. Ian Anderson, A First course in Combinatorial Mathematics, Springer, 1989
2. P. J. Cameron, Combinatorics: Topics, Techniques, Algorithms, Cambridge University Press, 2001.
3. J.H. van Lint and R.M. Wilson, A Course in Combinatorics, 2nd Ed., Cambridge University Press, 2001.
4. V. Krishnamurthy, Combinatorics, Theory and Application, Affiliated East-West Press 1985.
5. P.J. Cameron, Combinatorics, Topics, Techniques, Algorithms, Cambridge University Press, 1995.
6. M. Jr. Hall, Combinatorial Theory, 2nd Ed., John Wiley & Sons, 1986.
7. S.S. Sane, Combinatorial Techniques, Hindustan Book Agency, 2013.
8. R.A. Brualdi, Introductory Combinatorics, 5th Ed., Pearson Education Inc., 2009.

Probability and Statistics

MTL-2251   **L-T-P: 3-0-2 (Credits=4)**

UNIT-I

Definitions, Scope and importance of statistics, General nature of statistical data, qualitative and quantitative data, discrete and continuous data, Primary and secondary data, classification & Tabulation, frequency distribution and their graphical and diagrammatic representations histogram, frequency curves, bar diagram, Ogive and measures of central tendency (A.M.,G.M.,H.M.) Median and mode, their merits and demerits. Measures of Dispersion: Range. Inter Quartile range, Mean Deviation, Standard Deviation, Variance & Coefficient of Variation. Skewness and Kurtosis meaning and measures.

UNIT-II

Probability: Random experiment, events, algebra of events, definitions of Probability, conditional Probability. Independent events, simple illustrations, Bayes Theorem and its applications. Probability mass function and Probability density function, joint marginal and conditional pmf and pdf. Independence of random variables, Discrete and continuous random variables.

UNIT-III

Mathematical expectation, expectation of sum of two random variables and product of two independent random variables, conditional expectation and conditional variance, moment generating function and its properties. Bivariate data: Correlation and Regression, Karl Pearson and Spearman Rank Correlation coefficient. Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves.

Recommended Books:

1. Erwin Kreyzig, Advanced Engineering Mathematics.
2. S. Ross, A First Course in Probability,
3. W. Feller, An introduction to Probability Theory and its applications
4. S.P. Gupta, Statistical Methods, Sultan Chand and sons.
5. S.C. Gupta, V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand and Sons.
6. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.

Vector Calculus

MTL-2243   **L-T-P: 4-0-0 (Credits=4)**

UNIT-I

Scalar and vector product of three vectors, product of four vectors, Reciprocal vectors. Vector differentiation, Scalar Valued point functions, vector valued point functions, derivative along a curve, directional derivatives, Gradient of a scalar point function, geometrical interpretation of grad, Divergence and curl of vector point function, characters of Divergence and Curl of a vector point functions, Gradient, divergence and curl related vector identities.

UNIT-II

Orthogonal curvilinear coordinates Conditions for orthogonality fundamental triad of mutually orthogonal unit vectors. Gradient, Divergence, Curl and Laplacian operators in terms of orthogonal curvilinear coordinates, Cylindrical co-ordinates and Spherical coordinates.

UNIT-III

Vector integration, Line integral, Surface integral, Volume integral. Theorems of Gauss, Green & Stokes and problems based on these theorems.

Recommended Books:

1. Murrary R. Spiegal : Theory and Problems of Advanced Calculus, Schaum Publishing Company, New York.
2. Murrary R. Spiegal : Vector Analysis, Schaum Publisghing Company, New York.
3. N. Saran and S.N. NIgam. Introduction to Vector Analysis, Pothishala Pvt. Ltd., Allahabad.
4. Shanti Narayna : A Text Book of Vector Calculus. S. Chand & Co., New Delhi.

Multivariable Calculus

MTL-3231   **L-T-P: 4-0-0 (Credits=4)**

UNIT-I

Concept of neighbourhood of a point in R^n ($n > 1$), interior point, limit point, open set and closed set in R^n ($n > 1$). Functions of several variables, limit and continuity of functions of two variables. Partial differentiation, total differentiability and differentiability, sufficient condition for differentiability. Chain rule for one and two independent parameters, directional derivatives, the gradient, maximal and normal property of the gradient, tangent planes.

UNIT-II

Extrema of functions of two variables, method of Lagrange multipliers, Concavity and Convexity, Definition of vector field, divergence and curl, Double integration over rectangular region, double integration over nonrectangular region, Double integrals in polar co-ordinates.

UNIT-III

Triple integrals, Triple integral over a parallelepiped and solid regions. Volume by triple integrals, cylindrical and spherical co-ordinates. Change of variables in double integrals and triple integrals, Line integrals, Applications of line integrals: Mass and Work, Fundamental theorem for line integrals, conservative vector fields.

Recommended Books:

1. M. J,.Strauss, G. L. Bradley and K. J. Smith, Calculus (3rd Edition), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007.
2. S C Mallik and S Arora: Mathematical Analysis, New Age International Publications
3. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
4. E. Marsden, A.J. Tromba and A. Weinstein, Basic Multivariable Calculus,Springer(SIE). Indian reprint, 2005.

Coding Theory

MTL-3241   **L-T-P: 3-1-0 (Credits=4)**

UNIT-I

Introduction to Coding Theory: Code words, distance and weight function, Nearest-neighbour decoding principle, Error detection and correction, Matrix encoding techniques, Matrix codes, Group codes, decoding by coset leaders, Generator and parity check matrices, Syndrome decoding procedure, Dual codes.

UNIT-II

Linear codes, Matrix description of linear codes, Equivalence of linear codes, Minimum distance of linear codes, Dual code of a linear code, Weight distribution of the dual code of a binary linear code, Hamming codes. Polynomial codes, Finite fields, Minimal and primitive polynomials, BCH codes, Golay Codes, Introduction to geometric codes.

UNIT-III

Cyclic codes, Algebraic description of cyclic codes, Check polynomial, Hamming codes as cyclic codes, Maximum distance separable codes, Necessary and sufficient conditions for MDS codes, Weight distribution of MDS codes, an existence problem, Reed-Solomon codes. Convolutional code: Encoding, state diagram, trellis diagram, distance properties, Decoding of convolutional codes, BCJR algorithm, Performance bounds for convolutional codes.

Reference Books:

1. Fundamentals in information theory and coding, Monica Borda, Springer.
2. Communication Systems: Analog and digital, Singh and Sapre, TataMcGraw Hill
3. Roman Steven, Coding and Information Theory, Springer Verlag, 1992.
4. Garrett Paul, The Mathematics of Coding Theory, Pearson Education, 2004.
5. Vera P., Introduction to the Theory of Error Correcting Codes, John Wiley and Sons, 1998
6. Vermani L R, Elements of Algebraic Coding Theory, Chapman and Hall, 1996.

Fuzzy Logic and Applications

L-T-P: 3-0-2 (Credits=4)

MTL-3242

UNIT-I

Fuzzy Sets: Basic definitions, α-cuts, strong α-cuts, level and support of a fuzzy set, core and height, normal and subnormal, convex fuzzy sets, cutworthy and strong cutworthy property, standard fuzzy set operations, equilibrium points, fuzzy set inclusion, cardinality of a fuzzy set, the degree of subsethood, Representation of fuzzy sets, three basic decomposition theorems of fuzzy sets, Extension principle for fuzzy sets, the Zadeh's extension principle, Images and inverse images of fuzzy sets, Fuzzy numbers, relation between fuzzy number and a convex fuzzy set.

UNIT-II

Operators on fuzzy sets: fuzzy complements, equilibrium of a fuzzy complement, equilibrium of a continuous fuzzy complement, first and second characterization theorems of fuzzy complements, fuzzy intersections (t-norms), standard fuzzy intersection as the only idempotent t-norm, standard intersection, algebraic product, bounded difference and drastic intersection as examples of t-norms, decreasing generator, the Pseudo-inverse of a decreasing generator, increasing generators and their Pseudo inverses, conversion of decreasing generators and increasing generators, characterization theorem of t-norms, Fuzzy unions, standard union, algebraic sum, bounded sum and drastic union as examples of t-conorms, characterization theorem of t-conorms.

UNIT-III

Fuzzy Relations: Crisp and fuzzy relations, projections and cylindrical extensions, binary fuzzy relations, domain, range and height of a fuzzy relation, membership matrices, sagittal diagram, inverse of a fuzzy relation, composition of fuzzy relations, standard composition, max-min composition. Decision–making in Fuzzy environment: Individual decision-making, fuzzy decision, simple examples, idea of weighting coefficients, Fuzzy group decision, Pattern recognition, Clustering, Fuzzy optimization Models.

Recommended Books:

1. G.J. Klir and B. Yuan: Fuzzy Sets and Fuzzy Logic; Theory and Applications, Sixth Indian Reprint, Prentice Hall of India, New Delhi, 2002.
2. H.J. Zimmerman, Fuzzy Set Theory and it Application, Second revised edition, Springer Science+Business Media, Newyork, 1990.

Integral Transforms

L-T-P: 3-1-0 (Credits=4)

MTL-3243

UNIT-I

Fourier Analysis: Periodic functions, trigonometric series, Fourier series for functions with period 2Π, complex form of the series, functions with arbitrary period, even and odd functions, half range

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series, approximation by trigonometric polynomials, square error, Bessel's inequality, Parseval's identity, Fourier integral.

UNIT-II

Laplace Transforms: Function of bounded variation, Laplace transform of 1, t^n, e^{at}, $\sin(at)$, $\cos(at)$, $\sinh(at)$, $\cosh(at)$, $\mathrm{erf}(t)$, shifting properties, expressions with proofs for: 1. $L\{t^n f(t)\}$ 2. $L\{f(t)/t\}$ 3. $L\{\int f(u)\,du\}$. Unit step functions, Heaviside function, direct functions and their Laplace transformation, Laplace transform of periodic function. Evaluation of inverse Laplace transform, partial fraction method, Heaviside development, convolution theorem. Application to solve initial and boundary value problems involving the ordinary differential equation with one dependent variable.

UNIT-III

Fourier transforms: Properties of Fourier transform, Fourier cosine and sine transforms of elementary functions, Properties of Fourier Transform: Linearity, Shifting, change of scale, Modulation, Fourier Transform of Derivatives and Integrals, Convolution Theorem (statement only), Inverse of Fourier Transform and its examples. Z-transforms: Properties of Z-transform, and inverse Z-transforms and applications, region of convergence of Z-transforms.

Recommended Books:

1. S.C. Malik & S. Arrora , Mathematical Analysis, New Age International, 1992.
2. T. Veerarajan, Engineering Mathematics, Tata McGraw Hill
3. Jordan, Mathematical Techniques, Oxford Press
4. Potter, Advance Engineering Mathematics, Oxford Press
5. Irvin Kreyszig, Advanced Engineering Mathematics, Wiley

Ordinary Differential Equation

MTL-3243   **L-T-P: 3-0-2 (Credits=4)**

UNIT-I

Definitions, Geometrical meaning of a differential equations of the first order and first degree, formation of a differential equation, variable separable form, homogenous equations, equation reducible to homogenous form, linear differential equations, equation reducible to linear form , exact differential equations, equations reducible to exact differential forms, First order higher degree equations solvable for x, y, p. Clairaut's form and singular solutions. Orthogonal trajectories. Linear differential equations with constant coefficients, Applications of differential equations of first order.

UNIT-II

Linear differential equations of higher order, Operator D, Rules to find the complementary solutions of the differential equations, Rules to find the particular solutions of the differential equations, Method of Variation of Parameters technique, Cauchy's Homogenous linear equations, Method of variation of parameters. Ordinary simultaneous differential equations.

UNIT-III

Series solutions of differential equations: Series solution of second order linear differential equations, Power series method, and regular singular point of the differential equations, Methods of Frobenius to solve differential equations, Legendre's and Bessel differential equation, solution of Legendre's and Bessel equations and their properties: Convergence, recurrence, and generating relations. Orthogonality of functions.

Recommended Books:

1. N.P.Bali, Manish Goyal, A Text Book of Engineering Mathematics, PLI
2. Ross, Wiley, Differential Equations

Minutes of Meeting of 8th BoS of SoM (Dated: 6th March, 2020)

3. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, Inc.,9th edition, 2011.
4. Simons, George, Differential equations with applications

Number Theory & Cryptography
MTL-3245   **L-T-P: 3-1-0 (Credits=4)**

UNIT-I
Divisibility, Greatest common divisor, Euclidean Algorithm, The Fundamental Theorem of arithmetic, linear congruences, Special divisibility tests, Chinese remainder theorem, residue classes and reduced residue classes, Fermat's little theorem, Wilson's theorem, Euler's theorem.

UNIT-II
Congruences: Definition and properties, Euler's phi function, Fermat's Theorem, Euler's Theorem, Wilson's Theorem, Solutions of Congruences, The Chinese Remainder Theorem, Multiplicative property of Euler's phi function, Primitive Roots, Quadratic Reciprocity, Quadratic Residues, The Legendre Symbol and its properties, Lemma of Gauss, The Gaussian Reciprocity Law, The Jacobi symbol.

UNIT-III
Mobius inversion Formula, the greatest integer function, perfect numbers, Mersenne primes and Fermat numbers. Quadratic residues, Diophantine equations, sums of two and four squares, Introduction to Cryptography, need of the cryptosystems, Symmetric Key and Asymmetric Key, discrete log, the idea of public key cryptography, DES, IDEA and RSA.

Reference Books:

1. Stallings, W., Cryptography and Network Security, 5 th Edition. Pearson, 2010.
2. Burton, D.M., Elementary Number Theory, 7 th Edition. McGraw-Hill Education, 2010.
3. Hardy, G.H. and Wright, E.M., An introduction to the Theory of Numbers, 4 th Edition. Oxford University Press, 1975.
4. H. Davenport, The Higher Arithmetic, Cambridge University Press, 2008

Linear Algebra
MTL-3232   **L-T-P: 4-0-0 (Credits=4)**

UNIT-I
Vector spaces, subspaces, Sum and Direct sum of subspaces, Linear span, Linearly Independent and dependent subsets of a vector space. Finitely generated vector space, Existence theorem for basis of a finitely generated vactor space, Finite dimensional vector spaces, Invariance of the number of elements of bases sets, Dimensions, Quotient space and its dimension, Homomorphism and isomorphism of vector spaces, Linear transformations, Vector space of all the linear transformations.

UNIT–II
Dual Spaces, Bidual spaces, annihilator of subspaces of finite dimensional vector spaces, Null Space, Range space of a linear transformation, Rank and Nullity Theorem, Algebra of Linear Transformation, Minimal Polynomial of a linear transformation, Singular and non-singular linear transformations.

UNIT–III
Matrix of a linear Transformation, Diagonal, permutation, triangular, and symmetric matrices. Rectangular matrices and column vectors, Non-singular transformations, Inverse of LT, Change of basis, Eigen values and Eigen vectors of linear transformations, Inner product spaces, Cauchy-Schwarz inequality, Orthogonal vectors, Orthogonal complements, Orthogonal sets and Basis, Bessel's inequality for finite dimensional vector spaces, Gram-Schmidt, Orthogonalization process.

Recommended Books:

1. S. Axler, Linear Algebra Done Right, 2nd Edition, John-Wiley, 1999.
2. K. Hoffman and R. Kunze, Linear Algebra, 2nd Edition, Prentice- Hall of India, 2005
3. S. Lang, Linear Algebra, Springer UTM, 1997.
4. S. Kumaresan, Linear Algebra: A Geometric Approach, Prentice-Hall of India, 2004

Linear Programming and Game Theory

MTL-3261   **L-T-P: 3-1-0 (Credits=4)**

UNIT-I

Meaning and nature of Operations Research (OR), Historical and development of OR, Applications of OR, OR models, OR methodology. Linear Programming Problem (LPP): Introduction, Mathematical Formulation of LPP, Graphical Solution to Linear programming problems, Special cases in graphical method.

UNIT-II

General Formulation of LPP, Slack and Surplus Variables, Standard form of LPP, Assumptions, Limitations and Applications of LPP, Computational procedure of Simplex Method, Artificial Variables, Big-M method, Two-Phase method, Special cases in Simplex procedure.

UNIT-III

Mathematical Formulation of Transportation Problem, Initial Basic Feasible Solution by North West Corner Rule, Least Cost Method, Vogel's Approximation method, Assignment problems, Hungarian Algorithm, Applications of transportation and assignment problems. Introduction to Game Theory, Maximin-Minimax principle, Saddle point, Games with saddle point, Applications of game theory.

Recommended Books:

1. Hadley, G., Linear Programming, Narosa Publishing House, 8th edition.
2. Sharma, S. D., Operations Research, Kedar Nath Ram Nath-Meerut, 10th edition.
3. Swarup, K, Gupta, M. and Manmohan, Operations Research, Sultan Chand and Sons,15th Edition.
4. Taha, H A., Operations Research, Pearson Education, 8th edition.

Abstract Algebra

MTL-6231   **L-T-P: 3-1-0 (Credits=4)**

UNIT-I

Review of basic Group Theory and Ring Theory, Symmetric and alternating groups, Simplicity of Alternating group A_n for n>5, Commutators, Conjugates, Centralizer, series of subgroups, Jordan Holder theorem, solvable groups.

UNIT-II

Integral Domains, Fields, Ideals, Residue class Rings, Theorems on Homomorphisms, Division Rings, Prime and Maximal Ideals, Polynomial Rings, Divisibility, Eulclidean and Principal Ideal Domains, Unique Factorization Domains, Gauss Theorem.

UNIT-III

Prime fields, Field Extensions, Algebraic element, Algebraic Extensions, Separable Extensions, Perfect Fields and Splitting Field.

Recommended Books:

1. I.N. Herstein, Topics in Algebra, Wiley, 2004.
2. Rajendra Kumar Sharma, Sudesh Kumari Shah and Asha Gauri Shankar, Alegebra I: A Basic Course in Algebra, Pearson Education, 2011
3. N. Jacobson, Basic Algebra-I, 2 ed, Courier Coorporation, 2012.
4. J.B. Fraleight, A First Course in Abstract Algebra, 7 ed, Pearson, 2002.
5. Bhattacharya, Jain & Nagpal, Abstract Algebra, Cambridge University Press, 2 ed, 1994.

Advanced Real Analysis

MTL-6232   **L-T-P: 4-0-0 (Credits=4)**

UNIT-I

Metric spaces: Basic notions, Examples of Metric spaces, Continuity, Completeness, Compactness, Euclidean spaces, Cantor's Theorem, Bolzano Weierstrass theorem, Lindeloff covering theorem, Heine Borel theorem, Pointwise and Uniform convergences, Baire Category theorem.

UNIT-II

The Riemann-Stieltjes integral: partitions, definition of Riemann-Stieltjes integral, refinement, existence of the integral, properties of the integral, fundamental theorems of integral calculus, mean value theorems, integration by parts. Functions of bounded variation, total variation, bounded variation functions as difference of monotone functions, continuous functions of bounded variations,

UNIT-III

σ-algebra of sets, limits of sequences of sets, Borel σ-algebra, G and F-sets, Measurable space and measure space, Outer measures, regular outer measures, metric outer measures, construction of outer measures. Construction & properties of Lebesgue measure, Integration of simple functions, Lebesgue integral of non-negative and measurable functions, Properties of Lebesgue integrals.

Recommended Books:

1. Rudin Walter: Real and Complex analysis, McGraw-Hill, 1976.
2. T. M. Apostol: Mathematical Analysis, 2nd Edition, Addison Wesley, 1974.
3. J.Yeh Lectures on Real Analysis, World Scientific 2000.
4. M.E. Munroe, Measure and Integration, 2nd edition Addison Wesley, 1971.
5. G.DeBarra, Measure theory and Integration, Wiley Eastern Ltd.,1987.
6. H.L.Royden, Real Analysis,3rd edition, Macmillan, New York, 1988.

Partial Differential Equations

MTL-6241   **L-T-P: 4-0-2 (Credits=5)**

UNIT-I

Introduction of Partial Differential Equation (PDE), formulation of first order PDE and Derivation of PDE by eliminating method of arbitrary functions, Lagrange's method, Integral surfaces passes through a given curves, Cauchy problem for first order PDE.

UNIT-II

Compatible system of first order PDE, particular forms of non-linear partial differential equations, Charpit's method. Classification of second order PDE, canonical form for elliptic equations, parabolic and hyperbolic equations.

UNIT-III

Laplace equation and its derivation, boundary value problems, harmonic functions, spherical mean, mean value theorem, Maximum-Minimum principle and its applications, Linear partial differential equations with constant coefficients. Homogeneous equations, Non homogeneous equation.

Recommended Books:

1. K. Sankara Rao, Introduction to Partial Differential Equations, Prentice Hall of India, 2nd Edition, New Delhi 2007.
2. F. John, Partial Differential equations, Narosa Publication
3. I. N. Sneddon, Elements of Partial Differential Equations, Mc-Graw Hill
4. F. Watson, Advanced Calculus:An Introduction to Analysis, Wiley, 3 edition, 2016
5. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, Inc.,9th edition, 2011.

Advanced Calculus and Special Functions

MTL-6242   **L-T-P: 4-0-0 (Credits=4)**

UNIT-I

Limit of function of two variable, continuity, partial differentiation. Partial derivatives of higher order, Schwarz theorem, Young's Theorem, Homogeneous functions of three variables.

UNIT-II

Maxima and Minima, Restricted maxima and minima, Lagranges multipliers, Jacobian, Legendre polynomials $P_n(x)$, $Q_n(x)$; Rodrigues formulae, Orthogonality of Legendre Polynomials, Recurrance formulae.

UNIT-III

Bessels equations, Bessels functions, Recurrance relations, Orthogonality, generating function, integral expressions, Trigonometric expansion involving Bessel's function, Bessel's integrals, Fourier-Bessel expansion.

Recommended Books:

1. F. Watson, Advanced Calculus:An Introduction to Analysis, Wiley, 3 edition, 2016
2. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, Inc.,9th edition, 2011.
3. W. Rudin, Mathematical Analysis, Mc Graw-Hill, Inc., 3rd edition, 1976.
4. R. Goldberg, Methods of Real Analysis, John Wiley & Sons, Inc., 2nd edition, 1976.

Complex Analysis

MTL-6233   **L-T-P: 4-0-0 (Credits=4)**

UNIT-I

Analytic (Holomorphic) functions, Cauchy-Riemann equations, Polar form of Cauchy-Rieman equations, Harmonic functions, Exponential and Trigonometric functions, conformal transformation, Bilinear transformation.

UNIT-II

Integral along a path, Cauchy's Theorem, Cauchy Integral Formula, Taylor's and Laurent's expansions, Cauchy inequalities, Liouville's Theorem' Fundamental Theorem of Algebra, Morera's Theorem, Maximum modulus and minimum modulus Theorems, Argument Principle, Rouche's Theorem, Schwarz Lemma.

UNIT-III

Singularities, Different Types of singularities, Residue at a singularity, Cauchy's Residue theorem. Residue and Contour integration, Analytic continuation, Uniqueness of analytic continuation.

Reference Books:

1. John H. Mathews and Russell W. Howell, Complex analysis, Narosa Publication, 2006.
2. S. Lang, Complex Analysis Springer; 4th ed. 1999.
3. J.B. Conway, Functions of one Complex Variable, Springer; 2nd ed. 1978. Corr. 7th printing 1995 4. Ahlfors, Complex Analysis McGraw Hill Education India Private Limited;
4. Third edition, 2013
5. J.C. Chaturvedi & S.S. Seth, Functions of a Complex Variable McGraw-Hill, 1987
6. Walter Rudin, Real and Complex Analysis, McGraw-Hill, 1976.

Advanced Linear Algebra

MTL-6234	L-T-P: 4-0-0 (Credits=4)

UNIT-I

Review of basics of Inner product Space, The Riesz representation theorem, The Adjoint of a linear operator. Orthogonal projections, Quadratic maps. Symmetric forms, orthogonal bases. Symmetric forms over ordered fields. Hermitian forms. The spectral theorems in Hermitian and Symmetric cases. Alternating forms. Matrix groups: definition and examples, examples of compact linear groups, examples of connected linear groups.

UNIT-II

Normal operators. Spectral theorem for normal operators (statement only). Self-adjoint operators, unitary operators and Isometries. The polar decomposition of an operator. Singular Value Decomposition. Similar linear transformations, Invariant subspaces of vector spaces. Reduction of a linear transformation to triangular form. Nilpotent transformations. Index of nilpotency of a nilpotent transformation.

UNIT-III

Cyclic subspace with respect to a nilpotent transformation. Uniqueness of the invariants of a nilpotent transformation. Eigen values and Eigen vectors, Geometric and Algebraic Multiplicities, The Jordan Canonical Form, Rational Canonicals form of a linear transformation and its elementary divisior Triangularizability and Schur's Theorem, Diagonalizable Operators, Trace and transpose.

Recommended Books:

1. Roman, Steven. Advanced Linear Algebra. 3rd Edition. Springer. 2011
2. I.N. Herstein,: Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975
3. Hoffman &Kunze, Linear Algebra, Prentice Hall PTR,3rd revised ed., 1999
4. S. Lang, Linear Algebra, Springer New York, 1997

Differential and Integral Equations

MTL-6244	L-T-P: 4-0-0 (Credits=4)

UNIT-I

Simultaneous differential equations- Methods of solving simultaneous differential equation, Simultaneous equations of the first order, Linear differential equations of second order, Complete solution of the differential equations when one integral of the complementary function is known, Reduction to normal form, Solution by change of the independent variable, Solution by means of operational factors, Method of variation of parameters, Methods of undetermined coefficient.

UNIT-II

Exact linear differential equations of nth order, Condition of exactness for a linear equation of order n, Integrating factors, Non-linear differential equation of particular forms, Exact non-linear differential equations, Riccati's Equation, Homogeneous equations. Introduction and basic examples of Integral Equations.

UNIT-III

Classification, Conversion of Volterra Equation to ODE, Conversion of IVP and BVP to Integral Equation, Successive approximation, Successive substitution methods for Fredholm Integral Equations, series solution, successive approximation, successive substitution method for Volterra Integral Equations, Volterra Integral Equation of first kind, Integral Equations with separable Kernel, Fredholm's first, second and third theorem(statements only), Integral Equations with symmetric kernel, Eigen function expansion, Hilbert-Schmidt theorem.

Recommended Books:

1. E.L. Ince, Ordinary Differential Equations, Dover Publication Inc. 1956.
2. E.A. Coddington, An Introduction to ordinary differential equations, PHI,1990.
3. M. D. Raisinghania, Ordinary and Partial differential equations, S. Chand & Co., 2016.
4. C., Cordumeanu, Integral Equations and Applications, Cambridge University Press, 1991.
5. M. D. Raisinghanis, Integral Equations & Boundary Value Problems, S. Chand & Co., 2010.

Numerical Methods

MTL-6245   **L-T-P: 4-0-2 (Credits=5)**

UNIT-I

Differences: Error in interpolation, Detection of error by use of difference tables, Differences of a Polynomial, Newton's formula for Forward and Backward interpolation, Gauss Central difference Interpolation formula, Striling's formula, Bessel's formula, Interpolation with unequal intervals; Lagrange's formula, Divided differences and their properties, Newton's general Interpolation formula, Inverse interpolation.

UNIT-II

Errors in Numerical Calculations, Number and their accuracy, Errors and their analysis errors in a series approximation, Numerical solutions of algebraic and transcedental equations: Bisection Method, Iterative Method, Method of false-position, Newton-Raphson method, Secant method, curve fitting and approximation; fitting of a straight line. Approximation of functions, Chebyshev polynomials. Taylor's series approximation. Solution of linear systems of equations: Direct method, Elimination method, Gauss-seidel method, Jacobi method.

UNIT-III

Numerical Differentiation: Maximum and minimum value of a tabulted function, Numerical Integration: Trapezoidal Rule. Simpon's 1/3 and 3/8 Rule. Newton-cotes integration formula. Gaussian quardrature formula. Numerical evaluation of singular integrals. Numerical solution of ordinary differential equations: Solution by Taylor's series. Euler's method, Picard's method. Runge Kutta method. Predictor Corrector Method: Miline's method and Adams-Moulton's method.

Reference Books:

1. S.S. Sastry, Introductory Methods of Numerical Analysis, Prentice-Hall of India.
2. Gerald, C.F, and Wheatley, P.O, Applied Numerical Analysis, Sixth Edition, Pearson Education Asia, New Delhi, 2002.

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3. E. Balagurusamy, Numerical Methods, Tata McGraw-Hill Pub. Co. Ltd, New Delhi, 1999.
4. Burden, R.L and Faires, T.D., Numerical Analysis, Seventh Edition, Thomson Asia Pvt. Ltd., Singapore, 2002.
5. Conte S.D. & Boor C.D., Elementary Numerical Analysis, An algorithmic approach, Mc Graw Hill.

Optimization Techniques

MTL-7261   **L-T-P: 4-0-2 (Credits=5)**

UNIT-I

Introduction to Operations Research. Linear Programming: Principles of simplex Method, Simplex method in tabular form, Duality and Dual simplex Method, Degeneracy and cycling. Transportation and Assignment problems.

UNIT-II

Matrix games, Fundamental theorem of matrix games, Games with mixed strategies. Matrix game and its relation with linear programming. Network Scheduling: Networks and basic components, Rules for Network Construction, CPM and PERT.

UNIT-III

Queuing theory: Objectives, Different characteristics of a queuing system, Measures of Performance, Poisson process, Birth-death process, Steady-state behavior of Markovian and Erlangian queuing models (MM/1, MM/c, and $M/E_K/1$).

Recommended Books:

1. V.K. Kapoor, Operations Research, Sultan Chand and Sons, 9th Edition, 2014.
2. Taha, Operations Research, Pearson India, 9th Edition, 2014.
3. Kanti Swaroop, Operations Research, Sultan Chand, 2014.
4. S.D. Sharma, Operations Research, Kedar Nath Ram Nath and Co., 2013.
5. B.E. Gillet, Introduction of Operations research, Tata Mc-Graw Hill, 32nd Edition, 2008.
6. G.K. Murthy, Linear Programming, John Wiley & Sons Ltd. 1st Edition, 1983.
7. D. Gross and C.M. Harris, Fundamentals of Queuing Theory, Wiley India Private Limited; 4th Edition, 2012.

Topology

MTL-7231   **L-T-P: 4-0-0 (Credits=4)**

UNIT-I

Infinite sets, Countable & Uncountable sets, Statements of axiom of choice, Well ordering principle, Zorn's Lemma, Principle of transfinite induction, Housdorff's maximal principle, Topological spaces, open sets, closed sets, neighbourhoods, Bases for a Topology, order Topology, Product Topology, Subspace Topology, limit points, closures, interiors, closed sets, Continuous function. Homeomorphism. Metric Topology, quotient Topology (Introduction only).

UNIT-II

Connectedness and Compactness: Connectedness, Local Connectedness, path connectedness, Compact spaces, locally compact spaces and Limit point Compact spaces.

UNIT-III

Separation Axioms: Hausdorff spaces, Regularity, Normality, Urysohn's lemma, Tietze extension Theorem, Urysohn's Metrization Theorem. Tychnoff Theorem, Completely regular spaces, One-point Compactification and Stone-Cech compactification (Statement only).

Recommended Books:

1. J. R. Munkers, Topology- A First Course: Prentice Hall of India, 2 ed, 2002.
2. K. D. Joshi, General Topology, New age international, 2014.
3. M. G. Murdeshwar, General Topology, New Age International Pvt Ltd Publishers, 2008.
4. G. F. Simmons, Introduction to Topology & Modern Analysis, Tata McGraw-Hill Education, 2004.
5. J. L. Kelley, General Topology, Springer-Verlag, Berlin-Heidelberg-New York, 1975.
6. S. Willard, General Topology, Addison-Wesley Publishing company, Dover, 2012.

Calculus of Variations and Mechanics

MTL-7241   **L-T-P: 4-0-0 (Credits=4)**

UNIT-I

Introduction, problem of brachistochrone, problem of geodesics, isoperimetric problem, Variation and its properties, functions and functionals, Comparison between the notion of extrema of a function and a functional. Variational problems with the fixed boundaries, Euler's equation, the fundamental lemma of the calculus of variations, examples.

UNIT-II

Functionals involving more than one dependent variable and their first derivatives, the system of Euler's equations. Functionals depending on the higher derivatives of the dependent variables, Euler-Poisson equation, examples, Functionals containing several independent variables, Ostrogradsky equation, examples, Variational problems in parametric form, applications to differential equations, examples, Variational problems with moving boundaries, Transversality condition, examples.

UNIT-III

Generalized coordinates, Lagrange's equations, Applications of Lagrange Equations, Hamilton's canonical equations, Hamilton's principle and principle of least action, Two-dimensional motion of rigid bodies, Euler's dynamical equations for the motion of a rigid body about an axis.

Recommended Books:

1. L.E.Elsgolc, Calculus of Variations, Courier Corporation, 2012.
2. L.A. Pars, An Introduction to the Calculus of Variations, Courier Corporation, 2013.
3. I. M. Gelfand and S. V. Fomin, Calculus of Variations, PHI
4. M.G. Calkin, Lagrangian and Hamiltonian Mechanics, World Scientific Publishers, 1996.
5. Sankara Rao, Classical Mechanics, Prentice Hall India, 2005.

Modern Applied Algebra

MTL-7242   **L-T-P: 4-0-0 (Credits=4)**

UNIT-I

Binary Group Codes, Communication system and its problems, Binary Symmetric Channel, Encoding and Decoding, Error detecting and correcting codes, Block codes, Distance between words, Matrix Encoding Technique, Groups codes, Construction of Decoding Table, Hamming codes.

UNIT-II

Polynomial Rings, Polynomial Rings over field,Polynimal codes, Shift Register and its use in polynomial multiplication, Unique Factorization Theorem for polynomials,Complex Roots of unity, Formal Derivatives.

UNIT-III

Extension of fields, Simple Extensions, Computation in R[x]/[m(x)], Existence Theorem, Finite fields, Computation in GF (2^n). Root fields of Polynomials, BCH Codes.

Recommended Books:

1. G.Birkhoff., Barte, Thomas C., Modern Applied Algebra, CBS Publication
2. I.N. Herstein, Topics in Algebra, John Wiley & sons publisher, 2nd edition (1975)
3. Gill,Arthar, Applied Algebra for computer science, Prentice Hall of India.
4. Dornhoff, Larry L., Applied Modern Algebra , MacMillan & Co. & Franz E.
5. V. K. Bhat, Modern Algebra and its Applications, Narosa

Statistical Inference

MTL-7251   **L-T-P: 4-0-2 (Credits=5)**

UNIT-I

Probability and distributions: Definition of Probability, independent events, Addition and multiplication rules, conditional probability with examples. Bernoulli, Binomial, Poisson and Normal distributions. Mean and variance of these distributions and their applications.

UNIT-II

Hypothesis testing: Hypothesis, critical region, and error probabilities. Tests for means, proportion, equality of proportions. Chi-square test for independence.

UNIT-III

Methods of sampling: Use of random numbers to generate simple random samples with replacement and without replacement. Stratified sampling.

Recommended Books:

1. Miller Irwin and Miller Maryless, John E. Freund's Mathematical Statistics with Applications, Pearson Education, 2006.
2. Hogg V. Robert, Deceased Allen Craig, and McKean Joseph W., Introduction to Mathematical Statistics, Pearson Education, 2014.
3. J.N. Kapur and H.C. Saxena, Mathematical Statistics, S. Chand, 2012.
4. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand and Sons, 2015.
5. S.P. Gupta, Statistical Methods, Sultan Chand and Sons, 2012.

Differential Geometry

MTL-7232   **L-T-P: 4-0-0 (Credits=4)**

UNIT-I

Parametrized differential curve, regular curve, arc length, plane curves, Euler's theorem, curvature, fundamental theorem for plane curves, involutes and evolutes, Frenet-Serret theorem, torsion, helix, Fundamental theorem for curves in R^3.

UNIT-II

Regular surfaces. Inverse function theorem, Implicit function theorem, Change of Co-ordinates, tangent plane, Orientable surface, Tangential maps, First fundamental of a surface, Metric on a regular surface, Curvature for Surfaces, Euler's theorem, Gauss map, Meusnier theorem.

UNIT-III

Metric equivalence of surfaces, local isometry, Intrinisic and Extrinsic properties of surfaces, Christoffel Symbols of the first Kind and second kind, Gauss theorem, Fundamental theorem for regular surfaces in R3, Geodesic curves.

Recommended Books:

1. T.J. Will More, Introduction to differential Geometry, Oxford University press, 2012

SHRI MATA VAISHNO DEVI UNIVERSITY
Kakryal, Katra–182320 (J&K) INDIA
(A Statutory Technical University of J&K Legislature; recognized u/s 2(f) & 12(B) of UGC)

School of Mathematics

2. John Mccleary, Geometry from a differential view point, Cambridge University press, 2013
3. Barrett O'Neill, Elementary Differential Geometry, Academic press, 2006
4. W. Klingenberg, A course in differential geometry, springer- Verlag, 1978
5. E. Weatherburn, Differential geometry of three dimensions, Cambridge University press.

Functional Analysis

MTL-7233   **L-T-P: 4-0-0 (Credits=4)**

UNIT-I

Normed spaces, Banach spaces, Further properties of Normed spaces, Subspaces, Linear operators, Linear functionals, Bounded and continuous linear operators, Normed spaces of operators, Dual spaces.

UNIT-II

Hahn-Banach theorem (Extension of linear functionals) for normed spaces, Application to bounded linear functionals on $C[a,b]$, Adjoint operator, reflexive spaces, uniform boundedness theorem, Convergence of sequence of operators and functionals, Open mapping theorem, Closed linear operator, Closed graph theorem.

UNIT-III

Inner product spaces, Hilbert spaces, Further properties of inner product spaces, Orthogonal complements and direct sums, Orthonormal sets and sequences, Total orthonormal sets and sequences, Representation of functionals on Hilbert spaces, Hilbert adjoint operators, Self adjoint, Unitary and normal operators.

Recommended Books:

1. A. Mukherjea and K. Pothoven, Real and Functional Analysis, Springer-Verlag New York Inc.
2. E. Kreyszig, Introductory functional Analysis with application, John Willey and Sons, 1978.
3. Bachman and Naricel, Functional Analysis, Dover Publication, 2nd edition, 2003.
4. G.F. Simmons, Introduction to Topology and Modern Analysis, TMH, 2003.
5 P.K. Jain, O.P. Ahuja and Khalil Ahmed, Functional Analysis

Syllabus of Electives and Open Electives Courses

Non-Linear Analysis

MTE-3231   **L-T-P: 5-0-0 (Credits=5)**

UNIT-I

Laplace Transform. Laplace Transform of some elementary functions. Laplace Transform of derivatives. Laplace Transform of Bessel function. Inverse Laplace Transform of derivatives and integrals. Convolution of two functions. Convolution Theorem.

UNIT-II

Application of Laplace Transform to solve Differential equations. Solution of ordinary differential equations with constant co-efficient and with variable co-efficient. Application of Laplace Transform in initial and boundary value problem. Heat equation and Wave equation.

UNIT-III

Fourier Transforms. Fourier Sine and Cosine transforms. Convolution integral, Relationship between Fourier and Laplace Transform, Finite Fourier Sine and Cosine transforms, Inversion formula, Application of Fourier Transform in initial and boundary value problem.

Recommended Books:

1. I.N. Sneddon, The use of integral transforms. MacGraw hill, 1972 (illustrated), Digitised, 2010
2. A. R. Vashishtha, and R. K. Gupta, Integral Transforms. Krishna Prakashan media Merrut, 2nd ed. ,2004
3. B. Davies, Integral Transforms and their applications Springer, 3rd ed. 2002.

Graph Theory

MTE-3241   **L-T-P: 4-1-0 (Credits=5)**

UNIT-I

Review of basics: Graphs and digraphs, incidence and adjacency matrices, i Trees: Equivalent definitions of trees and forests, Cayley's formula, the Matrix-Tree theorem, minimum spanning trees. Cut vertices, cut edges, bonds, the cycle space and the bond space, blocks, Menger's theorem; Paths and Cycles: Euler tours, Hamilton paths and cycles, theorems of Dirac, Ore, Bondy and Chvatal, girth, circumference, Network flows.

UNIT-II

Matchings: Matchings: Berge's Theorem, perfect matchings, Hall's theorem, Tutte's theorem, Konig's theorem, Petersen's theorem, algorithms for matching and weighted matching (in both bipartitie and general graphs), factors of graphs (decompositions of the complete graph), Tutte's f-factor theorem.

UNIT-III

Extremal Problems: Extremal problems: Independent sets and covering numbers, Turan's theorem, Ramsey theorems; Colorings: Brooks theorem, the greedy algorithm, the Welsh-Powell bound, critical graphs, chromatic polynomials, girth and chromatic number, Vizing's theorem; Graphs on surfaces: Planar graphs, duality, Euler's formula, Kuratowski's theorem, toroidal graphs, 2-cell embeddings, graphs on other surfaces.

Recommended Books:

1. B. West Douglas, Introduction to Graph Theory, Prentice Hall of India,2002.
2. Narsingh Deo, Graph Theory with Applications to Engineering and Computer Science. Prentice-Hall,2004.
3. Frank Harary, Graph Theory, Narosa, 2000.
4. R. Ahuja, T. Magnanti, and J. Orlin, Network Flows: Theory, Algorithms, and Applications, Prentice-Hall.
5. Bela Bollobas, Modern Graph Theory, Springer.

Theory of Reliability

MTE-3242   **L-T-P: 5-0-0 (Credits=5)**

UNIT-I

Basics of Reliability, Classes of life Distributions. Series, Parallel, stand by configuration, (k, n) systems, Bridge structure. Reliability Models of maintained and non– maintained systems. Availability Theory and its Modeling for various configurations.

UNIT-II

Reliability Allocation problems. Discrete Replacement Policies Age, Block, Preventive and Corrective Maintenance policies, concept of minimal repair, notions of aging.

UNIT-III

Renewal theory and its applications, Solution of Renewal type equations, Algorithms by Min Xie. Optimisation problems with respect to systems Reliability. Overhaul and repair decision and other related problems. Introduction to Software Reliability.

Recommended Books:

1. Barlow, R.E. and Proschan, F., Mathematical theory of Reliability, John Wiley and Sons, New York 1965.
2. Cox., D.R., Renewal Theory, Matheun London, 1962
3. Jardine, A.K.S., Maintenance, Replacement and Reliability, Pitman
4. Morse, P.M., Queues, Inventories and Maintenance, John Wiley and Sons,
6. Rau, John, G., Optimization and Probability in systems engineering, Van Nostrand Reinhold Company, 1970.
7. Roy, Billinton and Ronald, W. Allan, Reliability Evaluation of Engineering Systems, Pitman Publication, 1983.
8. Tillman, F.A. Hwang, Optimisation of systems Reliability Marcel Dekker inc.
9. 8. Musa, J.D. Jannino Antony, Software Reliability Measurement, Prediction and Applications, McGraw Hill, 1987.
10. Lewis, E.E., Introduction to Reliability Engineering, 2nd edition, John Wiley & Sons, 1994.
11. Villemeur, A., Reliability, Availability, Maintainability and Safety Assessment, John Wiley,

Information Theory

MTE-3243   L-T-P: 4-1-0 (Credits=5)

UNIT-I

Measure of Information – Axioms for a measure of uncertainty, The Shannon entropy and its properties. Joint and conditional entropies, Transformation and its properties, Noiseless coding - Ingredients of noiseless coding problem, Uniquely decipherable codes, Necessary and sufficient condition for the existence of instantaneous codes, Construction of optimal codes.

UNIT-II

Discrete Memoryless Channel - Classification of channels, Information processed by a channel, Calculation of channel capacity, Decoding schemes, The ideal observer, The fundamental theorem of Information Theory and its strong and weak converses, Continuous Channels-The time-discrete Gaussian channel, Uncertainty of an absolutely continuous random variable, The converse to the coding theorem for time-discrete Gaussian channel, The time-continuous Gaussian channel, Band-limited channels.

UNIT-III

Some intuitive properties of a measure of entropy –Symmetry, normalization, expansibility, boundedness, recursivity, maximality, stability, additivity, subadditivity, nonnegativity, continuity, branching, etc. and interconnections among them, Axiomatic characterization of the Shannon entropy due to Shannon and Fadeev, Information functions, The fundamental equation of information.

Recommended Books:

1. Ash, R., Information Theory, Inderscience Publishers, New York, 1965.
2. Reza, F.M., An Introduction to Information Theory, MacGraw-Hill Book Company Inc., 1961.
3. Aczela, J. and Daroczy, Z., On Measures of Information and their Characterizations, Academic Press, New York

Biomathematics

MTE-3244   **L-T-P: 4-1-0 (Credits=5)**

UNIT-I

Dynamic Modeling with Difference equations: The Malthusian Model, Non-linear models, Analyzing non-linear models, Variations on the Logistic Model. Linear Models of Structured Populations: Linear models and Matrix algebra, Projection matrices for structured models, Eigenvectors and Eigenvalues. Curve Fitting and Biological Modeling: Fitting curves to data, The method of least squares, Polynomial curve fitting.

UNIT-II

Modeling Molecular Evolution: Background on DNA, An introduction to Probability, Conditional Probabilities, Matrix Models of Base Substitution. Genetics: Mendelian Genetics, Probability distributions in genetics, Linkage, Gene frequency in populations. Applications of stochastic processes in biology, Markov processes, Markov chains, Chapman-Kolmogorov Equations, Limiting distribution of Markov chain.

UNIT-II

Introduction of a Field K and an Algebra A over K, Examples, Types of Algebras, Basis and Dimensions of an Algebra, Gametic Algebra for Simple Mendalian Inheritance, Zygotic Algebra, Communicative Duplication of Algebras. Non associativity of Inheritance. Baric Algebra and Weight Function, Idempotents and Train Algebras, Genetic Algebra, Application of the Genetic Algebra in theory to genetics (Self-fertilization, autopolyploid and Sex-linked Inheritance).

Recommended Books:

1. Allman, Elizabeth S. and Rhodes, John A., Mathematical Models in Biology, Cambridge University Press (2004).
2. Keshet, E. L., Mathematical models in biology, Mc Graw-Hill, New York (1988).
3. Rubinow, S. I., Introduction to Mathematical Biology, John Wiley, New York (1975).
4. W-Busekros, A., Algebras in genetics, Lecture notes in biomathematics, Vol.-36, Springer-Verlag, New York (2006).
5. Medhi, J., Stochastic processes, New Age International (2010).

Financial Mathematics

MTE-3281   **L-T-P: 4-1-0 (Credits=5)**

UNIT-I

Role of Financial Management. Financial Analysis and planning. Working Capital Management. Cost of Capital, Capital Structure and Dividend Policies, Short term and Long-term Financial Planning.

UNIT-II

Analytical Approach to Finance. Technique of Goal Programming and its Application to Profit Planning and Financial Budgeting. Capital Expenditure Decision under Risk.

UNIT-III

Financing Decision: Problem of determining optimal capital structure, Leasing, Debt Management, Analysis of commitment of funds and risk of cash insolvency; Receivables and Inventory Management Approaches, Simulation Approach to Working Capital Management.

Recommended Books:

1. Van Horne J.C., Fundamentals of Financial Management, Prentice Hall
2. Brigham E.F., Gapenski L.C., Financial Management: Theory and Practice, The Dryden Press, 9th edi., 1998.

3. Khan M.Y. and Jain P.K., Financial Management, Tata McGraw Hill Pub. Co.,
4. Clark J.J. Hendland T.J. and Pritchard R.E, Capital Budgeting Planning and Control of Capital Expenditures, Prentice Hall, Englewood Cliffs, NJ, 1986.
5. Donaldson G. and Bertrand F., Corporate Debt Capacity: A Study of Corporate Debt Policy and the Determination of Corporate Debt Capacity, Beard Books, 2000.
6. Fogler, R.H. and Ganpathy, S., Financial Econometrics, Prentice Hall,
7. Levy H. and Sarnat M., Capital Investment and Financial Decisions, Prentice Hall, Englewood Cliffs, NJ, 1982.
8. Mao J.C.T., Quantitative Decision of Financial Decisions, Macmillan, NY,

Decision Theory

MTE-6281   **L-T-P: 5-0-0 (Credits=5)**

UNIT-I

Concepts of process, Bayesian Procedure, Decision Functions, Different Decision Criterion for Decision Problems under risk and Uncertainty. Regret versus Loss Function, Expected Value of perfect Information, Utility and its Application in Decision Problems.

UNIT-II

Multilevel (Multi-Stage) Decision problem, Principles of Diagramming and Locating of Optimal Strategy. Decision Analysis with Continuous Distribution for the Events.
Decision Process with Sampling Information: Simple Sampling and Binomial Sampling and with Updating the Prior Distribution of the Events (Use of Posterior Distribution). Decision Process and Normal Distribution of Event.

UNIT-III

Basic Concepts of the Sampling time Markov Decision process Examples, Stationary Policies, Average Cost Criterion, Policy- Iteration Algorithm, Linear Programming Formulation Procedure and Comparison of Linear Programming Formulation Procedure and Policy Iteration Algorithm for Solving an Infinite Stage Markov Decision Problem. Simple Concept of Semi Markov Decision Process. Application of Markov Decision Process to Inventory Management, Maintenance, Manufacturing Process, Telecommunication and Queuing theory.

Recommended Books:
1. Baird, Bruce F., Managerial decision under uncertainty – An introduction to the analysis of ecision making (chapters- 7,8,10,12), John Wiley, 1989.
2. Buchanan, J. T., Discrete and dynamic decision analysis, 1982.
3. Bunn, D. W., Applied decision analysis, McGraw Hill book co., 1986.
4. Mogran Johns, Introduction to decision theory.
5. Tijms, H. C., Stochastic model – An algorithmic approach, John Wiley

Intelligent Systems and Control

MTE-6282   **L-T-P: 4-1-0 (Credits=5)**

UNIT-I

Introduction of Linear and Nonlinear Systems, Positive definite functions and matrices, condition number of matrix, LTI state space model, nonlinear state space model, modelling of different nonlinear systems, discrete time systems, Nonlinear control strategies, Lyapunov Stability Theory.

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School of Mathematics

UNIT-II

Adaptive control, model identification, Continuous and discrete time affine systems, discrete time non-affine systems, Direct adaptive control, Single Input and Single Output (SISO) affine systems, Multi Input and Multi Output (MIMO) systems.

UNIT-III

Back-stepping control, The HJB formulation, HJB for affine systems, HDP and DHP, Fuzzy logic control (FLC), construction of FLC, Fuzzy PD Controller, Fuzzy PI controller, Takagi-Sugeno Fuzzy Model Based Control, Applications of FLC.

Recommended Books.

1. M. Vidhyasagar, Nonlinear Systems Analysis, IInd Edison, Prentice Hall, Englewood Oths,. New Jersey 1993
2. Hassan K. Khalil Nonlinear Systems Analysis, IIInd Edison, Prentice Hall of India
3. Laxmidhar Behera and Indrani Kar, Intelligent Systems and Control, Oxford University Press.

Econometrics

MTE-6283 | **L-T-P: 4-1-0 (Credits=5)**

UNIT-I

Two-variable linear model: Linear model and underlying assumptions, ordinary least squares estimators, linear hypothesis, Testing a single coefficient, Testing the significance of the complete regression, Testing the significance of a subset of coefficients confidence estimation, R^2 and adjusted R^2, Use of extraneous information in terms of exact and stochastic linear restrictions, restricted restrictions, Prediction in the least squares model, point and interval predictors.

UNIT-II

Tests for structural change, use of dummy variables, problem of multicollinearity and its remedies, estimation of parameters by generalised least squares in models with non spherical disturbances, heterosceldasticity of disturbances, estimation under autocorrelated disturbances.

UNIT-III

Bayesian analysis of linear models, Simultaneous equation model, concept of structural and reduced forms, problem of identification, rank and order conditions of identifiability, indirect least squares, Two stage least square and limited information maximum, likelihood estimation.

Recommended Books:

1. J. Johnston, Econometric methods
2. Judge, Griffiths, Hill, Hitkepohl, The theory and practice of econometrics.
3. D.N. Gujrati, Basic Econometrics (McGraw-Hill).

Algebraic Number Theory

MTE-6241 | **L-T-P: 5-0-0 (Credits=5)**

UNIT-I

Elements integral over a ring, Integral Extensions, Integrally Closed Rings, Integers in quadratic number fields, Norms and Traces, The Discriminant, Cyclotomic Fields and their ring of integers, Noetherian Rings and Modules, Dedekind domains.

UNIT-II

Norm of an Ideal, Ideal Classes and the Unit Theorem, Finiteness of the ideal class group, Units in imaginary and real number rings, Splitting of Primes Ideals in an Extension Field, The Discriminant and Ramification, Splitiing of a prime number in a quadratic number field.

UNIT-III

Prime decomposition in number rings, Dedekind domains, Ideal class group, Galois theory applied to prime decomposition, Gauss reciprocity law, Dirichlet unit theorem, valuations and completions of number fields, Dedekind zeta function and distribution of ideal in a number ring.

Recommended Books:
1. Pierre Samuel, Algebraic Theory of Numbers, Hermann Publishers, 1970.
2. D. A. Marcus, Number Fields, University text, Springer-Verlag, 1977.
3. G. J. Janusz, Algebraic Number Fields, Graduate Studies in Mathematics 7, American Mathematical Society, 1996.
4. S. Alaca, K. S. Williams, Introductory Algebraic Number Theory, Cambridge University Press, 2004.
5. J. Neukirch, Algebraic Number Theory, Springer-Verlag, 1999.
6. A. Frohlich, M. J. Taylor, Algebraic Number Theory, Cambridge Studies in Advanced Mathematics 27, Cambridge University Press, 1993.

Stochastic Processes

MTE-6251   **L-T-P: 4-1-0 (Credits=5)**

UNIT-I

Review of probability, random variables and probability distributions, expectations. Stochastic Process and its classification according to state space and parameter space. Discrete and Continuous-time Markov Chains: Transition probability matrix, Chapman-Kolmogorov equations, n-step transition and limiting probabilities, ergodicity, stationary distribution. Applications of Discrete-time Markov Chains. Kolmogorov differential equations for Continuous-time Markov Chains, infinitesimal generator, Poisson and birth-death processes.

UNIT-II

Brownian Motion: Wiener process as a limit of random walk; first -passage time and other problems, applications to finance. Branching Processes: Definition and examples branching processes, probability generating function, mean and variance, Galton-Watson brancing process, probability of extinction.

UNIT-III

Renewal Processes: Renewal function and its properties, renewal theorems, cost/rewards associated with renewals, Markov renewal and regenerative processes, applications.
Stationary Processes: Weakly stationary and strongly stationary processes, moving average and auto regressive processes.

Recommended Books:
1. S.M. Ross, Stochastic Processes, 2nd Edition, Wiley, 1996 (WSE Edition).
2. J. Medhi, Stochastic Processes, 3rd Edition, New Age International, 2009.
3. H.M. Taylor and S. Karlin, An Introduction to Stochastic Modeling, 3rd Edition, Academic Press, New York, 1998.
4. S.K. Srinivasan, K.M. Mehata, Stochastic Processes, Tata McGraw-Hill Publishing Company limited, New Delhi.
5. G. R. Grimmett and D. R.Stirzaker, Probability and Random Processes, 3rd Edition, Oxford University Press, 2001.

Partial Differential Equation and Special Functions

MTE-7241   **L-T-P: 4-1-0 (Credits=5)**

UNIT-I

Limit of function of two variable, continuity, partial differentiation. Partial derivatives of higher order, Schwarz theorem, Young's Theorem, Homogeneous functions of three variables.

Unit-II

Maxima and Minima, Restricted maxima and minima, Lagranges multipliers, Jacobian, Legendre polynomials $P_n(x)$, $Q_n(x)$; Rodrigues formulae, Orthogonality of Legendre Polynomials, Recurrance formulae.

Unit-III

Bessels equations, Bessels functions, Recurrance relations, Orthogonality, generating function, integral expressions, Trigonometric expansion involving Bessel's function, Bessel's integrals, Fourier-Bessel expansion.

Recommended Books:

1. F. Watson, Advanced Calculus:An Introduction to Analysis, Wiley, 3 edition, 2016
2. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, Inc.,9th edition, 2011.
3. W. Rudin, Mathematical Analysis, Mc Graw-Hill, Inc., 3rd edition, 1976.
4. R. Goldberg, Methods of Real Analysis, John Wiley & Sons, Inc., 2nd edition, 1976.

Advanced Topics in Algebra

MTE-7231   L-T-P: 4-1-0 (Credits=5)

UNIT-I

Rings, Matrix rings, Polynomial rings, Skew Polynomial rings, Laurant rings, Boolean rings. Opposite ring, Characteristic of a ring. Direct Products. Ideals, Homomorphism of rings, Endomorphism rings, Field of fractions, Prime fields, PIDS and UFDS.

UNIT-II

Modules Direct product, Direct sum of modules, Free modules, Homomorphism of modules, Maximal submodule, Minimal Submodule, Simple modules, Schurs lemma, Annihilator of a Subset of a module, Modules over PID's, Torsion modules, torsion free modules.

UNIT-III

Chain conditions, Artinian modules, Northerian modules, Composition series, Modules of finite length, Jordan Holder Theorem. Artinian rings, Noetherian rings, Hilbert Basis Theorem, I.S.Cohen's Theorem, Introduction of Nil radical and Jacobson radical.

Recommended Books:

1. C. Musili, Introduction to rings and modules, Narosa, 2003.
2. K.R. Gooderal and R.B. Warfield, Introduction to Non-commutative rings, Cambridge University Press.
3. N. McCoy, Ring Theory, Chelsea Pub Co., 1973

Queuing Theory

MTE-7261   L-T-P: 5-0-0 (Credits=5)

UNIT-I

Concept of Stochastic Process, Markov Chains with discrete and continuous time parameter. Objectives and different characteristics of a queuing system. Performance measures, Steady-state solution of queuing models: M/M/1, M/M/c, $M/E_k/1$ and $E_k/M/1$.

UNIT-II

Transient solution of M/M/1, M/M/c and $M/M/\infty$ queuing models including busy period distribution. Bulk Queues: Steady-state analysis of $M^{[X]}/M/1$ and $M/M^{[Y]}/1$ queuing models.

UNIT-III

Imbedded Markov chain technique and its use to the Queuing models: M/G/1, GI/M/1. Design and control of queuing systems. Queuing Networks: Open and Closed Queuing Networks, Jackson network,

Jackson Theorem, Tandem queuing networks. Applications of Queuing networks. Simulation procedures: Data generation and Book- keeping aspects.

Recommended Books:

1. Cooper, R.B., Introduction to Queuing Theory, 2nd Ed, North Holland,
2. Cox, D.R. and Smith W.L., Queues, Mathuen, 1961
3. Gross, D. and Harris C.M., Fundamentals of Queuing Theory, 2nd Ed., John
4. Kleinrock, L., Queuing Systems, Vol. I, John Wiley, 1975.
5. Medhi, J., Stochastic Model in Queuing theory, Academic Press, 1991.
6. Satty, T.L., Elements of Queuing Theory with Applications, Mc-Graw Hill,

Advanced Topic in Topology

MTE-7232   **L-T-P: 5-0-0 (Credits=5)**

UNIT-I

Directed sets, nets and subnets, convergence of a net, ultranets, partially ordered sets and filters, convergence of a filter, ultrafilters, basis and subbase of a filter, nets and filters in topology including characterization of compactness in terms of nets and filters.

UNIT-II

Tychonoff theorem, completely regular spaces, local compactness, one-point compactification, Stone-Cech compactification. Urysohn metrization theorem. Local finiteness, Nagata-Smirnov metrization theorem, partitions of unity, paracompactness, local metrizability, Smirnov Metrization theorem.

UNIT-III

Complete metric spaces, space-filling curve, compactness in metric spaces, equicontinuity, pointwise and compact convergence, the compact-open topology, Ascoli's theorem, Baire spaces, Baire category theorem, a nowhere differentiable function, An introduction to dimension theory.

Recommended Books:

1. Munkres, J.R., Topology, A First Course, Prentice Hall of India Pvt. Ltd., New Delhi, 2000.
2. Dugundji, J., Topology, Allyn and Bacon, 1966.
3. Simmons, G.F., Introduction to Topology and Modern Analysis, McGraw-Hill, 1963.
4. Kelley, J.L., General Topology, Van Nostrand Reinhold Co., New York, 1995.
5. Hocking, J., Young, G., Topology, Addison-Wesley Reading, 1961.
6. Steen, L., Seebach, J., Counter Examples in Topology, Holt, Reinhart and Winston, New York, 1970.
7. Willard, Stephen, General Topology, Addition-Wesley Publishing Company, 1970.

Fluid Mechanics

MTE-7242   **L-T-P: 5-0-0 (Credits=5)**

UNIT-I

Kinematics - Eulerian and Lagrangian methods. Stream lines, path lines and streak lines. Velocity potential. Irrotational and rotational motions. Vortex lines. Equation of continuity. Boundary surfaces, Acceleration at a point of a fluid. Components of acceleration in cylindrical and spherical polar co-ordiantes.

UNIT-II

Pressure at a point of a moving fluid. Euler's and Lagrange's equations of motion. Bernoulli's equation. Impulsive motion. Stream function, Acyclic and cyclic irrotation motions. Kinetic energy of irrotational flow. Kelvin's minimum energy theorem. Axially symmetric flows. Liquid streaming past a fixed sphere, Motion of a sphere through a liquid at rest at infinity.

UNIT-III

Equation of motion of a sphere. Three-dimensional sources, sinks, doublets and their images. Stoke's stream function, Irrotational motion in two-dimensions. Complex velocity potential. Milne-Thomson circle theorem. Two-dimensional sources, sinks, doublets and their images. Blasius theorem. Two-dimensional irrotation motion produced by motion of circular and coaxial cylinders in an infinite mass of liquid.

Recommended Books:

1. F. Chorlton, Text Book of Fluid Dynamics, C.B.S. Publishers, Delhi, 1985
2. M.E. O'Neill and F. Chorlton, Ideal and Incompressible Fluid Dynamics, Ellis
3. Horwood Limited, 1986.
4. R.K. Rathy, An Introduction to Fluid Dynamics, Oxford and IBH Publishing
5. Company, New Delhi, 1976.
6. W.H. Besant and A.S. Ramsay, A Treatise on Hydromechanics Part I and II, CBS
7. Publishers, New Delhi.
8. Bansi Lal, Theoretical Fluid Dynamics, Skylark Pub., New Delhi.

Fuzzy Systems

MTE-6242   **L-T-P: 3-0-0 (Credits=3)**

UNIT-I

Fuzzy Logic: An overview of classical logic, about logic functions of two variables, Multivalued logics, about three-valued logic, n-valued logic, degrees of truth, definition of primitives, Fuzzy propositions, classification, canonical forms, relation with possibility distribution function, Fuzzy Quantifiers, their two kinds, relation with possibility distribution function, Linguistic hedges, as a unary operation and modifiers, properties, Inference from conditional fuzzy propositions, relations with characteristic and membership functions, Compositional rule of inference, modus ponens and tollens, hypothetical syllogism, inference from conditional and qualified propositions, equivalence of the method of truth-value restrictions to the generalized modus ponens.

UNIT-II

Approximate reasoning: An overview of fuzzy expert system, Fuzzy implications as functions and operators, S-implications, R-implications, Gödel implication, QL implications, Zadeh implication, examples, properties, combinations, axioms of fuzzy implications and characterization (only statement). Selection of fuzzy implications, selection of approximate fuzzy implications to reasoning with unqualified fuzzy propositions, relation with compositional rule of inference, modus ponens and tollens, hypothetical syllogism Multi conditional approximate reasoning, method of interpolation, an illustration of the method for two if-then rules, as special case of compositional rule of inference and related results of fuzzy sets involved.

UNIT-III

An introduction to fuzzy control: Fuzzy controllers, its modules, Fuzzy rule base, Fuzzy inference engine, fuzzification and defuzzifications, steps of design of fuzzy controllers, defuzzification method, center of area method, center of maxima method and mean of maxima method. Decision –making in Fuzzy environment: Individual decision-making, fuzzy decision, simple examples, idea of weighting coefficients, Multi person decision-making, fuzzy group decision, examples, Multicriteria decision-making, matrix representation of fuzzy relation, convertion to single-criterion decision, examples, Multistage decision-making,idea of principle of optimality, Fuzzy ranking methods, Hamming distance, priority set, examples.

Recommended Books:

1. G. J. Klir and B. Yuan : Fuzzy Sets and Fuzzy Logic Theory and Appplications, PHI
2. H.J. Zimmerman, Fuzzy Set Theory and it Application, Second revised edition, Springer Science+Business Media, Newyork, 1990.
3. Timothy J. Ross, Fuzzy Logic with Engineering Applications, John Wiley & Sons, 2017.

Complex Dynamics

MTE-6231   **L-T-P: 3-0-0 (Credits=3)**

UNIT-I

Normal families, Montel's theorem; Iteration of polynomials and rational maps: The structure of the Fatou set, Sullivan classification of Fatou components, External rays.

UNIT-II

Properties of the Julia set, Polynomial like mapping, Parameter spaces of rational maps, Mandelbrot set, Holomorphic motion and stability, Renormalisation, Dynamics of transcendental entire and meromorphic functions.

UNIT-III

Singular points of inverse function, Baker domains and Wandering domains, Maps of bounded type, Escaping points, Omitted values and dynamics, Conformal measure on Julia sets, Dimension of Julia sets, Kleinian groups and Sullivan's dictionary.

Recommended Books:

1. J. Milnor, Dynamics in one complex variable, Princeton University Press
2. S. Morosawa et al, Holomorphic Dynamics, Oxford University Press
3. DierkShleicher, Complex Dynamics-Families and Friends, AK Peters Ltd
4. P. J. Rippon and G. Stallard, Transcendental Dynamics and Complex Analysis, Cambridge University Press
5. Curtis T. McMullen, Complex Dynamics and Renormalization, Princeton University Press
6. A. F. Beardon, Iteration of Rational Functions, Springer
7. L. Carleson and T.W. Gamelin, Complex Dynamics, Springer

Statistical Techniques

MTE-6252   **L-T-P: 3-0-0 (Credits=3)**

UNIT-I

Probability and distributions: Definition of Probability, independent events, Addition and multiplication rules, conditional probability with examples. Bernoulli, Binomial, Poisson and Normal distributions. Mean and variance of these distributions and their applications.

UNIT-II

Hypothesis testing: Hypothesis, critical region, and error probabilities. Tests for means, proportion, equality of proportions. Chi-square test for independence.

UNIT-III

Methods of sampling: Use of random numbers to generate simple random samples with replacement and without replacement. Stratified sampling.

Recommended Books:

1. Miller Irwin and Miller Maryless, John E. Freund's Mathematical Statistics with Applications, Pearson Education, 2006.
2. Hogg V. Robert, Deceased Allen Craig, and McKean Joseph W., Introduction to Mathematical Statistics, Pearson Education, 2014.

3. J.N. Kapur and H.C. Saxena, Mathematical Statistics, S. Chand, 2012.
4. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand and Sons, 2015.
5. S.P. Gupta, Statistical Methods, Sultan Chand and Sons, 2012.

Techniques in Numerical Analysis

MTE-6243   **L-T-P: 3-0-0 (Credits=3)**

UNIT-I

Errors in numerical calculations, Numbers and their accuracy. Numerical solution of algebraic and transcendental equations: biSection method, iterative method, false position method, Newton-Raphson method, secant method, curve fitting. Solution of system of equations, direct method, elimination method, Gauss seidel method, Jacobi method.

UNIT-II

Differences, Errors in interpolation, Differences of polynomials, Newton's formula for forward and backward interpolation, Interpolation with unequal intervals; Lagrange's method, divided difference and their properties.

UNIT-III

Numerical differentiation, Numerical integration: trapezoidal rule, Simpson's 1/3 and 3/8 rule. Newton-Cotes integration formula. Numerical solution of differential equations, Taylor series method, Picard's method, Runge-Kutta method.

Recommended Books:

1. Sankara Rao K. ,Numerical Methods For Scientists And Engineers, Princtice Hall of India Private, New Delhi, 2007.
2. Gerald, C.F, and Wheatley, P.O, Applied Numerical Analysis , Sixth Edition, Pearson Education Asia, New Delhi, 2002.
3. Balagurusamy, E., Numerical Methods, Tata McGraw-Hill Pub.Co.Ltd, New Delhi, 1999.
4. RajaRaman V. Computer Oriented Numerical Methods, Princtice Hall of India Private, New Delhi.
5. Burden, R.L and Faires, T.D., Numerical Analysis , Seventh Edition, Thomson Asia Pvt. Ltd., Singapore, 2002.
6. Conte S.D. & Boor C.D., Elementary Numerical Analysis, An algorithmic approach, Mc Graw Hill.

Soft Computing

MTE-6284   **L-T-P: 3-0-0 (Credits=3)**

UNIT-I

Neural Networks: Biological Neurons, Artificial Neuron, activation functions, Neural network architecture: single layer and multilayer feed forward networks, recurrent networks. Various learning techniques; perception and convergence rule, Auto-associative and hetro-associative memory. Architecture: perceptron model, solution, single layer artificial neural network, multilayer perception model; back propogation learning methods, effect of learning rule co-efficient ;back propagation algorithm, factors affecting backpropagation training.

UNIT-II

Fuzzy Logic: Basic concepts of fuzzy logic, Fuzzy sets and Crisp sets, Fuzzy set theory and operations, Properties of fuzzy sets, Fuzzy and Crisp relations, Fuzzy to Crisp conversion. Membership functions, interference in fuzzy logic, fuzzy if-then rules, Fuzzy implications and Fuzzy algorithms, Fuzzyfications & Defuzzificataions, Fuzzy Controller, Industrial applications

UNIT-III

Evolutionary and Nature Inspired Algorithms: Basic concepts of Evolutionary Algorithm (EA) and Nature Inspired Algorithms (NIA), working principle, procedures of EA and NIA, Genetic representations, (encoding) Initialization and selection, Genetic operators, Mutation, Generational Cycle, applications.

Recommended Books:

1. F. O. Karray and C.DeSilva, Soft Computing and Intelligent Systems Design.
2. S. Rajsekaran & G.A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications, Prentice Hall of India.
3. Siman Haykin, Neural Netowrks, Prentice Hall of India.

Commutative Algebra

MTE-6232   **L-T-P: 3-0-0 (Credits=3)**

UNIT-I

Rings and ideals: review of ideals in quotient rings; prime and maximal ideals, prime ideals under quotient, existence of maximal ideals; operations on ideals (sum, product, quotient and radical); Chinese Remainder theorem; nilradical and Jacobson radical; extension and contraction of ideals under ring homomorphisms; prime avoidance.

UNIT-II

Free modules; Projective Modules; Tensor Product of Modules and Algebras; Flat, Faithfully Flat and Finitely Presented Modules; Shanuels Lemma. Localisation and local rings, universal property of localisation, extended and contracted ideals and prime ideals under localisation, localisation and quotients, exacteness property, Results on prime ideals like theorems of Cohen and Isaac, Nagatas criterion for UFD and applications, equivalence of PID and one-dimensional UFD.

UNIT-III

Modules over local rings, Cayley-Hamilton, NAK lemma and applications, Examples of local-global principles, Projective and locally free modules, Patching up of Localization, Polynomial and Power Series Rings, Noetherian Rings and Modules, Hilberts Basis Theorem, Associated Primes and Primary Decomposition, Artininan Modules, Modules of Finite Length.

Integral Extensions: integral closure, normalization and normal rings, Cohen-Seidenberg Going-Up Theorem, Hilberts Nullstellensatz and applications, Valuations, Discrete Valuation Rings, Dedekind domains.

Recommended Books.

1. Introduction to Commutative Algebra, by M.F. Atiyah and I.G. MacDonald
2. Commutative Algebra, Vol.-II, by Oscar Zariski, Pierre Samuel
3. Commutative Algebra, by N.S. Gopalakrishnan.