SMVDU/SoM/22/961

Minutes of Meeting of 10th Board of Studies (BoS) of School of Mathematics

Date: 02/12/2022

Online Meeting of Board of Studies (BoS) of School of Mathematics (SoM) was held on 18th November, 2022, at 02:30PM. During the meeting following were present.

S. No.	Name / BoS Participants	Affiliation
1.	Dr. Kuldip Raj	I/c Head, SoM and Chairman, BoS.
2.	Dr. Gauree Shanker	Professor & Head, Department of Mathematics, Central University, Punjab External Expert member
3.	Prof. V K Bhat	Professor, School of Mathematics (SoM)
4.	Dr. Uday Pratap Singh	Associate Professor, SoM
5.	Dr. A K Das	Associate Professor, SoM
6.	Dr. Sandeep Bhougal	Assistant Professor & Member Secretary of BoS, SoM
7.	Dr. Surender Singh	Assistant Professor, SoM
8.	Dr. Sandeep Sharma	Assistant Professor, SoM
9.	Dr. Sunil Kumar Sharma	Assistant Professor, SoM
10.	Dr. Nitin Bisht	Assistant Professor, SoM

The following members could not attend the meeting.

1.	Dr. Wali Mohamad Shah	Professor & Head, Department of Mathematics, Central University, Kashmir, Jammu University, ***(External Expert member)***

6/12/22

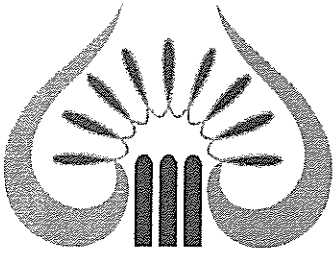
As per the agenda of BoS meeting, following were discussed and recommended:

Item:10.1	To confirm the minutes of the 9th meeting of Board of Studies (BoS), held on 27th January, 2022. **Member Secretary of BoS, welcomed external expert members and appraised the house about the compliance status of decisions taken during 9th BoS meeting and efforts made towards the same were appreciated.** **Minutes of last BoS meeting were confirmed.**
Item: 10.2	To discuss / review the programme structure and syllabus of existing M.Sc. (Mathematics) **Course structure and curriculum of the presently running M.Sc. (Mathematics) programme was discussed and reviewed. This has been done to assure that the same is confirming to the desired standard (in terms of advancements in the field).** ***(The finalized syllabus with course code (Semester-I to Semester-IV) of the said programme is Annexed as Annexure-I)***
Item: 10.3	**To discuss / review the programme structure and syllabus of Integrated B.Sc. (Hons)-M.Sc. Mathematics programme under CBCS in accordance with NEP, 2020 (CHOICE BASED CREDIT SYSTEM)** **The Syllabus and Course Code for new Integrated B.Sc. (Honours) Mathematics-M.Sc. (Mathematics) programme under CBCS in accordance with NEP, 2020 (CHOICE BASES CREDIT SYSTEM) was discussed and recommended.** ***(Syllabus with courses code for First Year is annexed as Annexure-II)***
Item: 10.4	**Any other item with the permission of chair**

The meeting ended with vote of thanks to Chair.

Dr. Sandeep Bhougal
(Member Secretary, BoS)

Dr. Kuldip Raj
(Chairman, BoS)



Master of Science in Mathematics

(Two Year Full Time Master Degree Program)

SYLLABUS

(M. Sc.)

School of Mathematics

Shri Mata Vaishno Devi University Katra

	ABBREVIATIONS / CODES / NOMENCLATURE
Course Code Convention	
SCT – LSAY Example ALL 9101 ALP 9102 ALS 9110	Course Code for various Courses / Subjects SC: School Code T: Course Type Code (Lecture/Studio/Practical/Project etc.) L: Course Level (1, 2, 3, 4 & 5 for First, Second years …) SA: Study Area / Sub Area Y: Semester Wise Course Number
AL	School Code (SoALD)
L	Lecture
P	Practical
U	Studio
E	Elective
C	Colloquium
D	Project Based
T	Training
S	Self Study
N	Non Credit
V	Special Lecture Topic
Teaching Scheme Convention	
L	Lecture
T	Tutorial
S	Studio
P	Practical
C	Course Credit
EvaluationScheme Convention	
Minor	(Mid Term Exams / Tests) I & II
Major	Semester End Examination (ESE)
FFCS	Fully Flexible Credit System
CBCS	Choice Based Credit System

VISION

Grow as Center of Excellence to Nurture Talented Human Resource by Providing High Quality Education in Mathematical Sciences to address Problems in Science, Engineering and Management Encompassing Human & Social Values.

MISSION

School of Mathematics strives to provide quality education that builds a rigorous and comprehensive foundation of Mathematical Education and Research in Compliance with Established International Standards.

School of Mathematics
Program Structure of M.Sc. (Mathematics) Two Year Full Time Degree

Semester I

Course Code	Course Title	L-T-P	Credit
MTL 6051	Abstract Algebra	4-0-0	4
MTL 6052	Real Analysis	4-0-0	4
MTL 6061	Discrete Mathematics	4-0-0	4
MTL 6067	Computer Programming and MATLAB	4-0-0	4
MTP 6067	Computer Programming and MATLAB Lab	0-0-2	1
MTL 6068	Advanced Calculus and Special Functions	4-0-0	4
	Total Credits	20-0-2	21

Semester II

Course Code	Course Title	L-T-P	Credit
MTL 6053	Linear Algebra	4-0-0	4
MTL 6054	Complex Analysis	4-0-0	4
MTL 6069	Differential and Integral Equations	4-0-0	4
MTL 6071	Probability & Statistics	3-0-0	3
MTP 6071	Probability & Statistics Lab	0-0-2	1
MTL 6066	Numerical Methods	3-1-0	4
MTP 6066	Numerical Methods Lab	0-0-2	1
	Total Credits	18-1-4	21

+ PCN 7067 Discourse on Human Virtues 3-0-0 0 (Non-credit course)

Semester III

Course Code	Course Title	L-T-P	Credit
MTL 7081	Optimization Techniques	3-0-0	3
MTP 7081	Optimization Techniques Lab	0-0-2	1
MTL 7051	Topology	4-0-0	4
MTL 7070	Calculus of Variations and Mechanics	4-0-0	4
MTE 70XX	Elective -I	*4-1-0 or 4-0-2	5
	Open Elective-I	3-0-0	3
	Open Elective-II	3-0-0	3
	Total Credits	22-3-0 Or 22-1-4 Or 22-2-2	23

REVISED for ~~New~~ Batch 2022–24

Course Code	Course Title	L-T-P	Credit
MTL 7081	Optimization Techniques	3-0-0	3
MTP 7081	Optimization Techniques Lab	0-0-2	1
MTL 7051	Topology	4-0-0	4
MTL 7070	Calculus of Variations and Mechanics	4-0-0	4
MTE 70XX	Elective -I	*4-1-0 or 4-0-2	5
MTP7021	Latex Lab	0-0-4	2
	Open Elective	3-0-0	3
	Total Credits	18-1-6 Or 18-0-8	22

Semester IV

Course Code	Course Title	L-T-P	Credit
MTL 7062	Differential Geometry	4-0-0	4
MTL 7063	Modern Applied Algebra	4-0-0	4
MTL 7052	Functional Analysis	4-0-0	4
MTD 7091	Minor Project/Survey/Research Article / Book Review	6-2-0	6+2**
MTE 70XX	Elective –II	*4-1-0 or 4-0-2	5
	Total Credits	*18-0-6	25

REVISED

Course Code	Course Title	L-T-P	Credit
MTL 7062	Differential Geometry	4-0-0	4
MTL 7063	Modern Applied Algebra	4-0-0	4
MTL 7052	Functional Analysis	4-0-0	4
MTD 7091	Minor Project/Survey/Research Article / Book Review	7-2-0	7#+2**
MTE 70XX	Elective –II	*4-1-0 or 4-0-2	5
	Total Credits	*23-3-0 Or 23-2-2	26

* Depends on the choice of the electives

** Credit to be earned from seminar presentations on the project during the semester

Contact hours with the project supervisor

Total Credits to be earned in order to become eligible for award of M.Sc. (Mathematics) (Two Year Full Time) Degree: **90**

List of Electives:

Course Code	Course Title	L-T-P	Credit
MTE 7012	Partial Differential Equations	4-1-0	5
MTE 7016	Measure Theory	4-1-0	5
MTE 7014	Non Linear Analysis	4-1-0	5
MTE 7015	Advanced Topics in Algebra	4-1-0	5
MTE 7011	Algebra-IV	4-1-0	5
MTE 7021	Information Theory	4-1-0	5
MTE 7022	Digital Signal Processing	4-1-0	5
MTE 7023	Real Time Systems	4-1-0	5
MTE 7024	Parallel Processing	4-1-0	5
MTE 7025	Distributed Computing	4-1-0	5
MTE 7026	Coding Theory	4-1-0	5
MTE 7027	Graph Theory	4-1-0	5
MTE 7028	Galois Theory	4-1-0	5
MTE 7029	Biomathematics	4-1-0	5
MTE 7031	Time Series and Stochastic Process	4-1-0	5
MTE 7032	Decision Theory	4-1-0	5
MTE 7033	Econometrics	4-1-0	5
MTE 7041	Queuing Theory	4-1-0	5
MTE 7042	Theory of Reliability	4-1-0	5
MTE 7043	Inventory Theory	4-1-0	5
MTE 7044	Modeling and Simulation	4-1-0	5
MTE7045	Theory of Games	4-1-0	5
MTE 7231	Financial Mathematics	4-1-0	5

List of Open Electives:

MTE 7141	Complex dynamics	3-0-0	3
MTE 7151	Techniques in numerical analysis	3-0-0	3
MTE 7152	Tensor Calculus	3-0-0	3
MTE 7153	Mathematical Modeling	3-0-0	3
MTE 7161	Statistical techniques	3-0-0	3
MTE 7171	Introductory Operation research	3-0-0	3

PEO's and PO's of School of Mathematics, Shri Mata Vaishno Devi University.

Program Education Objectives (PEOs)

The Graduates will be able to:

PEO1 acquire a strong and diversified background in mathematical sciences which includes courses from Mathematics, Computer Science, Management, Operations Research, Statistics and Professional Ethics.

PEO2 choose a successful career in the diversified sectors such as teaching, research, banking, planning and higher education.

PEO3. exhibit professionalism, ethics, communication skills, team work in their professionand adapt to current scenario by engaging in lifelong learning for the service of thesociety.

Program Outcomes (POs)

On successful completion, graduates will be able to:

PO1. solve problems through analytical thinking.

PO2. apply knowledge of mathematics to solve various real life problems.

PO3. formulate mathematical models to interpret and analyze data for interdisciplinary researchand development.

PO4. solve various mathematical problems by using relevant mathematical and statistical software.

PO5. communicate effectively both orally and in writing.

PO6. exhibit strong ethical and professional responsibility.

MTL 6051				Abstract Algebra			Pre Requisites		None	
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 Hour	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Learn the basic terminology and results concerning abstract algebra.
2. Understand, construct, and write proofs.
3. Build foundation to model the problems in coding, cryptography and switching circuits.

COURSE CONTENTS

Unit-I: (16 Contact Periods)

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

Unit-II: (16 Contact Periods)

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: (16 Contact Periods)

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

SUGGESTED BOOKS

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

MTL 6052			Real Analysis				Pre Requisites			
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Describe fundamental properties of the real numbers that lead to the formal development of real analysis.
2. Demonstrate an understanding of limits and how they are used in sequences, series, differentiation and integration.
3. Understand the concept of Bolzano-Weierstrass theorem, Rolle's theorem, extreme value theorem and the Mean Value theorem.
4. Evaluate Riemann integrable and Riemann sums.
5. Prove someresultson Riemann sums and Riemann integrals and their relations.

COURSE CONTENTS

Unit-I: (16 Contact Periods)

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: (16 Contact Periods)

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: (16 Contact Periods)

σ-algebra of sets, limits of sequences of sets, Borelσ-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.

SUGGESTED 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.

MTL 6061				Discrete Mathematics			Pre Requisites		None	
Version R-01							Co-requisites			
L	T	S/P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 Hour	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Understand the basic principles of sets, functions and relations and their applications
2. Understand the concept of lattice and Boolean Algebra with their applications relating to circuits and Networks.
3. Understand the basic terminology of graphs and trees and their applications
4. Understand the concept of recurrence relations and generating functions and their applications in problems of combinatorics.

COURSE CONTENT

Unit-I: (16 Contact Periods)

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: (16 Contact Periods)

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: (16 Contact Periods)

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.

SUGGESTED 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. NarsinghDeo, Graph Theory, Prentice Hall of India, 2004.

6. K.D. Joshi, Foundations of Discrete Mathematics, Wiely Eastern Ltd., 1989

MTL 6067			Computer Programming and MATLAB				Pre Requisites			
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 Hours	3.0 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Understand basic concepts of computer and computer programming.
2. Develop the ability to design algorithmic solution to problems.
3. Convert algorithms to C programs.
4. Understand basics of MATLAB.
5. Solve mathematical problems using MATLAB.

COURSE CONTENTS

Unit-I: (16 Contact Periods)

Review of basics of computer, Further Computer programming: Control statements -sequencing, conditional and unconditional branching and looping. Single and multi-dimensional arrays. Searching (linear, binary), sorting (exchange, bubble, selection and insertion) and merging. User defined data types.

Unit-II: (16 Contact Periods)

Stepwise refinement. Subroutines: Functions and Procedures. Parameter passing, call by value & call by reference. Functions and procedures as parameters, recursion. Further data structures: Records (simple, hierarchical and variant), sets, files (text and binary files).

Unit-III: (16 Contact Periods)

Basic introduction to matlab , writing basic scripts/functions, matrix computations , data fitting techniques (interpolation and least squares) , optimization problems, solving linear systems, quadrature, initial valueproblems , computational efficiency, and visualization.

SUGGESTED BOOKS

1. YashwantKanetkar, Programming in C, BPB Publications, New Delhi.
2. Introduction to Computer Science, ITL/ESL.
3. D.E.Knuth, Fundamental Algorithms
4. Brian R. Hunt, Ronald L. Lipsman, Jonathan M. Rosenberg, A Guide to MATLAB for Beginners andExperienced Users, Cambridge University Press, 1st Edition.

Computer Programming and MATLAB LAB

MTP 6067 **0-0-2=1**

Practical: (Programming in C)

1. Write a program to find the factorial of any number.
2. Write a program to find the roots of a quadratic equation.
3. Write a program to display ten digit Fibonacci series and its sum.
4. Write a program to find out all Armstrong numbers between 1 and 500.
5. Write a program to find out whether a number is Prime or not.
6. Write a program to find the sum of prime numbers between 1 and 500.
7. Write a program to find the sum of the series $x+x^2+x^3+.....n$ terms.

Practical: (Programming in MATLAB)

1. Basic introduction to matlab, data types, variables, arithmatic

operators, elementary functions, basics of plotting

2. One dimensional and two dimensional arrays

3. Matrices and matrix algebra

4. Solving arithmatic expressions involving arrays

5. Solving linear systems.

6. Ordinary differential equations: initial value problems

7. Graph theory.

Recommended Books:

1. Yashwant Kanetkar, Programming in C, BPB Publications, New Delhi.
2. Introduction to Computer Science, ITL/ESL.
3. D.E.Knuth, Fundamental Algorithms

4.Brian R. Hunt, Ronald L. Lipsman, Jonathan M. Rosenberg, A Guide to MATLAB for Beginners and Experienced Users, Cambridge University Press, 1st Edition.

MTL 6068				Advanced Calculus & Special Functions			Pre Requisites			
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Understand the concepts of Differentiability in several variables, the chain rule, the mean value theorem, higher order partial derivatives, Taylor's theorem, critical points, extreme value problems,Frechet derivatives.
2. Study the applications of Schwarz theorem and Young's Theorem.
3. Evaluate the Bessel's equations, Bessel's functions, Bessel's integrals and Fourier-Bessel expansion and by using these expansions solve some mathematical problems.

COURSE CONTENT

Unit-I: (16 Contact Periods)

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: (16 Contact Periods)

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: (16 Contact Periods)

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

SUGGESTED 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.

MTL 6053			Linear Algebra				Pre Requisites		None	
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 Hour	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Prove basic results in linear algebra using appropriate proof-writing techniques such as linear independence of vectors; properties of subspaces, etc.
2. Compute linear transformations, kernel and range, and inverse linear transformations, and find matrices of general linear transformations.
3. Create orthogonal and orthonormal bases, Gram-Schmidt process and use bases and orthonormal bases to solve application problems.
4. Understand various operators and their relationships understand the concept of invariant subspaces and their connections with nilpotent canonical forms.
5. Understand the concept of companion matrix, Jordan canonical form and Jordan blocks.

COURSE CONTENT

Unit-I: (16 Contact Periods)

Review of basics of linear Algebra, Linear functionals and the dual space, Dual basis, Second dual space, Annihilators, Inner product spaces, Cauchy-Schwarz inequality, orthogonality, orthonormal sets, Gram-Schmidt orthogonalization process(Section 4.3 to 4.4 of Topics in Algebra by I.N. Herstein). Minimal polynomial, Characteristic and minimum polynomials of linear operators(Section 6.1 to 6.2 of Topics in Algebra by I.N. Herstein).

Unit-II: (16 Contact Periods)

Hermitian, Unitary and Normal Transformations(Section 6.10 of Topics in Algebra by I.N. Herstein). 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. Cyclic subspace with respect to a nilpotent transformation. Uniqueness of the invariants of a nilpotent transformation. (Sections 6.4 to 6.5 of the book. Topics in Algebra by I.N. Herstein).

Unit-III: (16 Contact Periods)

Primary decomposition theorem. Jordan blocks and Jordan canonical forms. rational canonical forms, Cyclic module relative to a linear transformation. Companion matrix of a polynomial f(x). Rational Canonicals form of a linear transformation and its elementary divisior. Uniqueness of the elementary divisior. Trace and transpose. (Sections 6.6 to 6.8 of the book. Topics in Algebra by I.N. Herstein).

SUGGESTED BOOKS

1. I. N. Herstein, Topics in Algebra,Wiley Eastern Limited, 2nd edition, 1992.
2. S. Lang, Linear Algebra, Springer New York, 1997
2. Hoffman &Kunze, Linear Algebra, Prentice Hall PTR,3rd revised ed., 1999.
5. Seymour Lipschutz, Theory and Problems of Linear Algebra, McGraw-Hill, 1989.

MTL 6054				Complex Analysis			Pre Requisites			
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Understand the concepts of the theories for functions of a complex variable. They also understand the exploration of the algebraic, geometric and topological structures of the complex number field.
2. Define continuity of a function using limits. Determine where a function is continuous/discontinuous.
3. Define differentiability of a function using limits. Determine where a function is differentiable/non-differentiable.
4. Define analyticity of a function. Determine whether a function is analytic/not analytic or entire/not entire.
5. Evaluate a contour integral with an integrand which have singularities lying inside or outside the simple closed contour.
6. Find the residues of a function at given points or singularities. Use the residue theorem to evaluate a contour integral.

COURSE CONTENTS

Unit-I: (16 Contact Periods)
Analytic (Holomorphic) functions, Cauchy-Riemann equations, Polar form of Cauchy-Rieman equations, Harmonic functions, Exponential and Trigonometric functions, conformal transformation, Bilinear transformation.

Unit-II: (16 Contact Periods)
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: (16 Contact Periods)
Singularities, Different Types of singularities, Residue at a singularity, Cauchy's Residue theorem.Residue and Contour integration, Analytic continuation, Uniqueness of analytic continuation.

SUGGESTED 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; 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.

MTL 6069				Differential and Integral Equations			Pre Requisites			
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks (Assign ment)	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. understand and solve problems based on simultaneous linear differential equations
2. solve the second order differential equations using various methods
3. solve various problems based on Riccati's equation, exact differential equation, and homogeneous equations
4. understand the concept of integral equations and their use in solving initial and boundary value problems

Unit-I (16 Contact Periods)

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 (16 Contact Periods)

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 (16 Contact Periods)

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.

SUGGESTED 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.

MTL6071			Probability & Statistics				Pre Requisites			
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3.0 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Understand Probability and Distribution functions.
2. Gather knowledge of Correlation, Regression and their applications
3. Understand and apply Hypothesis testing, Analysis of Variance, sample survey in real life. situations.

COURSE CONTENT

Unit-I (16 Contact periods)

Review of probability- Random variable and Distribution function, Marginal and joint probability distribution Mathematical expectation of sum and product of random variables. Moments, Cumulates and their interrelationship, Moment generating function and cumulate generating function, Binomial, Normal and Poisson with their properties.

Unit-II (16 Contact periods)

Correlation and Regression, Karl Pearson and Spearman's rank correlation coefficient, Regression coefficient and lines of regression. Partial and multiple correlation, Sampling distribution, Standard error, Simple random sampling and stratified random sampling with their role.

Unit-III (16 Contact periods)

Test of significance for mean, variance, proportion and correlation coefficient, Test of goodness of fit and Independence of attributes, Analysis of variance for one way and two way classified data, Concept of estimation, Definition of unbiasedness, Consistency and efficiency, Statistical decision making: Risk function, Loss function. Baye's rule and Baye's approach.

SUGGESTED BOOKS

1. A.M. Goon, M.K. Gupta and B. Das Gupta, Fundamental of Statistics, Vol. I & Vol. II, World Press, 1988.
2. A.M. Goon, M.K. Gupta, B.Das Gupta, A Dublin of Statistical Theory-Vol. I & II, World Press, 1983.
3. S.C. Gupta , V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand and Sons, 2005.
4. An Introduction to probability theory and mathematical statistics: V.K. Rohatgi (Wiley Eastern Publisher Ltd., New Delhi), 1988.
5. S.P.Gupta, Statistical Methods, Sultan Chand and Sons, 2012.

Probability & Statistics Lab

MTP 6071 **0-0-2=1**

List of Experiments:

1. Fitting of binomial distributions for given n and p.
2. Fitting of binomial distributions after computing mean and variance
3. Fitting of Poisson distributions after computing mean
4. Application Problems based on area property of normal distribution
5. To find the ordinate for a given area for normal distribution
6. Fitting of normal distribution when parameters are given
7. Fitting of normal distribution when parameters are not given
8. To compute the multiple and partial correlation coefficients
9. To compute ranks and find rank correlation coefficient
10. To fit simple and multiple linear regression to the given data
11. To apply chi-square test for distribution fitting
12. To apply t-test for comparing two population means
13. To use F-test for testing the difference between several means

SUGGESTED BOOKS

6. A.M. Goon, M.K. Gupta and B. Das Gupta, Fundamental of Statistics, Vol. I & Vol. II, World Press, 1988.
7. A.M. Goon, M.K. Gupta, B.Das Gupta, A Dublin of Statistical Theory-Vol. I & II, World Press, 1983.
8. S.C. Gupta , V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand and Sons, 2005.
9. An Introduction to probability theory and mathematical statistics: V.K. Rohatgi (Wiley Eastern Publisher Ltd., New Delhi), 1988.
10. S.P.Gupta, Statistical Methods, Sultan Chand and Sons, 2012.

MTL 6066				Numerical Methods			Pre Requisites			
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	1	0	4	1.5 Hours	3.0 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1 find roots of algebraic/transcendental equations.
2 find polynomials which best fits a tabulated data.
3 solve linear system of equations.
4 differentiate and integrate a function which best fits a given data.
5 apply differentiation and integration to practical problems.
6 solve ordinary differential equations.

COURSE CONTENTS

Unit-I: (16 Contact Periods)

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: (16 Contact Periods)

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: (16 Contact Periods)

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. RungeKutta method. Predictor Corrector Method: Miline's method and Adams-Moulton's method.

SUGGESTED BOOKS

1. V. Rajaraman, Computer Oriented Numerical Methods, PHI; 3 edition, 1993.
2. Foroberg, Introduction of Numerical Analysis, Addison Wesley Publishing Company, 2nd Edition, 1969.
3. S.S. Shastri, Introductory methods of Numerical Analysis, 5th Edition, PHI, 2012
4. M.K. Jain et. al., Numerical Methods. New Age International P (Ltd), 4th Edition, 2004.
5. Steven C. Chapra, Applied Numerical Methods with MATLAB, Tata McGraw-Hill, 2nd Edition, 2007.

Numerical Methods Lab

MTP 6066 **0-0-2=1**

Practical: (Programming in C/MATLAB based on numerical methods)

1. Write a program to find the roots of a given equation by biSection method.
2. Write a program to find the roots of a given equation by regula-falsi method.
3. Write a program to find the roots of a given equation by Secant method.
4. Write a program to find the value of the polynomial x^3+x^2+3x+5 correct up to three decimal places by Newton Raphson method.
5. Write a program to find a solution of system of equations by Guass elimination method.
6. Write a program to solve a given system of equations by Gauss-Seidel method.

Recommended Books:

1. V. Rajaraman, Computer Oriented Numerical Methods, PHI; 3 edition, 1993.
2. Foroberg, Introduction of Numerical Analysis, Addison Wesley Publishing Company, 2nd Edition, 1969.
3. S.S. Shastri, Introductory methods of Numerical Analysis, 5th Edition, PHI, 2012
4. M.K. Jain et. al., Numerical Methods. New Age International P (Ltd),4th Edition, 2004.
5. Steven C. Chapra, Applied Numerical Methods with MATLAB, Tata McGraw-Hill, 2nd Edition, 2007.

MTL 7081			Optimization Techniques				Pre Requisites			
							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks (Assign ment)	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. formulate and solve various industrial and managerial problems as linear programming problems
2. formulate and solve various transportation and assignment problems
3. apply the principles of game theory and network scheduling methods to solve problems that arise in business and industry
4. develop queuing models for solving congestion problems

Unit-I (16 Contact Periods)

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 (16 Contact Periods)

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 (16 Contact Periods)

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 $M/E_K/1$).

SUGGESTED BOOKS

1. V.K. Kapoor, Operations Research, Sultan Chand and Sons, 9th Edition, 2014.
2. H. A. Taha, Operations Research, Pearson India, 9th Edition, 2014.
3. KantiSwaroop, Operations Research, Sultan Chand , 2014.
4. S.D. Sharma, Operations Research, KedarNath 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.

Optimization Techniques Lab

MTP 7081 **0-0-2=1**

OPERATIONS RESEARCH (MTL-7081)

List of Experiments:

1. To model a product-mix problem as a linear programming problem and solve it using TORA software.
2. To model an investment problem as a linear programming problem and solve it by MS-Excel Solver.
3. To obtain the optimal solution of a transportation problem using TORA software.
4. To solve an assignment problem using TORA software.
5. To solve a matrix game problem using TORA software.
6. To model a rectangular game problem as a linear programming problem and solve it by a MS-Excel Solver and TORA software
7. To solve a network scheduling problem by Critical Path Method with the help of TORA software
8. To solve a network scheduling problem by Program Evaluation Review Technique with the help of TORA software.
9. To solve a single server queuing model using TORA software.
10. To solve a multi-server queuing model using TORA software.

SUGGESTED BOOKS

1. V.K. Kapoor, Operations Research, Sultan Chand and Sons, 9th Edition, 2014.
2. H. A. Taha, Operations Research, Pearson India, 9th Edition, 2014.
3. KantiSwaroop, Operations Research, Sultan Chand , 2014.
4. S.D. Sharma, Operations Research, KedarNath 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.

MTL 7051			Topology				Pre Requisites			
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 Hours	3.0 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. work with sets and functions, images and preimages, and you can distinguish between finite, countable, and uncountable sets.
2. generate topology from basis and subbasis.
3. know how the topology on a space is determined by the collection of open sets/closed sets.
4. check connectedness or compactness of a topological space.
5. understand the concept of separation axioms and their characterizations.
6. Know the notions of compactification and metrization.

COURSE CONTENT

Unit-I: (16 Contact Periods)

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: (16 Contact Periods)

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

Unit-III: (16 Contact Periods)

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

SUGGESTED 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.

MTL 7070				Calculus of Variations and Mechanics			Pre Requisites		None	
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 Hour	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Handle optimization problems where the variables, instead of being finite dimensional as in ordinary calculus, are functions.
2. Formulatevariational problems and analyze them.
3. Understand the foundations of motion of a mechanical system.
4. Use Lagrange-Hamilton formalism to obtain the equations of chaotic motion for a variety of problems with the help of generalized coordinates.

COURSE CONTENTS

Unit-I: (16 Contact Periods)

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: (16 Contact Periods)

Functionals involving more than one dependent variables 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: (16 Contact Periods)

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.

SUGGESTED 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.

Latex Lab

MTP 7021 **0-0-4=2**

Understanding Latex Compilation; Basic Syntex, Writing equations, Matrix, Tables.

Page Layout- Titles, Abstract, Chapters, Sections, References, Equation references, citation.

Table of contents, generating new command, figure handling, numbering, list of figures, list of tables.

Classes: Article, Book, Report, Beamer, Slides.

Application to: Writing resume, writing question paper, writing Articles/Research paper, Presentation using Beamer.

Recommended Books:

1. Stefan Kottwitz, Latex Beginner's Guide, Ist Editon, Packt Publishing, 2011.
2. Helmut Kopka, Patrick W. Daly, Guide to Latex, 4th Edition, Addison-Wesley Professional, 2003.
3. Leslie Lamport, Latex: A document preparation system, User's guide and reference manual, Addison Wesley, 1994.

MTL 7062			Differential Geometry				Pre Requisites		None	
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 Hour	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. understand fundamental concepts of geometry like parametric curves, surfaces, manifold etc.
2. Based on above concepts they are able to understand fundanetal theorems like Frenet-Serret theorem, Fundamental form of Surfaces, Weingartem theorem etc.
3. they are able to understand the Intrinisic and Extrinsic properties of surfaces
4. they are able to solve numerical analysis poblem and applications based on above structures.

COURSE CONTENTS

Unit-I: (16 Contact Periods)

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 R3 .

Unit-II: (16 Contact Periods)

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: (16 Contact Periods)

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.

SUGGESTED BOOKS

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

MTL 7063				Modern Applied Algebra			Pre Requisites		None	
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Explain the fundamentals of Modern Algebra (Group, Rings and Fields)
2. Apply these techniques notions in coding by using matrix technique and polynomial technique.
3. Compare the process of coding and decoding by above mentioned techniques.
4. Explain some useful codes like Hamming codes and BCH-codes and their applications.

COURSE CONTENTS

Unit-I: (16 Contact Periods)

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: (16 Contact Periods)

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: (16 Contact Periods)

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

SUGGESTED 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,

MTL 7052			Functional Analysis				Pre Requisites			
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Understand the foundations of functional analysis in the context of normed linear spaces The Big Theorems (Hahn-Banach, Baire Category, Uniform Boundedness, Open Mapping and Closed Graph) and several applications. They can understand the important notion of duality in Banach and Hilbert spaces.
2. Define continuity of linear operators. Determine whether an operator is continuous/ discontinuous.
3. Apply his or her knowledge of functional analysis to solve mathematical problems.

COURSE CONTENT

Unit-I: (16 Contact Periods)

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: (16 Contact Periods)

Hahn-Banach theorem (Extension of linear functionals) for nomed 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: (16 Contact Periods)

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.

SUGGESTED 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.

Electives

MTE 7012				Partial Differential Equations			Pre Requisites			
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	1	0	5	1.5Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to:

1. Understand fundamental concepts of partial differential equations of first order, second order etc.
2. Learn various methods to solve linear and non linear partial differential equations.
3. Understand to solve various real life problems by formulating them into a partial differential equations.

Unit-I: (16 Contact Periods)

Partial Differential equation of the first order-formulation and Classification of partial differential equations, Lagrange's linear equation, particular forms of non-linear partial differential equations, Charpit's method. Linear partial differential equations with constant coefficients. Homogeneous equations, Non homogeneous equation.

Unit-II: (16 Contact Periods)

Partial differential equation of 2^{nd} and higher order, classification examples of partial differential equations, partial differential equations relevant to industrial problems, solution of elliptic, hyperbolic and parabolic equations.

Unit-III: (16 Contact Periods)

Partial Differential equations of second order with variable coefficients, Monge's Methods, Separation of variables, Canonical forms, Cauchy's problem, Legendre polynomials- Solution of Legendre's Equation, Generation function, Rodrigue's formula, orthogonal Properties. Integrals involving Legnedre polynmials, Fourier-Legendre expansion, Recurrence relations, Legendre's function of second kind $Q_n(x)$, Christoffel's summation formula.

ReferenceBooks:

1. F. John, Partial Differential equations, Narosa Publication
2. I. N. Sneddon, Elements of Partial Differential Equations, Mc-Graw Hill
3. H.F. Weinberger, A First Course in Partial Differential equations, John Willey & Sons,
4. W.E. William, Partial Differential equations, Clarendan Press, Oxford.
5. T. Amarnath, PDE, PHI.

MTE 7013				Measure Theory			Pre Requisites			
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	1	0	5	1.5Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. understand the basic concepts of measure and integration theory.
2. learn some standard inequalities useful solve various boundness problems in science and engineering.
3. understand signed measure and Radon Nikodyn derivatives which is useful for theoretical foundation of some applicable measures.
4. understand the concept of product measure and Fubini Theorem with their applications.

Unit-I: (16 Contact Periods)

Lebsegue integration & its properties.Fatou's Lemma, Lebesgue monotone convergence theorem, Lebesgue dominated convergence theorem, L^p Spaces: Cauchy-Schwartz inequality, Holder inequality, Minkowski inequality, Jensen inequality,

Unit-II: (16 Contact Periods)

Signed Measures,Signed Measure Spaces,Integration on a Signed Measure Space,Absolute Continuity of a Measure, The Radon-Nikodym Derivative, Absolute Continuity of a Signed Measure Relative to a Positive Measure, Properties of the Radon-Nikodym Derivative.

Unit-III: (16 Contact Periods)

Product Measure Spaces,Existence and Uniqueness of Product Measure Spaces, Integration on Product Measure Space, Fubini's Theorem, Completion of Product Measure Space, Convolution of Functions, Some related Theorems.

Recommended Books:

1. J.Yeh Lectures on Real Analysis, World Scientific 2000.
2. M.E. Munroe, Measure and Integration, 2nd edition Addison Wesley, 1971.
3. G.DeBarra, Measure theory and Integration, Wiley Eastern Ltd.,1987.
4. H.L.Royden, Real Analysis,3rd edition, Macmillan, New York, 1988.

Non Linear Analysis

MTE 7014 **4-1-0=5**

Section –A

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.

Section -B

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.

Section - C

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 applicationsSpringer, 3rd ed. 2002.

MTE 7015				Advanced Topics in Algebra			Pre Requisites		None	
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	1	0	5	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Understand application of modules over rings as an analogue of vector spaces over fields.
2. Understand the notion of lengths of chains of prime ideals in commutative Noetherian rings and its analogue in non-commutative set up.
3. Study the radicals i.e. Prime ideals, Jacobson radical and Nil radical and brief introduction to their possible application

COURSE CONTENT

Unit-I: (20 Contact Periods)

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: (20 Contact Periods)

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: (20 Contact Periods)

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.

SUGGESTED 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

Algebra- IV

MTE 7011 **Credits: 4-0-0**

Section A

Modules, Submodules, Annhilator, Direct product and direct sum of modules, Quotient modules, Homomorphism, Homeomorphism and Isomorphism theorems of modules Finitely generated Module, Cyclic module, Simple modules, Schur's Lemma, free modules, modules over a PID, Torsion modules, Torsion free modules, fundamental Theorem of Abelian groups.

Section B

Chain conditions, Artinian ring and modules, Noetherian rings & Noetherian modules, Hilbert's basis theorem, Cohen's theorem, integral extensions, Hilbert zero theorem, localization, discrete valuation fields, Introduction to nil redicals and Jacobson redical.

Section C

Skew Polynomial Rings, Primary Decomposition, Primary Decomposition of Skew Polynomial Rings , Applications of Skew Polynomial Rings, associated prime ideals, primary decomposition.

References:

1. Artin, Michael , Algebra, PHI Learning Pvt. Ltd., New Delhi, 2011.
2. Bhat, V. K., Modern Algebra and Applications, Alpha Science Intl. Ltd, 2013, 1st Edition.
3. Dummit, D.S. and Foote ,R.M., Abstract Algebra, Wiley India, 2011, 3rd Edition.
4. Gopalakrishnan, N.S., University Algebra, New Age International, 1986, 2nd Edition.
5. Herstein, I.N., Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975, 2nd Edition.
6. Jacobson, N., Basic Algebra, Vol-1, Freeman, 1985, 2nd Edition.
7. Musli, C., Introduction to rings and modules, Narosa, 2nd Edition.

Information Theory

MTE 7021 **4-1-0=5**

Section –A

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.

Section- B

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.

Section-C

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.

References:

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

Digital Signal Processing

MTE 7022 **4-0-2=5**

Section-A

Introduction of Signals, Systems and Signal Processing, Classification of Signals and Systems, Advantages of Digital over Analog Singnal processing, Signal Models - Continuous Time versus Discrete time signals, Periodic and Aperiodic Signals, Phasor Signals and Spectra, Energy and Power Signals, System Modeling Concepts, The superposition integral for Fixed and Linear Systems, Impulse Response of a Fixed and Linear System - Fourier Series - Trigonometric Series- Exponential Fourier Series-Symmetry Properties of the Fourier Coefficients.

Fourier Integral, Energy Spectral Density, Fourier Transforms in the Limit, Fourier Transform Theorems and Pairs, System Analysis with Fourier Transform, Laplace Transform Theorems, Network Analysis using the Laplace Transform.

Section-B

Discrete Time Signals and Systems - Review of Sampled Data Systems, Time Domain Representations of Discrete Time Signals, Frequency Domain Representation of Discrete Time Signals, Discrete Time Signals obtained by sampling, Discrete Fourier Transform. Z-Transform - Definition and Examples, Inverse Z-Transform, Properties of the Z-Transform,Introduction to Realization of Digital Systems - Block Diagrams and Signal Flow Graphs. Introduction to Realization of an IIR and FIR systems, Discrete Fourier Transforms (DFT) and Fast Fourier Transform (FFT)

Section-C

Design of Digital Filters : Introduction to Filters, A comparision of IIR and FIR Digital Filters.Design of IIR Digital Filters - Impulse Invariant Transformation, Bilinear Transformation, Design of Digital Butterworth and Chebyshev Filters.Design of FIR Digital Filters - Windowing and Rectangular Window, Filter Designs using Windows, Frequency Sampling Technique. DSP tools and DSP techniques in various applications.

Recommended Books:

1. Alan. V. Oppenheim, Ronald W. Schafer, Digital Signal Processing Prentice Hall of India

2. J. Defatta, Digital Signal Processing, John Willey & Sons

3. Prokians, Digital Signal Processing, PHI

Real Time Systems

MTE 7023 **4-0-2=5**

Section - A

Introduction to Real-time computing: Characterizing Real-time system & tasks; Performance measures of real time systems, estimation of program run time, Real-time system design: Hardware requirement, system-development cycle, data transfer techniques, synchronous & asynchronous data communication, standard interfaces.

Section - B

Task Assignment and Scheduling: Priority scheduling, scheduling with fixed priority dynamic priority scheduling, Real-time programming languages & Tool: desired language characteristics, data typing, control structure, run time error handling, overloading & generics, run time support, Real-time databases.

Section - C

Real time communication algorithms, Fault tolerence techniques: Causes of failure, fault types, fault detection, redundancy, integrated failure handling Reliability, Evaluation techniques: Parameter values, reliability model for hardware redundancy, software error model, Clock synchronization.

Recommended Books:

1. C.M. Krishna & K.G. Shen, Real Time Systems, Mc. Graw Hill, 1997.
2. P.D. Lawrence & K. Mauch, Real Time Microcomputer Design: An Introduction, McGraw Hill, 1988.
3. Mathai Joseph, Real Time systems: Specification, verification & analysis, Prentice Hall Inc., 1996.
4. Stuart Bennet, Real Time computer control, Prentice Hall Inc., 1988.
5. S. J. Young, Real time languages, John Willey & sons, 1982.

Parallel Processing

MTE 7024 **4-0-2=5**

Section - A

Introduction to parallel computing, advantages of parallel computing. Solving problems in parallel: Temporal parallelism, Data parallelism and their comparison. Intertask dependency and task graphs. Structures of parallel computers: Pipelined parallel computers, Array processors, Shared memory multi-processor, message passing multiprocesors, MMC systems. Integer Arithmetic: Carry look-ahead addition and carry-save addition on binary tree, integer multiplication and convolution on a linear array. Elementary sorting algorithm.

Section - B

Matrix Algorithms : Matrix-Vector multiplication and solving lower triangular system of equations on a linear array, matrix multiplication, LU decomposition, matrix inversion, Guassian elimination on a mesh.

Graph Algorithms : Mesh algorithm for transitive closure, connected component, shortest path, breadth first search and minimum spanning tree. Mesh of trees and its applications such as Matrix-Vector multiplication, Convolution and integer multiplication.

Section- C

More fancier networks : r-dimensional mesh of trees, shuffle trees, shuffle-exchange network, hypercube, De-bruijn network and butterfly, Some examples on these networks, sorting and FFT on butterfly.

Introduction to dataflow computers, Parallelism in logic programming, Programming parallel computers.

Recommended Books:

1. V. Rajaraman, Elements of Parallel Processing, Prentice-Hall of India, 1990.
2. Designing Efficient Algorithms on Parallel Computers, Mc-Graw Hill International, NewYork, 1987.
3. Parallel Algorithms, Dhall et. al., Mc-Graw Hill Int.

Distributed Computing

MTE 7025 **4-0-2=5**

Section-A

Distributed Operating System : Distributed computing system models, Issues in design of distributed operating system, message passing, Remote procedure calls, synchronization, Process management, resource management, Distributed file systems, Introduction to distributed data-bases.

Section-B

Distributed Algorithms : Introduction to distributed algorithms, synchronous and partial synchronous models, Algorithms in general synchronous leader election, Breadth first search, Shortest path, Randomized algorithms, Distributed concensus with link and process failures, Asynchronous system model, I/O automata, operation of automata, complexity measures, randomizations.

Section-C

Asynchronous shared memory model, mutual exclusion, resource allocation, concensus, Asynchronous network model, basic asynchronous network algorithms, shared memory Vs Networks. Introduction to parallel distributed processing: general framework, methods of learning.

Recommended Books:

1. PK Sinha, Distributed Operating System, PHI, 1997.

2. AS Tanenbaum, Modern Operating Systems, PHI.

3. Nancy A Lynch, Distributed Algorithms, Morgan Kaufmann Pub. Inc.,

4. DF Rumelhart, JI Mc Clelland & PDP group, Parallel Distributed Processing vol I&II, MIT Press, 1995.

5. Simon Haykin, Neural Networks, IEEE Press.

Coding Theory

MTE 7026 **Credits: 4-1-0=5**

Section A

Divisibility and Euclidean algorithm, congruences, Finite fields, Legendre symbol and quadratic reciprocity, Jacobi symbol.

Section B

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.

Section C

Introduction to algebraic structures, Field extensions, Quadratic Residues, Krawtchouk Polynomials, Combinatorial Theory, Probability Theory, Shannon's Theorem, Coding gain problems, Linear and good codes

Recommended Books:

1. Neal Koblitz, A Course in Number Theory and Cryptology, Graduate Texts in Mathematics, Springer ,1987.

2. Rosen M. and Ireland K., A Classical Introduction to Number Theory, Graduate Texts in Mathematics, Springer (1982).

3. David Bressoud: Factorization and Primality Testing, Undergraduate Texts in Mathematics, Springer, 1989.

4. Birkhoff.G. , Barte, Thomas C., Modern Applied Algebra, CBS Publishers.

Graph Theory

MTE 7027 **4-1-0=5**

Section– A

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.

Section – B

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

Section – C

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, andApplications, Prentice-Hall.
5. Bela Bollobas, Modern Graph Theory, Springer.

Galois Theory

MTE 7028 **Credits: 4-1-0=5**

Section A

Field theory and Compass constructions: Algebraic, Complex algebraic numbers, Number fields: transcendental, separable, normal purely inseparable extensions.Finite fields: the Frobenius of a field of positive characteristic,perfect fields, theorem of the primitive element. Ruler and Compass constructions: constructing regular polygons.

Section B

Galois theory and applications: Group of automorphisms of fields, fundamental theorem of finite Galois Theory, cyclic extensions, solvability by radicals, Kummer theory, Determining the Galois group of a polynomial.

Section C

Transcendental extensions: Transcendence basis theorem, Luroth's theorem transcendence of e. Algebraically closed fields: Existence and uniqueness of an algbebraic closure.

Recommended Books:

1. Garling D.J.H., Galois Theory (Cambridge Univ. Press)
2. Stewart I.N., Galois Theory (Chapman Publ. Co.)
3. Jacobson N., Lectures on Abstract Algebra Vol.3
4. Lang S., Algebra (Adison Wiley)

Biomathematics

MTE 7029 **3-1-2=5**

Section – A

Pre-requisites: Basic knowledge of mathematics such as calculus, matrices and probability is required.

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.

Section-B

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.

Section-C

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, autopolyploidy and Sex linked Inheritance).

Practicals: (Using MATLAB)

1. Find out inverse and determinant of a matrix.
2. Compute eigenvalue of a given matrix.
3. Compare two sequences of data and produce a frequency array.
4. Curve fitting.
5. Computation of higher transition probabilities of Markov chains.
6. Numerical computation of the models discussed in Section C.

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).

MTE 7031				**Time Series And Stochastic Process**			Pre Requisites			
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks (Assignment)	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	1	0	0	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Understand Time Series, Stochastic processes and their analysis.
2. Understand the variant difference method, AR, MA, ARMA process, tests for stationary stochastic process.
3. Gather knowledge of Markov chain and stationary probability.
4. Understand and apply Poisson process, random walk, Renewal theory and their applications.

Unit-I (20 Contact Periods)

Time series as a stationary or non stationary stochastic process, time domain analysis based on correllogram, sample autocovariance function and autocorrelation function at log K, log correlation.

Measurement of cyclic fluctuations: Periodogram and its relation with acvf, Harmonic analysis. Measurement of irregular component: Variant difference method.

AR(p) process, MA(q) process, mited ARMA(p,q) process, Stationarity and inevitability conditions, ARIMA (p,d,q) model, estimation of parameters, tests for stationarity Stochastic – Process.

Unit-II (20 Contact Periods)

Markov Chain having two states, n-step transition probabilities, Classification of states, recurrent and transient states, Chapman-Kolmogorov equations, Stationary probability theorems and limit theorem for ergodic chains, martingales.

Unit-III (20 Contact Periods)

Poisson process, birth and death process, Random walk and Gambler's Ruin problem, Wiener process, Renewal theory and its application, Branching chains: Discrete Process (Galton-Watson), Continuous process (Markov Branching), Fundamental theorem of Extinction.

Recommended Books:

1. P.G.Hoel, S.C. Port, C.J. Stone, Introduction to stochastic processes, Universal Book Store, New Delhi.
2. S.K. Srinivasan, K.M. Mehata, Stochastic Processes, Tata McGraw-Hill Publishing Company limited, New Delhi.
3. J. Medhi, Stochastic Processes.
4. G.E.P. Box and G.M. Jenkins, Time series Analysis: Forecasting and control.
5. C. Chatfield, The Analysis of Time Series: Theory and Practice

Decision Theory

MTE 7032 **4-1-0=5**

Section - A

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.

Section -B

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.

Section- C

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

MTE 7033			Econometrics				Pre Requisites			
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks (Assign ment)	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	1	0	5	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. To understand advanced Econometrics Techniques.
2. To apply advanced Econometrics concept to real life situations with help of Mathematical tools.
3. To built complex Mathematical model with the help of Econometrics Techniques.

Unit-I (20 Contact Periods)

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, R2 and adjusted R2, 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 (20 Contact Periods)

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 (20 Contact Periods)

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.

SUGGESTED 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).

MTE 7041				Queuing Theory			Pre Requisites			
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks (Assign ment)	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	1	0	5	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. understand the concept and applications of Markov chains
2. develop and solve the Markovian as well as non-Markovian queuing models, and apply them
3. derive the transient solutions of Markovian queuing systems
4. develop and apply bulk queuing models, and queuing network models
5. apply simulation procedures for solving queuing problems

Unit-I (20 Contact Periods)

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 (20 Contact Periods)

Transient solution of M/M/1, M/M/c and M/M/∞ 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 (20 Contact Periods)

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.

SUGGESTED BOOKS

1. Cooper, R.B., Introduction to Queuing Theory, George Washington Univ. Dept. of, 3rd Edition, 1990.
2. D.R. Cox and W. L. Smith, Queues, Springer, 1971.
3. D. Gross and C.M. Harris, Fundamentals of Queuing Theory, Wiley India Private Limited; 4th Edition, 2012.
4. L. Kleinrock, Queuing Systems (Vol. I), Wiley India Pvt. Ltd., 2013.
5. J. Medhi, Stochastic Model in Queuing theory, Academic Press, 2nd Edition, 2002.
6. T.L. Satty, Elements of Queuing Theory with Applications, Dover Publications Inc., New Edition, 1984.

Theory of Reliability

MTE 7042 **4-1-0=5**

Section - A

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.

Section - B

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

Section - C

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,
5. Rau, John, G., Optimization and Probability in systems engineering, Van Nostrand Reinhold Company, 1970.
6. Roy, Billinton and Ronald, W. Allan, Reliability Evaluation of Engineering Systems, Pitman Publication, 1983.
7. Tillman, F.A. Hwang, Optimisation of systems Reliability Marcel Dekker inc.
8. Musa, J.D. Jannino Antony, Software Reliability Measurement, Prediction and Applications, McGraw Hill, 1987.
9. Lewis, E.E., Introduction to Reliability Engineering, 2nd edition, John Wiley & Sons, 1994.
10. Villemeur, A., Reliability, Availability, Maintainability and Safety Assessment, John Wiley,

Inventory Theory

MTE 7043 **4-1-0=5**

Section – A

Analytical structure of Production and Inventory problems, Inventory related costs, Properties of Inventory system, Factors influencing inventories.

Deterministic inventory models and extensions without and with lead time, Inventory models with partial backlogging and sales, Models with continuous production and non-constant demand with known production capacity, Inventory models with constraints, Quantity discounts; All units and incremental. Sensitivity of the lot size system, N-products and M-Machines model.

Section – B

Stochastic Inventory Models and Extension without and with lead time, Use of transformation from time-dependent for continuous and discrete demand, Power demand pattern Inventory Model, Safety stock and Buffer stock.

Section – C

Simulation in Inventory system, Production scheduling, Classification of items viz; BAC, VED, FNS, Two-way analysis of ABC & FNS, Case studies.

Recommended Books:

1. Koenigsber, Buchan J. E., Scientific Inventory Management, prentice Hall,1963
2. Hadley, G., Whitin, T. M., Analysis of Inventory Systems, prentice Hall,1963.
3. Hansman, Fred, Operations Research in Production and Inventory Control, John Wiley, 1968.
4. Naddor, E., Inventory System, John Wiley, 1966.
5. Johnson, L. A., Montgomery, D. C., Operations Research in Production planning, Scheduling and Inventory Control, John Wiley, 1974.
6. Stephen, L., Inventory Control, McGraw Hill, 1979.
7. Silver, E. and Perterson, R., Decision System for Inventory Management and Production Control, Wiley, NY, 1985.

Modelling & Simulation

MTE 7044 **4-0-2=5**

Section-A

Modelling : Definition of a SYSTEM, System concepts, types of system, continuous & discrete systems, modelling process, verification & validation.

Simulation : Introduction, classification of simulation models, advantages and disadvantages of simulation, Discrete system simulation : Monte Carlo method, Random Number Generation.

Section-B

Queuing Theory : Introduction, Notation and assumption, Queuing model with poisson input, exponential service and arbitrary service times. Simulation of queuing system, Simulation of a single-server queue, Simulation of two-server queue.

Inventory Control : Elements of inventory theory, more complex inventory models, finite and infinite delivery rate model with and without back ordering. Simulation of inventory systems.

Section-C

Evaluation of simulation, length of simulation runs, variance reduction technique.

Project management : PERT/CPM techniques, simulation of PERT networks. Model as components of information systems, modelling for decision support.

Virtual reality : the ultimate interactive model.

Recommended Books:

1. Gorden, G., System Simulation, Prentice Hall of India.

2. Narsing Deo, System Simulation, Mcgraw Hill.

3. Payne, J.A., Introduction to Simulation, Mc-Graw Hill 1982.

Theory of Games

MTE 7045 **4-1-0=5**

Section – A

Game theory: Introduction, characteristics of game theory, basic definitions, Fundamental theorem of Rectangular Zero-sum games, Properties of Strategies, Solutions of games with saddle point, Relation of Dominance, Solution of Games without saddle point, Methods of solving Rectangular Zero-sum games. Equivalence of rectangular game and linear programming.

Section – B

Games with infinitely many strategies.The fundamental theorem of continuous games. Nash equilibrium. Existence of a mixed strategy Nash equilibrium for continuous games. mixed strategy Nash equilibria in games with infinite strategy sets. differential Games, Separable games with convex pay-off function.

Section – C

Solution of n-persons games with and without zero-sum restriction. Lanchester's equations and their application to games of strategy. Stochastic Games: Introduction, Markov games, histories and rewards, behavioral strategy, Markov strategy, stationary strategy, Markov perfect equilibrium, Two player zero-sum stochastic games and their applications.

Recommended Books:

1. R. Meyerson, Game theory: Analysis of conflict, Harvard University Press, Cambridge Mass, Harvard University Press; Reprint edition (1997).
2. R. L.Levin and R. B.Desjardin, Theory of games and strategies, International Textbook Co.(1970).
3. R.Luce and H.Raiffa, Games and Decision, John Wiley & Sons Inc. 1st edition (1957).
4. J. C. McKinsey, Introduction to Theory of Games, Dover Publications (2012).
5. J. D.William, The complete strategist, McGraw Hill (1966).

Financial Mathematics

MTE 7231 **4-1-0=5**

Section -A

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.

Section- B

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

Section- C

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,

Open Electives

Complex Dynamics

MTE 7141 **3-0-0**

Section – A

Rational Maps, Fixed points, Critical points, Formal definition of Fatou and Julia sets, Completely invariant sets.

Section – B

Normal families and equicontinuity, Properties of the Fatou and Julia sets, Examples, Quadratic polynomials, Mandelbrot set.

Section – C

Completely invariant components of the Fatou Set, Maps between components of the Fatou set, Components of the Julia Set, Periodic points, The existence of periodic points, Super attracting cycles, Repelling cycles, The Julia set and periodic points.

Rational Maps, Fixed points, Critical points, Formal definition of Fatou and Julia sets, Completely invariant sets, Normal families and equicontinuity, Properties of the Fatou and Julia sets, Examples, Quadratic polynomials, Mandelbrot Set.

Completely invariant components of the Fatou Set, Maps between components of the Fatou set, Components of the Julia Set, Periodic points, The existence of periodic points, Super attracting cycles, Repelling cycles, The Julia set and periodic points.

Recommended Books:

1. Alan F. Beardon, Iteration of Rational Functions: Complex Analytic Dynamical Systems, *Volume 132 of Graduate Texts in Mathematics*, Springer, 2000.
2. Lennart Carleson, Theodore W. Gamelin, Complex Dynamics, Springer, 1993.

Techniques in Numerical Analysis

MTE 7151 **2-0-2=3**

Section-A

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.

Section-B

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.

Section-C

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.

Tensor Calculus

MTE 7152 **3-0-0=3**

Section A

Contravariant vector, covariant vector, transformation of contravariant and covariant vector, definition of a tensor, tensor field, addition and subtraction of tensors, multiplication of tensors.

SectionB

Inner product of tensors, contraction on tensors, symmetric tensors, anti symmetric tensors, properties of tensors, Invariant of tensors.

Section C

Differential manifolds, Lie –brackets, properties of Lie- bracket, connexions,properties of connexions, covariant derivatives

Recommended Books:

1.Prasun Kumar, Nayak, Textbook of Tensor Calculas and Differential Geometry,PHI learning,2012

2.R.S. Mishra, A course in Tensors with applications to Riemannian Geometry, Pothishala private limited,1973

3. J.L. Synge, Tensor Calculas, Dover publications, 2012

4.Shalini Singh, Tensor Calculas, Ivy publishing house, 2009

Mathematical Modeling

MTE 7153 **3-0-0=3**

Section A

Mathematical Modeling: Introduction, needs, scope, limitations, types of models, Elementary ideas of dynamical systems. Mathematical Models in Biology: Modeling blood flow, viscosity, Poiseuille law, Oxygen transfer in red cells, diffusion. Single speciespopulation models: Basic concepts, Exponential growth model, Logistic growth model, Gompertz growth model, Mathematical modeling of epidemics: Basic concepts, Simple epidemic model.

Section B

Models on the spread of scientific and technological innovations: Atomic waste disposal,electrical networks, image model, graph theoretic models, communication system model, ordinary and partial differential equation models.

Section C

Optimization models: One variable optimization, multi-variable optimization, programming models, game theoretic models. Statistical Models: Probability models and regression models with applications.

References:

1. N. Bailey,The Mathematical Theory of Infectious Diseases, Haftier Press, New York, 1975.
2. S. Allman, Elizabeth and John A. Rhodes, Mathematical Models in Biology, Cambridge University Press, 2004.
3. Narsing Deo, Graph Theory with Applications to Engineering and Computer Science, PHI, 2016.
4. J. N. Kapur, Insight into Mathematical Modeling, Indian National Science Academy, New Delhi, 1983.
5. S.C. Gupta, V. K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand and Sons,New Delhi, 2014.
6. H. A. Taha, Operations Research and Introduction, 7th edition, Pearson education, New Delhi, 2005.

Statistical Techniques

MTE 7161 **3-0-0=3**

Section -A

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.

Section - B

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

Section -C

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.

Introductory Operations Research

MTE7171 **3-0-0=3**

Section-A

Meaning and nature of Operations Research (OR). History and development of OR. Applications of OR. Models in OR and Methodology of OR. Linear Programming Problem (LPP): Introduction, General Formulation of LPP, Assumptions, Limitations and Applications of LPP, Graphical Solution to LP problems, Special cases in graphical method.

Section-B

Computational procedure of Simplex Method; Artificial Variables, Big-M method; Special cases in Simplex procedure; Degeneracy in LPP.

Transportation Problem: Initial Basic Feasible Solution by North West Corner Rule, Least Cost Method and Vogel's Approximation method. u v – Method.

Section-C

Assignment problem, Hungarian Algorithm; Applications of transportation and assignment problems.Introduction to Game Theory, Maximin-Minimax principle, Saddle point, Games with and without saddle point, Applications of game theory.

References:

1. Swarup, K, Gupta, M. and Manmohan, Operations Research, Sultan chand and sons, 15th Edition (1998).
2. Sharma, S. D., Operations Research, Kedar Nath Ram Nath, 10th Edition (2013).
3. Taha, H A., Operations Research, Pearson Education, 9th Edition (2014).
4. Hadley, G., Linear Programming, Narosa Publishing House, 8th Edition (1994).

B.Tech courses

MTL 2022				Integral Transforms & Complex Analysis			Pre Requisites			
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	0	1.5Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Understand the Basic properties of Complex numbers and functions including differentiability.
2. Evaluate line integrals in the complex plane.
3. Determine and work with Laurent and Taylor series.
4. Understand the method of Laplace transforms and evaluate the inverse transform.
5. To understand the basic tools of Fourier series and Fourier transform and enable it to use in technical subject of Engineering like, Signal system, Thermodynamics etc. for their practical problems.

COURSE CONTENT

Unit-I: (13 Contact Periods)

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

Unit-II: (13 Contact Periods)

Laplace Transforms: Function of bounded variation, laplace transform of 1, t^n, e^{at}, sin(at), cos(at), sinh(at), cosh(at), 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: (13 Contact Periods)

Complex Analysis: Curves and regions in complex plane, complex functions, analytic functions, Cauchy-Riemann equations, Laplace equations. Rational, exponential, trigonometric, hyperbolic functions, derivatives of analytic functions, Power series, Taylor series, Laurent series, zero and singularity behaviour of f(z) at infinity.

SUGGESTED BOOKS

1. Bali and Iyengar, Engineering Mathematics, LuxmiPublications(P), 2004.
2. S.C. Malik & S. Arrora, Mathematical Analysis, New Age International, 1992.
3. M.R.Spiegel, Complex Analysis, Schuam'sout line Series, New edition.
4. B.S. Grewal , Higher Engineering Mathematics , Khanna Publisher,43rd ed., 2004
5. Anthony Croft, Engineering Mathematics, Pearson Education, 4th ed., 2013.

MTL 1024			Discrete Structures				Pre Requisites			
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students will be able to;

1. Understand the basic principles of sets, functions and relations and their applications.
2. Understand the concept of lattice and Boolean algebra with their application in simplification in switching circuits.
3. Understand the fundamentals of algebraic structures like group, ring, field and vector spaces.
4. Understand the concept of recurrence relations and generating functions and their applications in problems of combinatorics.
5. Write an argument using logical notation and determine if the argument is or is not valid.
6. Understand the concept of metric space and its application in brief.

COURSE CONTENTS

Unit-I: (12 Contact Periods)

Sets, Binary relation, equivalence relation. Functions, Injective, Surjective & Bijective mappings. Partial order relations, PO-set, Lattice & Boolean algebra. Algebraic structures, Semi group, Monoid, Group, Cyclic group, Subgroup, Normal subgroup, Quotient group, Homomorphism of groups.

Unit-II: (12 Contact Periods)

Ring, Integral domain, Field. Vector space, Linear dependence & independence. Basis & Dimension. Combinatorics, Recurrence relations & Generating functions.

Unit-III: (12 Contact Periods)

StatementCalculus- sentential connectives, Truth tables, Logical equivalence, Deduction theorem. Predicate Calculus- Symbolizing everyday language, validity and consequence, first order theories.

Definition and examples of Metric space, Open & Closed spheres, Open & Closed sets.

SUGGESTED BOOKS

1. R.R Stoll., Set Theory and Logic, Dover Publications, New ed., 2012.
2. I. N. Herstein, Topics in Algebra, Wiley, new ed., 2004.
3. K. H. Rosen, Discrete Mathematics and Its Applications with Combinatorics and Graph. Theory (English) Macgraw Hill Education, 7th Edition
4.P.K. Jain and Khalil Ahmad, Metric Spaces, Narosa, 2nd ed., 2004.

MTL 1025			Engineering Mathematics-I				Pre Requisites			
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3.0 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. Introduce the basic concept of differential calculus to understand the different subjects of engineering as well as basic sciences.
2. Enable the students to develop the concept of partial differentiation to understand their applications in engineering
3. Understand the fundamentals of Integral calculus to understand their applications to length, area, volume, surface of revolution, moments and centre of gravity
4. Understand the improper integrals and Beta and Gamma functions and their applications.
5. Understand the idea of Linear Algebra which are useful to all branches of engineering.

COURSE CONTENTS

Unit-I (12 Contact periods)

Differential Calculus: Partial differentiation, asymptotes, concavity, convexity, point of inflexion, curvature, radius of curvature, curve tracing, envelopes and evolutes, change of variables, Jacobian, expansion of functions of several variables, chain rule, mean value theorem, Taylor series with remainder term, maxima & minima, saddle point.

Unit-II (12 Contact periods)

Integral Calculus: Fundamental theorem of Integral calculus, reduction formulae, properties of definite integral, applications to length, area, volume, surface of revolution. Moments, centre of gravity, improper integrals, β-γ functions.

Unit-III (12 Contact periods)

Matrices: Elementary row and column transformation, linear dependence, rank of a matrix, consistency of system of linear equations, solution of linear system of equations, characteristic equations, Cayley Hamilton theorem, eigen values and eigen vectors, diagonalization, complex matrices.

SUGGESTED BOOKS

1. E. Kreysig, Advanced Engineering Mathematics, Wiley 1oth edition, 2011.
2. A . K. Gupta, Engineering Mathematics, Macmillan 7th edition 2013.
3. McQuarri Macmillan, Mathematical Methods by Scientists & Engineers, 1st edition 2003.
4. Shanti Narayan, Differential Calculus, S Chand; 30thRevised edition, 2005.

MTL 2024				Engineering Computational Methods			Pre Requisites			
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3.0 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students will be able to;

1. Introduce the basic concept of Computational methods and their uses in engineering.
2. Enable the students to understand the concept of errors and their analysis in Numerical calculations.
3. Understand the methods of interpolation and extrapolation and their applications in engineering.
4. Understand the Numerical Differentiation and Numerical Integration and their uses in Engineering.
5. Understand the Numerical solution of ordinary differential equations which are useful to all branches of engineering.

COURSE CONTENTS

Unit-I (12 Contact periods)

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, Stirling's formula, Bessesl's formula, Interpolation with unequal intervals; Lagrange's formula, Divided differences and their properties, Newton's general Interpolation formula, Inverse interpolation.

Unit-II (12 Contact periods)

Errors in Numerical Calculations, Number and their accuracy, Errors and their analysis errors in a series approximation. Numerical solutions of algebraic and transcendental equations: Bi-Section 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 polynimals. Taylor's series approximation. Solution of linear systems of equations: Direct method, Elimination method. Gauss-seidel method, Jacobi method.

Unit-III (12 Contact periods)

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

SUGGESTED BOOKS

1. Rajaraman V. :Computer Oriented Numerical Methods, PHI
2. Foroberg:Introduction of Numerical Analysis. Addison Wesely.
3. B.S.Grewall: Higher engineering Mathematics, Khanna Publishers.
4. Conte, C.D. & Boor, C.D.:Elementary Numerical Analysis An algorithmic approach, Mc-Graw Hill.
5. Kendall, N.A. & Atkinson, K.E.: An Introduction to Numerical Analysis, John Willey & Sons
6. Krishnamurthy V.: Computer based Numerical Algorithms, East West Press.
7. ShastriS.S.:Introductory methods of Numerical Analysis, PHI.
8. Jain M.K. et.l.: Numerical Methods for scientific and engineering computation, New Age International.

BUL 8223			Research Methodology				Pre Requisites			
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 Hours	3.0 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students will be able to;

1. Introduce the basic concept of research, sampling methods.
2. Enable the students to understand the measures of Central tendency and dispersion, Probability Distributions
3. Understand the different methods ofTesting of Hypothesis, Correlation, regression and Analysis of Variance.
4. Understand the different methods ofCorrelation, regression and Analysis of Variance.

COURSE CONTENTS

Unit-I (16 Contact periods)

Meaning and Objectives of Research, Criteria of good research, Significance of research, Types of research, Research methods: Historical method, case study method, survey method, and experimental method. Research process, Identification and formulation of a research problem, Relevance of literature review. Hypothesis: types and characteristics. Research Design: need, features and characteristics of a good research design. Different research designs: descriptive, exploratory and experimental. Design of Sample surveys: concept of census and sample survey, Sampling and non-sampling errors, Probabilistic and non-probabilistic sampling designs and their types.

Unit-II (16 Contact periods)

Measurement and Scaling Techniques: Scales of measurement for qualitative and quantitative data, Scaling techniques: comparative and no-comparative, Multi-dimensional scaling. Collection of data: Method of collection of primary and secondary data, Questionnaire design. Data preparation process: editing, coding, classification, tabulation and graphical representation. Descriptive Statistics: Measures of central tendency, Measures of dispersion, and Measures of relationship. Association of Attributes. Concept of probability distribution, Normal, Binomial and Poisson distributions.

Unit-III (16 Contact periods)

Elementary knowledge of matrices, vectors and differential calculus. Inferential Statistics: Point and Interval estimation, determination of sample size. Sampling distribution. Type-I and Type-II errors. Hypothesis testing procedure, t-test, z-test, chi square test, F-test, ANOVA. Regression Analysis: Simple linear regression, multiple linear regression, Logistic regression. Problem of multicollinearity. Factor Analysis: Centroid and Principal Components Method.
Writing Scientific Report, Writing a research project proposal, Academic ethics and Plagiarism, Intellectual Property Rights and Patent Law.

SUGGESTED BOOKS

1. S.C. Gupta , V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand and Sons, 2005.
2. S.P.Gupta, Statistical Methods, Sultan Chand and Sons, 2012.
3. C.R. Kothari, Research Methodology, New Age International Publishers, 2004.
4. Deepak Chawla, NeenaSondhi, Research Methodology, Vikas Publishing House 2016.
5. P. Sivaramakrishna Das, C. Vijayakumari, Engineering Mathematics, Pearson 2017.

MTL 1026			Engineering Mathematics II				Pre Requisites			
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Marks (Assign ment)	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	0	1.5 Hours	3 Hours	10	20	20	50	100

COURSE OUTCOMES

After successful completion of this course, students shall be able to;

1. understand the concepts of vector calculus like directional derivative, gradient, divergence and curl, and their applications.
2. learn and apply the concepts of vector integral calculus for the computation of work done, circulation, and flux.
3. formulate the differential equations concerning physical phenomena like electric circuits, wave motion, heat equation etc.
4. learn various methods of solution of ordinary and partial differential equations.
5. solve various partial differential equations arising in heat conduction problems and wave propagation problems.

Unit -I (12 Contact Periods)

Vector Calculus: Beta & Gamma functions. Differentiation of vector functions of scalar variables. Gradient of a scalar field, Divergence & Curl of a vector field and their properties. Line & surface integrals. Green's theorem, Stokes' theorem & Gauss' theorem both in vector & Cartesian forms (statement only) with simple applications.

Unit-II (12 Contact Periods)

Ordinary Differential Equation(ODE): Formation of ODE, definition of order and degree of ODE and solution, ODE's of first order, method of separation of variables, homogenous and non-homogenous differential equations and their solution, exactness and integrating factor, Bernoulli's equation, linear ODE's of n^{th} order, operator method, method of undetermined coefficients, method variation of parameters, solution of simple simultaneous ODE's.

Unit-III (12 Contact Periods)

Partial Differential Equation(PDE): Formation of (PDE), Solution of PDE by direct integration, Lagrange's linear equation, Non-linear PDE of first order, Method of separation of variables, Heat, Wave & Laplace's equations (Two dimensional Polar & Cartesian Co-ordinates).

SUGGESTED BOOKS

1. E. Kreysig, Advanced Engineering Mathematics, Wiley 10^{th} edition 2011.
2. Frank Ayres , Vector Analysis, Mc Graw Hills, 6^{th} edition 2011.
3. T. Marsden and W.H. Freeman,VectorCalclus, Freeman, 6 edition 2011.
4. G. Simons, Differential Equations with Applications, TMH, McGraw-Hill Higher Education; 2 edition 1991.
5. S.L. Ross, Differential Equations, Wiley 3^{rd} edition 1984.
6. R. Zalman, A Course in Ordinary and PDEs, Academic Press, 1^{st} edition 2014.

CO - PO Mapping for M.Sc. Mathematics Two Year Full Time Degree Program

		PO1	PO2	PO3	PO4	PO5	PO6
1	MTL6051	3	3	1	2	2	2
2	MTL6052	3	3	1	2	2	2
3	MTL6061	3	3	2	2	2	2
4	MTL6062	2	3	2	3	2	2
5	MTL 6063	3	3	1	2	2	2
6	MTL 6053	3	3	1	3	2	2
7	MTL 6054	3	3	1	1	2	2
8	MTL 6065	3	3	1	2	2	2
9	MTL 6071	3	3	3	3	2	2
10	MTL 6066	3	3	1	3	2	2
11	MTL 7081	3	3	3	2	2	2
12	MTL 7051	3	3	1	1	2	2
13	MTL 7061	3	3	1	1	2	2
14	MTL 7062	3	3	1	1	2	2
15	MTL 7063	3	3	1	2	2	2
16	MTL 7052	3	3	1	1	2	2
17	MTD7091	3	3	3	3	3	3
18	MTE 7012	3	3	1	2	2	2
19	MTE 7013	3	3	0	0	2	2
20	MTE 7015	3	3	1	0	2	2
21	MTE 7033	3	3	2	2	2	2
22	MTE 7041	3	3	1	2	2	2
23	MTE 7231	2	3	3	1	2	2

Course Outcomes of every course in M.Sc. (Mathematics) Program are mapped to POs consideringfollowing;

0 Value = Addressing to Zero Degree
1 Value = Addressing to Low Degree
2 Value = Addressing to Medium Degree
3 Value = Addressing to High Degree

Note: In this outcome based education syllabus only those elective courses are included which has been offered by School of Mathematics during the last five years.

ANEXURE-II

SCHOOL OF MATHEMATICS

Course structure for Integrated B.Sc. (Hons) Mathematics-M.Sc. Mathematics Programme Under CBCS in accordance with NEP, 2020
CHOICE BASED CREDIT SYSTEM

B.Sc. (Hons) Mathematics I YEAR

SEMESTER I

Broad Category of Course	Course Title	L-T-P	Credits
Core	Differential Calculus (MTL1231)	4-0-0	4
Core	Elements of Discrete Mathematics(MTL1241)	4-0-0	4
Multi-disciplinary	Fundamentals of Calculus and Applications(MTL1236) (For students of other schools) For the students of Five year program of Mahematics, the multidisciplinary course shall be offered by other schools.	3-0-0	3
AEC (Ability Enhancement)	Modern Indian Language/English Language/ Hindi Language / Communication Skills/Professional communication (Students can choose one of the Subjects)		3
SEC (Skill Enhancement Course)	Computer Applications/ Presentation Skills/ Personality Building/Modern Office Management/Financial Literacy and Banking/ Critical Thinking (Students can choose one of the Subjects)		2
Value Added Courses (2+2)	Understanding India/ Sports and Fitness/Yoga Education/Health and Wellness/ EVS/Digital Technology (Students can choose one of the Subjects)		2
	Understanding India/ Sports and Fitness/Yoga Education/Health and Wellness/ EVS/Digital Technology (Students can choose one of the Subjects)		2
Total Credits			**20**

SEMESTER II

Broad Category of Course	Course Title	L-T-P	Credits
Core	Integral Calculus(MTL1232)	4-0-0	4
Core	Analytical Geometry of 3D and Trigonometry(MTL1233)	4-0-0	4
Multi-disciplinary	Probability & Statistics with applications (MTL1243) (For students of other schools) For the students of Five year program of Mahematics, the multidisciplinary course shall be offered by other schools.	3-0-0	3
AEC (Ability Enhancement)	Modern Indian Language/English Language/ Hindi Language/ Communication Skills (Students can choose one of the Subjects)		3
SEC (Skill Enhancement Course)	Computer Applications/ Presentation Skills/ Personality Building/Modern Office Management/Financial Literacy and Banking/ Critical Thinking (Students can choose one of the Subjects)		2
Value Added Courses (2+2)	Understanding India/ Sports and Fitness/Yoga Education/Health and Wellness/ EVS/Digital Technology (Students can choose one of the Subjects)		2
	Understanding India / Sports and Fitness/Yoga Education/Health and Wellness/ EVS/Digital Technology (Students can choose one of the Subjects)		2
Total Credits			**20**

SEMESTER ONE

CORE(4CREDITS)

Differential Calculus

MTL-1231			Differential Calculus				Pre Requisites			
							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Assessment	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 Hours	3 Hours	10	20	20	50	100

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.

CORE(4CREDITS)

Elements of Discrete Mathematics

MTL-1242				Elements of Discrete Mathematics			Pre Requisites			
							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Assessment	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 Hours	3 Hours	10	20	20	50	100

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

MULTIDISCIPLINARY(3 CREDITS)

Fundamentals of Calculus and Applications

MTL - 1236				Fundamentals of Calculus and Applications			Pre Requisites			
							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Assessment	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 Hours	3 Hours	10	20	20	50	100

UNIT-I

The real line, geometrical representation of real lines, limit and continuity (ε and δ definition), Differentiability of functions, 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.

UNIT-II

Tangent and Normal, Curvature, Asymptotes, Singular points, Double point, Rolle's theorem, Mean Value theorems, Applications based on Rolle's theorem and Mean Value theorems.

UNIT-III

Taylor's theorem with Lagrange's and Cauchy's forms of remainder, Maxima and Minima for functions of two variables, Lagranges multipliers, Indeterminate forms, Applications (Heat Equation, wave equation, CR equations etc.)

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
8. Marvin L. Bittinger, David J. Ellenbogen and Scott A. Surgent Calculus and its applications, 10th Edition Addison-Wesley.

1. ABILITY ENHANCEMENT COURSES(SEC) (3CREDITS)

Modern Indian Language/English Language/ Hindi Language/ Communication***Skills (Students can choose one of the Subjects)***

2. SKILL ENHANCEMENT COURSE (2CREDITS)

Computer Applications/ Presentation Skills/ Personality Building/Modern Office Management/Financial Literacy and Banking/ Critical Thinking ***(Students can choose one of the Subjects)***

3. VALUE ADDED COURSES (VAC) (TWO SUBJECTS OF 2 CREDITS)

Understanding India/ Sports and Fitness/Yoga Education/Health and Wellness/ EVS/Digital Technology ***(Students can choose any two Subjects)***

SEMESTER TWO

CORE(4 CREDITS)

Integral Calculus

MTL-1232				Integral Calculus			Pre Requisites			
Version R-01							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Assessment	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 Hours	3 Hours	10	20	20	50	100

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).

CORE(4 CREDITS)

Analytical Geometry of 3-D and Trigonometry

MTL-1233				Analytical Geometry of 3-D and Trigonometry			Pre Requisites			
							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Assessment	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
4	0	0	4	1.5 Hours	3 Hours	10	20	20	50	100

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.

MULTIDISCIPLINARY(3CREDITS)

Probability & Statistics with Applications

MTL - 1243			Probability & Statistics with Applications				Pre Requisites			
							Co-requisites			
L	T	P	C	Minor Duration	Major Duration	Internal Assessment	Minor-I Marks	Minor-II Marks	Major Marks	Total Marks
3	0	0	3	1.5 Hours	3 Hours	10	20	20	50	100

UNIT-I

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

Review of probability- Random variable and Distribution function, Marginal and joint probability distribution Mathematical expectation of sum and product of random variables. Moments, Moment generating function.

UNIT-III

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.

Suggested Books:

1. R. D. Yates and D. J. Goodman, Probability and Stochastic Processes, Wiley, 1999.
2. Leon-Garcia, Probability, Statistics, and Random Processes for Electrical Engineering, Third Edition, Prentice-Hall, 2008.
3. P. Z. Peebles, Probability, Random Variable and Random Signal Processing, Fourth Edition, McGraw-Hill, 2001.
4. S. Ross, First Course in Probability, Sixth Edition, Prentice-Hall, 2002.
5. R. E. Ziemer, Elements of Engineering Probability and Statistics, Prentice Hall, 1997.
6. M. B. Pursley, Random Processes in Linear Systems, Prentice-Hall, 2002.
7. H. Stark and J W. Woods, Probability and Random Processes with Applications to Signal Processing, Third Edition, Prentice-Hall, 2002.
8. R. Gallager, Stochastic Processes: Theory for Applications, Cambridge, 2014.

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