SHRI G. S. INSTITUTE OF TECHNOLOGY AND SCIENCE, INDORE
(GOVERNMENT AIDED AUTONOMOUS INSTITUTE)

DEPARTMENT OF
APPLIED MATHEMATICS AND COMPUTATIONAL SCIENCE

Syllabi of M.Tech. Subjects

INDEX

DEPARTMENT OF APPLIED MATHEMATICS AND COMPUTATIONAL SCIENCE
M.TECH. ELECTRICAL ENGINEERING (Semester I)
(Specialization: Power Electronics and Power System & Control)
MA 60025: ADVANCED ENGINEERING MATHEMATICS

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
L	P	TU	T	P	TU	THEORY		PRACTICAL		TOTAL MARKS
						CW	END SEM	SW	END SEM	
3	--	-	3	--	-	30	70	--	--	100

COURSE OBJECTIVE

To introduce the concept of linear system of equations, stochastic process, neural network, non- linear and combinatorial optimization.

COURSE OUTCOMES

After completion of the course, students are able to

CO1 solve the system of linear equations and linear transformations.
CO2 use the correct techniques to solve the non-linear and combinatorial optimization problems.
CO3 acquire the knowledge of graph theory and its applications in solving optimization problems.
CO4 explain the concepts of stochastic theory and its applications.
CO5 implement the concept of neural network to train and analyze the data.

COURSE CONTENTS

THEORY

Unit 1 **Linear system of equations:** Basic concepts, rank of matrix, linear independence, solution of linear systems of equations: existence, uniqueness and general form, homogeneous and non-homogeneous equations, Eigen values, Eigen vectors, Matrix Eigen-value problems, Applications of Eigen value problem.

Unit 2 **Non-Linear Optimization:** Formulation of non-linear programming, general non-linear programming problem, Lagrangean method, Kuhn-Tucker condition, Fibonacci Search, Quadratic Interpolation.

Unit 3 **Combinatorial Optimization:** Introduction and basic terminology of graphs, path, circuit, Eulerian circuits, Hamiltonian cycles, shortest path problem, Dijkstra's algorithm. Tree, spanning tree, minimum spanning tree algorithms: Kruskal's and Prim's algorithm. Flow augmented paths, Ford-Fulkerson algorithm, Max. Flow min. cut Method theorem.

Unit 4 **Elements of Stochastic Process:** Random variable, sample space, statespace, random process (Stochastic process), Classification of stochastic process, Autocorrelation and auto covariance. Markov Process: probability vector, stochastic matrix, regular stochastic matrix and their applications, transition matrix, Poisson Process.

Unit 5 **Neural Network:** Basic Idea, Artificial neural network and its building blocks, Terminologies learning rules, back propagation network and its rule, feedback network, Adaline and madaline network, Neurons as function of single monotocity, Perceptrons , Functional link network and fuzzy logic.

ASSESSMENT

1. Internal Assessment for continuous evaluation, mid-term tests, tutorials, class performance, etc.(30%)
2. End semester Theory Exam (70%)

TEXT BOOKS RECOMMENDED

1. Erwin Kreyszig: Advance Engineering Mathematics, John Wiling & Sons, 8thEdition.
2. S. S. Sastry: Engineering Mathematics, VolII, 2nd Edition, PHI, New Delhi.

REFERENCE BOOKS

1. K.K.Vinoth, Neural Network and Fuzzy Logic,1st Edition, KATSON Book,2009.
2. Pannerselvam R.,Operations Research ,Prentice Hall of India Pvt. Ltd. ,New Delhi, 2004.

DEPARTMENT OF APPLIED MATHEMATICS AND COMPUTATIONAL SCIENCE

M.TECH. (Electronics and Communications Engineering) Semester I

MA 65014: LINEAR ALGEBRA, PROBABILITY THEORY AND OPTIMIZATION

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
						THEORY		PRACTICAL		TOTAL MARKS
L	P	Tu	T	P	Tu	CW	END SEM	SW	END SEM	
3	-	1	4	-	-	30	70	-	-	100

COURSE OBJECTIVE

To introduce the concepts of Linear algebra, Probability, Calculus and Optimization for wireless communication

COURSE OUTCOMES

After completion of course, students will be able to

CO1 use matrix analysis concept to solve communication problem.
CO2 Interpret the concept of vector space.
CO3 use the probability and random process concept in network.
CO4 implement the calculus concept in wireless communication.
CO5 apply the optimization technique in network.

COURSE CONTENTS

THEORY

Unit 1 **Matrix Analysis:** Basic Concepts, type of matrices, scalar multiplication, matrix multiplication, properties, hadamard product, inverse, rank, system of linear equations, linear transformation, Eigen values and Eigen vectors, positive definite matrix, Principle component analysis, Singular value decomposition.

Unit 2 **Vector Space:** Definition, scalars, addition, scalar multiplication, inner product(dot product), vector projection, cosine similarity, orthogonal vectors, normal and orthonormal vectors, vector norm, vector space, subspace, linear combination, linear span, linear independence, basis and dimension.

Unit 3 **Probability:** Events, sample space, dependent and independent events, conditional probability, Random variables- continuous and discrete, expectation, variance, binomial, Bernoulli, Poisson, exponential, Gaussian distributions, random process, Markov Chain- definition, transition matrix, stationary.

Unit 4 **Calculus:** Differentiation, chain rule, partial derivatives, total differentiation, implicit differentiation, Jacobian, gradient, directional derivative, Expansion of functions by Taylor's and Maclaurin's series of one and two variables.

Unit 5 **Optimization:** Maxima and minima, saddle point, Lagrange's method of undetermined multipliers and their applications, non-linear optimization, Kuhn-Tucker condition, Fibonacci search, quadratic interpolation optimization, evolutionary algorithms.

ASSESSMENT

1. Internal Assessment for continuous evaluation, mid-term tests, assignments, seminars, class performance, etc.(30%)
2. End semester Theory Exam (70%).

TEXT BOOKS RECOMMENDED

1. S. Lipschutz & M. Lipson, Schaum's outlines on Linear Algebra, McGraw Hill Education, 2005.
2. James Stewart, Calculus, Brooks/Cole; International ed edition, 2003.

REFERENCES

1. Scott Miller & Donald childers, Probability and Random Processes with Applications to Signal Processing and Communications, Elsevier Science, 2004.
2. Kalyanmoy Deb, Multi-objective optimization using evolutionary algorithms, Wiley, 2001.

DEPARTMENT OF APPLIED MATHEMATICS AND COMPUTATIONAL SCIENCE
M.TECH. I SEMESTER (INFORMATION TECHNOLOGY)
MA78011: MATHEMATICAL FOUNDATION OF COMPUTER SCIENCE

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
						THEORY		PRACTICAL		TOTAL MARKS
L	P	Tu	T	P	Tu	CW	END SEM	SW	END SEM	
3	-	-	3	-	-	30	70	-	-	100

COURSE OBJECTIVE

To introduce the concepts of set theory, statistical inference, graph theory**,** combinatorial enumeration problems and recurrence relations.

COURSE OUTCOMES

After completion of course, students will be able to

CO1 use logical notation to define and reason about fundamental mathematical concepts such as sets, relation and function.

CO2 analyze problem of statistical inference, problem of testing of hypothesis and multivariate statistical models like regression and its classification.

CO3 concept of discrete and continuous random variables and their probability distribution including expectation and its application.

CO4 apply the basic concept of graph theory and use permutation and combinations to solve counting problems with sets and multisets and apply them to combinatorial problems.

CO5 solve the problem involving recurrence relation and generating function.

COURSE CONTENTS

THEORY

Unit 1 **Set Theory:** introduction, operations on binary sets, principle of Inclusion and Exclusion. Relations: properties of binary relations, relation matrix and digraphs. Operations on relations. Partitions and covering. Transitive closure, Equivalence. Compatibility and partial ordering relations. Functions: Bi-jective functions, comparison of functions, inverse functions, permutation functions, recursive function.

Unit 2 **Statistical inference, Introduction to multivariate statistical models:** regression and classification problems, principal components analysis, the problem of over-fitting model assessment. Random samples, sampling distributions.

Unit 3 Probability mass, density, and cumulative distribution functions, parametric families of distributions, Expected value, variance, conditional expectation, Applications of the univariate and multivariate Central Limit Theorem, Probabilistic inequalities, Markov chains.

Unit 4 **Graph Theory:** Isomorphism, Planar graphs, graph coloring, Hamilton circuits and Euler cycles. Permutations and Combinations with and without repetition. Specialized techniques to solve combinatorial enumeration problems.

Unit 5 **Recurrence Relations:** Generating Functions, Function of Sequences, Partial Fractions, Calculating Coefficient of Generating Functions, Recurrence Relations, Formulation as Recurrence Relations, Solving Recurrence Relations by Substitution and Generating Functions, Method of Characteristic Roots, Solving Inhomogeneous Recurrence Relations.

ASSESMENT

1. Internal Assessment for continuous evaluation, mid-term tests, assignments, seminars, class performance, etc.(30%)
2. End semester Theory Exam (70%).

TEXT BOOKS RECOMMENDED

1. K.H. Rosen, Discrete Mathematics and its Applications with Combinatorics and Graph Theory, 7^{th} Edition, Tata McGraw Hill.
2. John Vince, Foundation Mathematics for Computer Science A Visual Approach, Springer.
3. K. Trivedi., Probability and Statistics with Reliability, Queuing, and Computer Science Applications, Wiley.

REFERENCE BOOKS

1. M. Mitzenmacher and E. Upfal, Probability and Computing: Randomized Algorithms and Probabilistic Analysis,
2. Alan Tucker, Applied Combinatorics, Wiley.

DEPARTMENT OF APPLIED MATHEMATICS AND COMPUTATIONAL SCIENCE
M.TECH. I SEMESTER (Mechanical Engineering Design and Thermal Engineering)
MA 84201/ MA 85201: ADVANCE MATHEMATICAL METHODS IN ENGINEERING

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
						THEORY		PRACTICAL		TOTAL MARKS
L	P	Tu	T	P	Tu	CW	END SEM	SW	END SEM	
3	-	-	3	-	-	30	70	-	-	100

COURSE OBJECTIVE

To introduce the concepts and applications of ordinary, partial differential equations, random variables, distributions, their significances and techniques to solve ANOVA.

COURSE OUTCOMES

After completion of course, students will be able to

CO1 classify differential equations according to certain features and solve first order differential equations.
CO2 solve homogeneous partial differential equations of n th order and their classification.
CO3 use techniques to solve second order partial differential equations.
CO4 acquire the knowledge of random variables as well as distribution and their significance.
CO5 analyze the concept of test of hypothesis and different techniques of ANOVA.

COURSE CONTENTS

THEORY

Unit 1 **Ordinary Differential Equation:** First-order equation (Linear, Equi- dimensional, Separable, Exact, Homogeneous); Second-order linear differential equation with constant coefficients (homogeneous and non homogeneous); Solution methods such as undetermined coefficients and variation of parameters.

Unit 2 **Partial Differential Equation :** First order Partial Differential Equation- Lagrange's and Charpit's Method; Second order linear homogeneous Partial Differential Equation with constant coefficients; Classification of PDE, Canonical form.

Unit 3 **Variable separable method** : derivations and problems, Second order Parabolic, Elliptic and hyperbolic equations in rectangular coordinate system (Steady state method); Solution of PDE by Fourier transform method.

Unit 4 Random Variables, Distribution Function and Density Function, Standard Discrete distribution(Binomial distribution, Poisson distribution, Geometric distribution)and Continuous distribution (Uniform distribution, Exponential distribution, Gamma distribution, Weibull distribution, Normal distribution), Central Limit Theorem and its significance.

Unit 5 **Relevant topics required for ANOVA (Sample Estimates and Test hypothesis)ANOVA:** One- way, Two-way with/without interactions, latin squares ANOVA techniques.

ASSESSMENT

1. Internal Assessment for continuous evaluation, mid-term tests, assignments, seminars, class performance, etc.(30%)
2. End semester Theory Exam (70%).

TEXT BOOKS RECOMMENDED

1. ZafarAhsan, Differential Equation and their Applications, Prentice Hall of India Pvt. Ltd., NewDelhi 2004
2. T. Veerarajan, Probability, Statistics and Random Processes, Third edition, McGraw Hill Education Pvt. Ltd., New Delhi 2008.

REFERENCES

1. K. Sankara Rao, Introduction to Partial Differential Equations,Third edition, PHILearning Private Ltd, 2019.
2. Sanjeev Kumar, V.S. Verma, Computer Based Numerical & Statistics Technique, Ram Prashad Publication, Revised Addition 2019.

DEPARTMENT OF APPLIED MATHEMATICS AND COMPUTATIONAL SCIENCE

M.TECH. Biomedical Engineering (Signal Processing and Instrumentation)

MA 75503: Applied Computational Linear Algebra

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
						THEORY		PRACTICAL		TOTAL MARKS
L	P	Tu	T	P	Tu	CW	END SEM	SW	END SEM	
3	-	-	3	-	-	30	70	-	-	100

COURSE OBJECTIVES

To understand the various concepts of linear algebra for solving system of linear equations, inner product spaces, orthogonality, Eigen values and eigenvectors.

COURSE OUTCOMES

After completion of this course, students are able to

CO1 solve the system of equations using various techniques.
CO2 explain the concept of vector space and linear mapping.
CO3 use the concept of inner product space and orthogonal in their core domain.
CO4 analyze the linear transformation and identify the eigenvectors using many techniques.
CO5 solve Eigen value problem using various numerical techniques.

COURSE CONTENTS

THEORY

Unit 1 **Matrices and System of Linear Equations:** Basic definitions, Elementary operations, Rank of a matrix, Solution of linear system of equations, Direct method: Gauss elimination method, Gauss- Jordan method, LU decomposition method, Cholesky decomposition method, Iterative methods: Gauss-Jacobi and Gauss-Seidel – SOR Method.

Unit 2 **Vector Spaces and Linear Mapping:** Vector spaces, Subspaces, Linear combinations, Linear dependence and independence, Basis and Dimension, , The four fundamental subspaces, Linear transformation, Matrix Representation of linear transformation, Null space, Range dimension theorem, Change of basis.

Unit 3 **Inner Product Spaces and Orthogonality:**Inner product spaces, Cauchy- Schwarz inequality, Orthogonality, Orthogonal sets and bases, Gram- Schmidt orthogonalization process, Least square approximations.

Unit 4 **Diagonalization: Eigen values, Eigen vectors:** Eigen values and Eigen vectors, Diagonalization, Difference equations and the powers A^k, Differential equations and e^{At},Similarity transformations, Test for positive, negative and semidefinite and indefinite matrices.

Unit 5 **Numerical Solution of Eigen value problems and Generalized Inverses:** Eigen value Problems: Power method, Inverse Power method, Jacobi's rotation method, conjugate gradient method, QR algorithm, Singular Value Decomposition method (SVD), Principal-Component Analysis and the SVD, Using the SVD in PCA, Singular values of Sparse Matrices.

ASSESSMENT

1. Internal Assessment for continuous evaluation, mid-term tests, assignments, seminars, class performance, etc.(30%)
2. End semester Theory Exam (70%).

TEXT BOOKS RECOMMENDED

1. Strang,G.,LinearAlgebraanditsapplications‖,Thomson(Brooks/Cole),NewDelhi,2005.
2. Lipschutz, S. & Lipson, M.L., Schaum'soutine of Theory and Problems of Linear Algebra, Third edition, McGraw Hill Edu. Pvt. Ltd, 2005.

REFERENCES

1. Kumaresan,S.,LinearAlgebra,A geometric approach ,Prentice Hall of India,New Delhi, Reprint,2010.
2. Bernard Kolman, David R. Hill, Introductory Linear Algebra‖, Pearson Education, New Delhi, First Reprint2009.

DEPARTMENT OF APPLIED MATHEMATICS AND COMPUTATIONAL SCIENCE

M.TECH. III Semester

MA51902/MA52902/MA59902/MA54902/MA71902/MA87902/MA81902/MA82902/MA78902/ MA65902/MA61902/MA63902/MA66902/MA85902/MA69902/MA75902/MA84902

Research Methodology & IPR

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
						THEORY		PRACTICAL		TOTAL MARKS
L	P	Tu	T	P	Tu	CW	END SEM	SW	END SEM	
2	-	-	2	-	-	30	70	-	-	100

COURSE OBJECTIVES

1. Discuss the research types, methodology and formulation.
2. Identify the sources of literature, survey, review and quality journals.
3. Discuss the research design for collection of research data.
4. Analyze the research data and write the research report.
5. Identify and apply appropriate research methodology in order to plan, conduct and evaluate basic research.
6. Compare between the scientific method and common sense knowledge while laying the foundation for research skills at higher levels.

COURSE OUTCOMES

After completion of this course, students are able to

CO1 illustrate the research types and methodology.
CO2 collect research data and use various tools and techniques for data analysis
CO3 do literature survey using quality journals.
CO4 process research data to write research report for grant proposal.
CO5 explain the importance and benefit of IPR protection.

COURSE CONTENTS

THEORY

Unit 1 **Research:** Types of research, research process, research proposals and aspects, research methodology, objectives of research, motivation in research, significance of research, selecting the research problem, scope and objective of research problem, Technique involved in defining a problem.

Unit 2 **Statistical Tools:** Measures of central tendency, measures of dispersion and measures of relationship: correlation and regression analysis. Data Sampling, Testing & Research Modelling: Student t-test, F-test, analysis of variance (ANOVA), data graphics and data interpretation.

Unit 3 **Literature Review :** National and international scenario of scientific research, effective literature reviewing, reference citation, scientific, engineering and research journals, impact valuation, indexing and abstracting.

Unit 4 **Report Writing:** Significance of report writing, types, formats, steps of report writing and publications in research journals. Technique of interpretation, oral presentation. Plagiarism and research ethics.

Unit 5 Patents, Designs, Trademarks, Geographical Indications and Copyright, Process of patenting and development, International cooperation on Intellectual Property. Scope of patent rights. Licensing and transfer of technology. Patent information and databases, new developments in IPR.

ASSESSMENT

1. Internal Assessment for continuous evaluation, mid-term tests, assignments, seminars, class performance, etc.(30%)
2. End semester Theory Exam (70%).

TEXT BOOKS RECOMMENDED

1. C.R Kothari, Research Methodology, Methods & Technique, New Age International Publishers, New Delhi, 2004.

2. R. P. Merges, P. S. Menell, M.A. Lemley, Intellectual Property in NewTechnological Age, 2016.

REFERENCES

1. R. Ganesan, Research Methodology for Engineers, MJP Publishers, Chennai,2011.

2. T. Ramappa, Intellectual Property Rights Under WTO, S. Chand, 2008