Masters of Applied Mathematics (24 months. Full Time)

West Bengal University of Technology

Structure of Syllabus & Details of First year.

COURSE OBJECTIVE:

1. To impart fundamental knowledge, thinking skills and technical skills for superior mastery in the areas of mathematical science and applications.

2. Enable the students to be well placed in leading business organizations anywhere in the world.

COURSE DURATION:
The course duration is of 24 months spread over four semesters with credit hours as per the WBUT norms. The course has sufficient emphasis on mathematical skills as well along with its science and management parts.

COURSE CURRICULUM PLAN:
The Course Curriculum is based on comparative analysis of existing MSc. Applied mathematics and Pure Mathematics curriculums of other Universities, IITs and NITs. The curriculum has sufficient exposure to hands-on skills and is much more directed towards higher employability. It is also well suited for upward accommodation of science graduates and Mathematics graduates.

Eligibility: Any Mathematics Graduate/ Any Graduate in Science with Mathematics as a core subject and Any Engineering Graduate.

Summary

Semester No	**Contact hr/wk**	**Credit**
1	31	24
2	31	24
3	28	22
4	24	22
Total	**114**	92

Semester – I

A. THEORY

Papers	CODE	THEORY	CONTACTS PERIODS/WEEK				CREDITS
			L	T	P	TOTAL	
1	MAM101	Abstract and Linear Algebra	4	1	0	5	4
2	MAM 102	Real Analysis	4	1	0	5	4
3	MAM 103	Differential Equations	4	1	0	5	4
4	MAM 104	Numerical Methods	4	1		5	4
5	MAM105	C-Programming and Data Structure	4	1		5	4
Total of Theory						**25**	20
B. PRACTICAL							
6	MAM 106	Numerical Methods	-	-	3	3	2
7	MAM 107	Data Structure Using C	-	-	3	3	2
Total of Practical						**6**	**4**
Total of Semester			**31**				24

Semester – II

A. THEORY

Papers.	CODE	THEORY	CONTACTS PERIODS/WEEK				CREDITS
			L	T	P	TOTAL	
1	MAM 201	Probability and Statistics	4	1		5	4
2	MAM 202	Classical Mechanics	4	1	-	5	4
3	MAM 203	Operations Research	4	1		5	4
4	MAM 204	Complex Analysis	4	1		5	4
5	MAM 205	RDBMS	4	1		5	4
Total of Theory						**25**	20
B. PRACTICAL							
6	MAM 206	Statistics using MAT Lab	-	-	3	3	2
7	MAM 207	RDBMS (SQL + PLSQL)	-	-	3	3	2
Total of Practical						**6**	**4**
Total of Semester			**31**				24

Semester – III

A. THEORY

Papers	**CODE**	**THEORY**	**CONTACTS PERIODS/WEEK**				**CREDITS**
			L	**T**	**P**	**TOTAL**	
1	MAM 301	Functional Analysis	4	1		5	4
2	MAM 302	Discrete Mathematics	4	1	-	5	4
3	MAM 303	Object Oriented Programming with C++	4	1		5	4
4	MAM 304	Continuum Mechanics	4	1		5	4
5	MAM 305	Integral Transformation and Integral Equation	4	1		5	4
Total of Theory						**25**	20
B.							
6	MAM 306	Seminar	-	-	3	3	2
Total of Semester			**28**				22

Semester – IV

A. THEORY							
Papers	**CODE**	**THEORY**	**CONTACTS PERIODS/WEEK**				**CREDITS**
			L	**T**	**P**	**TOTAL**	
1	MAM E 401	Elective I	4	1	0	5	4
2	MAM E 402	Elective II	4	1	0	5	4
3	MAM E 403	Elective III	4	1	0	5	4
Total of Theory						**15**	12
B.							
4	MAM 404	Project Dissertation	-	-	9	9	6
5	MAM 405	Viva Voce	-	-	-	-	4
						9	10
Total of Semester			24				22

Elective	**Course Code**	**Topic**
I (Choose anyone)	MAM E401 A	Financial Mathematics
	MAM E401 B	Advanced Optimization Techniques
	MAM E401 C	Information Theory and Decision Analysis
II (Choose any one)	MAM E 402 A	Dynamical System
	Course Code	MAM E 402 B	Network Security
	MAM E 403 A	Mathematical Biology
	MAM E 403 B	Cryptography

FIRST SEMESTER

MAM-101: ABSTRACT AND LINEAR ALGEBRA

(40 CLASSES)

Abstract Algebra:

Group and its elementary properties, direct product, internal and external direct products and their relation. Group actions, conjugacy class equation, Cauchy's theorem, P-groups, Sylow theorems; Simple groups, non simplicity of groups of p^n (n>1) , pq, p^2 q, p^2q^2 (p,q being both prime). Solvable and nilpotent groups, normal and composite series, Jordan-Holder Theorem. Commutative Subgroups, Necessary and sufficient condition for solvability of group. Insolvability of S_n (n≥5). Finite Abelian groups.

Ring Theory. Ideal and homomorphism, quotient ring, Isomorphism,Prime and maximal ideals. Noetherian and Artinan ring with identity.

Linear Algebra:

Matrices over a field. Matrix, characteristic and minimal polynomials, eigen values and eigen vectors. Caylay-Hamilton Theorem.

Linear transformation(L.T), rank and nullity, dual space and basis, representation of L.T by matrices. Change of basis. Normal form of matrices. Invariant factors and elementary divisors. Unitary similarity,unitary and normal operators on inner product spaces. Triangular,Jordan and rational form of matrices.

Bilinear forms,equivalence,symmetric and skew- symmetric forms. Sylvester law of inertia for quadratic form. Hermitian form.

Modules,modules with basis,rank of a finitely generated module.

Reference Books:

1. Topics in Algebra- I.N.Herstein
2. Fundamentals of Abstract Algebra – Malik,Mordeson & Sen
3. A First Course in Abstract Algebra-J.B.Fraleigh
4. Lectures in Abstract Algebra-N.Jacobson
5. Contemporary Abstract Algebra- J.A.Gallian
6. Linear Algebra-K.Hoffman & R.Kunze
7. Introduction to Linear Algebra-G.Strang
8. Linear Algebra-G.E.Shiby
9. Foundation of Linear Algebra-A.I.Malcev
10. Linear Algebra-J.H.Kwak & S.Hong
11. Linear Algebra and Matrix Theory-E.D.Nering

MAM-102: REAL ANALYSIS

(40 CLASSES)

Elementary set theory,finite,countable and uncountable sets. Real number system as a complete ordered field. Archimedean property, supremum, infimum.

Riemann-Stieltjes integral,properties,integration and differentiation, fundamental theorem of calculus.

Sequence and Series,convergence, limsup,liminf. Bolzano-Weierstrass Theorem. Heine-Borel Theorem.

Sequence and Series of Function,pointwise and uniform convergence, Cauchy Criterion for uniform convergence. Weierstrass's M-Test, Abel's and Dirichlet's Test for uniform convergence, uniform convergence and continuity, uniform convergence and Riemann-Stieltjes integration, uniform convergence and differentiation, Weierstrass approximation Theorem. Power Series,uniqueness theorem. Abel's and Tauber's Theorem.

Function of Several Variables. Directional derivative,derivative as a linear transformation.Taylor's Theorem,Inverse function and implicit function theorem,Jacobians,extremum problems with constraints.

Monotonefunctins, types of discontinuity,functions of bounded variation,Lebesgue measure and Lebesgue integral.

Reference Books:

1. Mathematical Analysis- T.M.Apostol
2. Real Analysis- R.R.Goldberg
3. Theory of Function of Real Variable (Vol.1)- I.P.Natanson
4. Principle of Mathematical Analysis-G.W.Rudin
5. Analysis I and II-Serge Lang
6. Real Analysis: An Introduction- A.J.White

MAM-103: DIFFERENTIAL EQUATION
(40 CLASSES)

Ordinary Differential Equation(ODE):
Existence and uniqueness of solution of initial value problem of first order ODE. General Theory of homogeneous and non homogeneous ODE,Wronskian,Abel identity,adjoint and self-adjoint equation. Strum-Liouville equation and boundary value problem. Green function.
Solution of Second order ODE, in complex domain, existence of solution near an ordinary point and a regular singular point. Solution of Bessel and Legendre equation. Bessel's functions,generating fnction, for integral index, recurrence relation, representation for the indices $\frac{1}{2}$ and - $\frac{1}{2}$, Bessel's integral formula, Bessel's functions of second kind.
Legendre polynomials,generating function,reccurence relation, Rodrigue's formula,Schlafli's and Laplace's integral formulae, orthogonal property.

Partial Differential Equation(PDE):
Lagrange's and Charpit's method of solving first order PDE, Cauchy-Kwalewski theorem(Statement only),Cauchy problem for first order PDE, classification of second order PDEs. General solutions of higher order PDEs with constant coefficients. Solution of Laplace,heat and wave equation by separation of variables method(upto two-dimensional cases).

Reference Books:
1. Ordinary Differential Equation- M.Birkhoff and G.C.Rota
2. Ordinary Differential Equation- E.L.Ince
3. Differential Equation- G.F.Simmons
4. Ordinary Differential Equation-Ross
5.Theory of Ordinary Differential Equation- E.E.Coddington & N.Levinson
6.Special Function and Their Application-N.N.Lebedev
7. Special Functions of Mathematical Physics and Chemistry- I.N.Sneddon
8.An Introduction to The Theory of Functions of a Complex Variable- E.T.Copson
9.Elements of Partial Differential Equation- I.N.Sneddon
10. Partial Differential Equation-E.Epstein
11. Introduction to Partial Differential Equation-G.Greenspan
12. Introduction to The Theory of Partial Differential Equation-M.G.Smith

MAM 104: NUMERICAL Methods
(40 CLASSES)

Interpolation: Confluent divided difference,Hermite interpolation, interpolation by iteration-Aitken's and Neville's Schemes. Cubic Spline interpolation,minimizing property and error estimation.
Approximation of function: Least square, weighted least square and mini-max polynomial approximations. Orthogonal polynomials, Gram-Schmidt orthogonalisation process, Chebyshev's polynomials.

Numerical integration: Gaussian quadrature formula and its existence. Bernoulli polynomials and Bernoulli numbers. Euler-Maclaurin sum formula and Gregory –Newton quadrature formula, Romberg integration.

System of linear algebraic equations. Factorization and SOR methods. Eigen value and eigenvector problems-Jacobi and Power methods.

Nonlinear equations: Fixed point iteration, Newton-Raphson, modified Newton-Raphson, Muller and inverse interpolation methods, error estimations and convergence analysis.

Ordinary differential equations: Picard's successive approximation, Euler, Runge-Kutta, Milne's predictor-corrector methods, error estimations and convergence analysis.

Boundary value problems: Shooting method, error estimate and convergence analysis.

REFERENCE BOOKS

1. Introduction to Numerical Analysis - C.E.Froberg

2. Introduction to Numerical Analysis - F.B.Hilderbrand

3. Numerical Analysis –Fished

4. A First Course in Numerical Analysis – A.Ralston & P.Rabinnowits

5. Numerical Analysis- K. Atkinson & W. Cheney

6. Numerical Analysis- K.David & W.Cheney

7. Numerical Methods for Scientific and Engineering Computation-M. F. Jain ,S.R.K. Iyenger &P.K. Jain

8. A Text Book of Numerical Analysis- D.C .Sanyal & K.Das

MAM-105: DATA STRUCTURE AND ALGORITHM
(40 CLASSES)

Introduction to Data Structure and Algorithm. Use of Big O and Small o
Big Omega and small omega notations. Efficiency of algorithms. Analysis of recursive programs.Solving recurrence equation, divide and conquer algorithms.Dynamic programming,Greedy algorithms.
Implementation of Abstract Data Types(ADT),list,stack,queue hashing. Tree Structure,binary trees,AVL trees,Red-Black Trees,priority queues,Tree-Traversal Algorithms,Graphs and algorithms.Prim's and Kruskal's algorithms,Dijkstra's method,backtracking minimum spanning trees,Sorting and searching algorithms.
Introduction to NP problem, polynomial time,abstract problems,encoding; NP completeness and reducibility, circuit satisfiability, NP complete problem; Vertex cover,subset-sum,Hamiltonian-cycle,Travelling-Salesman Problem.

Reference Books:

1.Data structure using c and c++ - Tanenbaum
2.Fundamentals of Data structure in c++ - E.Horwitz,Sahni,D.Mehta
3.Introduction to Algorithms – T.H.Cormen,C.E.Leiserson & R.L.Riveit
4.The Design and Analysis of Computer Algorithms- A.V.Aho, J.E.Hoperoft & J.D.Ullman

MAM 191
Numerical Methods Lab (30 classes)

Solving various problems In C. 2. Implement Numerical problems Using C/MAT LAB 3. Assignments on Interpolation: Newton forward &backward, Lagrange Assignments on Numerical Integration: Trapezoidal Rule, Simson's 1 /3 Rule, Weddle's Rule 5. Assignments on Numerical solution of a system of linear equation: Gauss elimination, Gasuss Jacobi, Matrix Inversion, Gauss Seidel 6. Assignments on Algebraic Equation: Bisection, Secant, Regula-falsi, Newton Raphson 7. Assignments on Ordinary Differential Equation: Taylor Series, Euler's method, RungaKutta.

MAM 192
Data Structure and Algorithms Lab Using C (30 classes)

Programming using C, study of various features of the language, Structured and modular programming, various data structures in applications such as sorting, searching, string and list manipulation.

SECOND SEMESTER

MAM 201: PROBAILITY AND STATISTICS
(40 CLASSESS)

Probability Theory: Joint,marginal and conditional distributions,moments and conditional moments,correlation and regression,transformation of variables,bivariate normal and Dirichlet distribution.
Multivariate distribution: χ^2 ,t and F distributions. correlation and regression;Multinomial, uniform distribution on bounded subsets of R^p , multivariate normal and Dirichlet distributions,Cauchy distributions.Order statistics.
Chebyshev's Inequality,Convergence in probability,Bernoulli's theorem,Convergence almost surely,weak law of large numbers,Central and De-Moivre Laplace limit theorems.
Statistics: Sampling distribution: χ^2 ,t and F distributions.
Estimation: Method of moments,maximum likelihood estimation,unbiasedness,consistency,comparing two estimators,confidence interval estimation for mean,difference of means,variance,proportions,sample size problems.
Test of Hypothesis: Neyman-Pearson Lemma,composite hypothesis,comparison of normal populations, large-sample test,test on multinomial distributions,goodness of fit.
Curve fitting and Correlation: Principle of least squares and curve fitting, correlation and regression,scatter diagram,regression lines,bivariate frequency distribution.
Theory of errors: Gauss Postulate of arithmetic mean,normal law,error function. Principle of least squares,confidence interval.

Reference Books:

1. Elements of Probability and Statistics – A.P.Baisnab and M.Jas
2. Probability and Statistics – M.H.Degroof
3. Elementary Probability Theory – Chung
4. Modern Probability Theory and Application – E.Parzen
5. Mathematics of Statistics Vol I & II – J.F.Kenney & E.S.Keeping
6. Introduction to Statistics – R.G.D.Steel

MAM-202: CLASSICAL MECHANICS
(40 CLASSES)

Generalised coordinates, degrees of freedom,holonomic and non holonomic systems,scleronomic and rhenomic systems, D'Alemberts's Principle, Lagrange's equation, energy equation for conservative fields, cyclic (ignorable) coordinates,generalized potential.
Moving coordinate system with relative translational motion. Rotating coordinate system,Coriolis Force and its effect on freely falling particle.
Euler's equation of motion of a rigid body. Eulerian angle.
Calculus of variations and its application for the shortest distance, minimum surface of revolution,Branchistochrone problem, geodesic.
Hamilton's Principle, Principle of least action, Hamilton's equation of motion.
Cannonical coordinates and canonical transformations. Poincare's theorem.
Lagrrange's and Poisson's Brackets. Legendre transformation.Generating functions. Condition of Cannonicality.
Hamilton's equation of motion in Poisson bracket.Hamilton-Jacobi equation. Hamilton's Principle function and characteristic function.
Small oscillation,general case of coupled oscillation. Eigen vectors and eigen frequencies, orthogonality of eigen vectors. Normal coordinates.

Reference Books:
1.A Treatise of Analytical Dynamics of Particles and rigid Bodies-E.T.Whttaker
2.Dynamics- D.T.Greenwood
3. Dynamics-F.Chorlton
4.Classical Mechanics- H.Goldstein
5. Mechanics:Newtonian,Classical,Relativistic Theory,Problems and Application.

MAM 203: OPERATIONS RESEARCH
(40 CLASSESS)

Revised simplex method and algorithm approaches to linear programming problem,dual simplex method,decomposition principle and its use to linear programmingfor decentralized planning problems.
Bi-Criterion Transportation models,cost and time minimizing transportation problems,trade off ration technique.
Waiting lines- characteristics of a queuing system,arrival and service patterns,single and multiple channel,queue model with Poisson arrival and exponential service times.
Simulatin Modelling: Monte-Carlo Simulation,using random numbers,applications in waiting lines,maintenance and finance areas.
Replacement Models: Different types of replacement models, replacement of assets deteriorating with time; Markov Analysis-Brand Switching analysis,Prediction of market shares for future periods, equilibrium conditions, Uses of Markov analysis.
Dynamic Programming: Basic features, Bellman's principle, multi-stage decision process.

Reference Books:
1. Operation Research: H.A.Taha
2. Operation Research: A.Ravindran,D.T.Philips & J.J.Solberg
3. Operation Research:J.K.Sharma
4. Principle of Operation Research: H.W.Wagner
5. Nonlinear and Dynamic Programming: g.Hadley

MAM 204: COMPLEX ANALYSIS
(40 CLASSES)

Complex Integration: Cauchy-Goursat theorem. Cauchy integral formula. Higher order derivatives. Morera's Theorem.Cauchy inequality and Liouville's Theorem.Fundamental Theorem of Algebra.Taylor's Theorem.Maximum Modulus Principle.Convex function,Hadamard's Three circle theorem.Schwarz Lemma.Laurent's Series.Isolated singularities.Meomorphic functions,Rouche's Theorem,Inverse function theorem,Open mapping theorem.
Residues: Cauchy Residue Theorem,Evaluation of integrals.Branches of mang-valued functions with special reference to argz,logz, and z^a . Branch Points.
Bilinear Transformations: Properties and classification. Definition and examples of conformal mappings.

Reference Books:

1. Complex Variables and Applications – R.V.Churchiv & J.W.Brown
2. Functions of One Complex Variable –J.B.Conway
3. Theory of Functions of One Complex Variable, vol I & II – A.I.Markushivch.
4. Foundation of Complex Analysis – S.Pommusamy
5. The Theory of Function – E.C.Titchmarsh
6. Complex Analysis – S.Lang

MAM 205: RDBMS
(40 CLASSESS)

Overview of Database Management;Conceptual,logical and Physical Database Design.
Relational Database: Relation,Optimization,Catalog,Base relvars and views,transitions,the suppliers and parts database.
Relational Model: Constraining,referential integrity constraints,update operators on relations,Structural Query Language (SQL),Data Definition Language Commands, Data Manipulation Language Commands, Transaction Control Commands,SQL Command syntax and usage.Basic query block,Querying Data with multiple conditions,Bassic Relational Algebra operations,The Select Operation,Additional Relational operations.
ER – and EER – To Relational Mapping: ER to relational Mapping Algorithm,Summary of mapping for model constructs and constraints, Mapping EEr Model concepts to relation.
Query, Processing and Optimization: Query Processing, Query Optimization,Database tuning
Object Oriented Database Systems : Characteristics of an Objective Relation Database Management System(ORDBMS),Complex Objects,Inheritance,Function Overloading ruls.
Distributed Database: Distributed Database system and Design,Data Fragmentation,Data Replication,Data Allocation,Query Processing in Distributed Databases.
Recovery: Transactions; Transactions -,System and Media Recovery,Two phase Commit.

Reference Books:

1. Database System Concepts – Silberchatz,Korth & Sudarshan
2. Fundamentals of Database Systems – R.Elmasri & S.Navathe
3. Database Design and rlational theory : Normal Forms and All that Jazz – C.J.Date

MAM 291
OR Lab using C (30 classes)

Linear Programming (Transportation , Assignment , Duality , Simplex), Revised Simplex Method, Simulation Method, Queuing Theory, PERT/CPM

MAM 292
RDBMS (30 classes)

Study of commercial DBMS package such as Oracle. Developing database application with Oracle Creation of a database, writing SQL queries and retrieving data, PL/SQL.