Department of Sciences
Manipal Academy of Higher Education
M.Sc. (Applied Mathematics & Computing) Program
Choice Based Credit System - 2020 (CBCS - 2020)
(To be implemented from the academic year 2020-21)

Signature of Registrar

Signature of Deputy Registrar (Tech)

Signature of Coordinator (DoS)

Signature of HOD, Dept. of Mathematics

Contents

Department of Science
M.Sc. (Applied Mathematics and Computing)

Rules and Regulations

Admission Procedure
Admissions are merit based on the marks secured in B.Sc.

Eligibility
A pass with 50% in aggregate in B.Sc.

Duration
2 years (Four Semester)

Attendance requirements
All students are expected to attend all the lectures, tutorial and practical classes. A student with less than 75% attendance shall not be permitted to write end semester examination in that course and will be given a DT letter grade in the course.

Evaluation procedure
(a) Theory Paper: The performance of the students in each subject is evaluated using internal system of continuous assessment. The students are evaluated based on class / tutorial participation, assignment work, class tests and end-semester examinations. In all the theory papers, fifty percent weightage will be given to the in-semester evaluation and the remaining fifty percent for end-semester evaluation. The in-semester evaluation will comprise of two sessional tests each carrying 15 marks and assignment/quiz will carry 20 marks. End semester examination will be of 50 marks. A student must obtain 40 marks altogether with minimum of 18 marks in the end semester examination. Students will be notified at the commencement of each semester about the evaluation methods being used for the subjects and the weightage given to the different assignments / activities.

(b) Lab Work: Lab work is continuously assessed, and sixty percent weightage will be given to the in-semester evaluation and the remaining forty percent for end-semester test evaluation

(c) Seminar: Written report will be evaluated for subject content, clarity of concepts, coherence, correctness, logical aspects, descriptive skills and creative writing skills. Oral presentation will be assessed for ability to express subject matter, verbal communication skills, response to questions, time management skills, and clarity of visuals on a scale exceptional (highest 1 %), excellent/outstanding (highest 5%), very good (highest 10%), good (upper 25%), fair/average (upper 50%) and poor/below average (lower 50%).
(d) Project work: Project work evaluation is done in two phases. Once in the middle of the semester and one more at the end of the semester. Evaluation is done based on the following criteria.

- Clear and concise presentation of work
- Demonstration of depth of technical understanding
- Coverage of related work; knowledge of the field
- Quality of any products or processes
- Demonstration of ability to critically analyze other work and come up with original analyses and ideas
- Any contribution to knowledge
- Demonstration of professional conduct, considering ethical issues where appropriate, and of course no evidence of plagiarism.

Relative Grading

At the end of the evaluation a letter grade in the 10-point grading system will be given to each theory / lab courses. The grade point average (GPA) is calculated at the end of each semester and CGPA at the end of each semester after the second.

Marks obtained in the in-semester and end-semester examinations (50% weightage for both) are added together and a 10-point grading system will be used to award the student with an overall letter grade for the subject. A student must obtain a minimum 40% in each subject inclusive of in-semester and end-semester examination, with minimum of 18 marks in the end semester examination, to be considered for award of the grade in that subject.

Letter Grading System

Final evaluation of subject is carried out on a TEN POINT grading system. Performance Grades and Grade Points are as shown below:

Grade	A+	A	B	C	D	E	F (Fail)
Grade Points	10	9	8	7	6	5	0

A student who earns a minimum of 5-grade points (E grade) in a subject is declared to have successfully completed the course and is deemed to be have earned the credits assigned to that course. A course successfully completed cannot be repeated.

If a student is eligible for but fails to appear in the end-semester examination, he / she will be awarded an "I" grade (incomplete) on the grade sheet. For all practical purposes, an 'I' grade is treated as "F".

If a student is not eligible to appear in the end semester examination owing to his / her not fulfilling the minimum attendance requirements, he / she will be required to discontinue the programme temporarily till such time he / she fulfills the minimum attendance requirements by re-registering for those courses in which he / she had attendance shortage at the next available opportunity.

Grade Point Average (GPA) and Cumulative Grade Point Average (CGPA)

Each subject grade is converted into a specific number of points associated with the grade. These points are weighted with the number of credits assigned to a course. The

Grade Point Average (GPA) is the weighted average of Grade Points awarded to a student. The grade point average for each semester will be calculated only for those students who have passed all the courses of that semester. The weighted average of GPA's of all semesters that the student has completed at any point of time is the cumulative grade point average (CGPA) at that point of time.

CGPA up to any semester will be calculated only for those students who have passed all the courses up to that semester.

Calculation of GPA and CGPA

Example:

Courses	Credits	Letter Grade	Grade Value	Credit Value	Grade Points
Maths	3	C	7	3x7	21
Chemistry	3	B	8	3x8	24
Physics	3	A	9	3x9	27
English	2	B	8	2x8	16
Total	11				88

In this case GPA, total grade points / Credits = 88 / 11 = 8.0

Suppose the GPAs in two successive semesters are 7.0 and 8.0 with 26 and 24 respective course credits, then the

CGPA = (7.0 x 26) + (8.0 x 24) / (26 + 24) = 374 / 50 = 7.48

Generally,

$$GPA = \frac{\sum_{i=1}^{n} Ci\,Gi}{\sum_{i=1}^{n} Ci} \text{ and } CGPA = \frac{\sum_{j=1}^{N} GPAj\ x\ \sum_{i=1}^{n} Ci}{\sum_{j=1}^{N}(\sum_{i=1}^{n} Ci)}$$

where

n = number of subjects

Ci = subject credits

N = number of semesters

Gi = grade values

After the result is declared, grade cards will be issued to each student which will contain the list of courses for that semester and the grades obtained by the student, as well as GPA of that semester and CGPA up to that semester.

Re-valuation of answer papers

In case any student feels aggrieved about the evaluation, he / she shall have access to his / her answer paper in the end semester examination which may be shown to him / her by the teacher/s concerned. If the case is genuine, teacher may re-value the paper and forward a revised grade, if any, to the Head of the Department with justification for the revision. No further revision is permitted once the results are sent to the University for record.

Re-registration
Students can re-register in one or more subjects of the previous semester(s) (odd semester subjects in the odd semester only, and even semester only), provided they have F grade(s) in that subject / those subjects, by paying the prescribed fees.

Re-registration entitles the student to attend the classes (with minimum of 75% attendance requirement), and appear for the sessional tests, the end semester examinations, in the subject(s) in which they have re-registered. Re-registered candidates will have to appear for sessional tests / end-semester examinations along with the regular students.

End-Semester Examination and Make-up (Supplementary) Examination
The examinations at the end of a semester will be conducted only in the subjects of the current semester. That is, at the end of the odd-semester, examinations in the subjects of the odd-semester only will be conducted. Similarly, at the end of the even-semester, examinations will be conducted only in the subjects of the even-semester.

About 4 weeks after the conclusion of the regular examinations in the current semester subjects, there will be make-up (supplementary) examinations, before the commencement of the next semester classes. The make-up examinations will also be in the current semester subjects only. Students who have F / I grades in one or more subjects and those who missed one or more examinations in the regular series due to serious medical reasons, are eligible to appear for the make- up examinations in the relevant subjects. The cut-off marks for conversion of marks into grades in the make-up examination will be same as those in the regular end-semester examination, in a particular subject.

However, for a student with “F” grade in any course a maximum of “C” grade will be awarded in subsequent examination irrespective of his/her performance. Student with the “I” grade with valid reasons will be allowed to retain whatever the grade he/she obtain in the make-up examinations.

Withholding of Results
Results will be withheld when a student has not paid his / her dues or when there is a case of indiscipline pending against him / her.

(These rules and regulations are subject to change / amendment from time to time, as and when need arises).

Course structure

Semester	Subject code	Subject	L-T-P-C	Credits
First semester	MAT 5131	Differential Equations	4-0-0-4	4
	MAT 5132	Algebra I	4-0-0-4	4
	MAT 5133	Real Analysis	4-0-0-4	4
	MAT 5134	Linear Algebra	4-0-0-4	4
	MAT 5135	Topology	4-0-0-4	4
	MAT 5136	Mathematical Softwares - Lab	0-0-4-2	2
Total credits				22
Second semester	MAT 5251	Measure and Integration	4-0-0-4	4
	MAT 5252	Complex Analysis	4-0-0-4	4
	MAT 5253	Numerical Analysis	4-0-0-4	4
	MAT 5254	Probability Theory & Stochastic Process	4-0-0-4	4
	MAT 5255	Algebra II	4-0-0-4	4
	MAT 5257	Research Methodology and Technical communication	3-0-0-3	3
Total credits				23
Third semester	MAT 6101	Linear Optimization	4-0-0-4	4
	MAT 6102	Graph Theory	4-0-0-4	4
	MAT 6103	Functional Analysis	4-0-0-4	4
	MAT 6104	Theoretical Foundation for Computer Science	4-0-0-4	4
	MAT 6105	Mid- Term Project Work	0-0-4-0	0
	MAT 6061	Open elective	3-0-0-3	3
Total credits				19
Fourth semester	MAT 6201	Number Theory and Cryptography	4-0-0-4	4
	MAT 6202	Project Work	0-0-0-6	6
	MAT 60XX	Elective I	3-0-0-3	3
	MAT 60XX	Elective II	3-0-0-3	3
Total credits				16
Grand Total				**80**

List of electives

MAT 6001: Design and Analysis of Algorithms
MAT 6002: Statistical Quality Control
MAT 6003: Non-linear Optimization
MAT 6004: Graphs and Matrices
MAT 6005: Mathematical Modelling
MAT 6006: Fluid Dynamics
MAT 6007: Advanced Numerical Analysis and Finite Element Methods

1st Semester

MAT 5131: Differential Equations
[4-0-0-4]

Course Outcomes:
At the end of the course students will be able to:

- understand the concept of solution and existence and uniqueness of solution.
- obtain the solution in terms of special functions.
- learn the concept of adjoint form of differential equations.
- understand the method of solution of PDE's

Pre-requisites:
B.Sc. Mathematics background

Syllabus
Linear differential equations with constant and variable coefficients of n^{th} order initial value problems existence and uniqueness, Solution of homogenous equation, Wronskian, linear independence and non homogenous equations

Boundary value problems – two point boundary value problems. Self-adjoint problem and standard properties. Sturn – Liouville problems.

Power series solution – about an ordinary point, solution about regular singular point. Bessel, Ledgendre, Hermite equations, Lagurre and Chebyshev equation.

Quasilinear and general nonlinear equations – standard method of solution. Second order partial differential equations, classification and reduction to canonical form , standard method of solution of parabolic elliptic and hyperbolic partial differential equations

REFERENCES:

1. E.A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall , 1986.
2. G.Birkoff and G.C.Rota, Ordinary Differential Equations, Ginn and Co., 1982.
3. Snedon I.N, Elementary partial differential equations, Mc GrawHill,1987
4. S.J.Farlow, Partial differential equations for Scientists and engineers, John Wiley and Sons (1982)
5. T.Amarnath ' An elementary course in partial differential equations" Narosa publications.

MAT 5132: ALGEBRA – I

[4-0-0-4]
Course Outcomes:
At the end of the course students will be able to:

- understand notion integer modulo and applications of Dihedral groups
- explore subgroups and group acting on a set by conjugation – Caley's theorem
- apply Sylow's theorems and study groups of order of the form p, pq etc.
- study isomorphism theorems of rings
- understand various domain such as Euclidean, UFG, PID etc. Further to study splitting fields and applications

Pre-requisites:
B.Sc. Mathematics background

Syllabus
Preliminaries: Properties of the Integers – $Z/Z_{n:}$ The Integers Modulo n.-Introduction to Groups - Basic Axioms and Examples - Dihedral Groups - Symmetric Groups - Matrix Groups - The Quaternion Group - Homomorphisms and Isomorphisms Group Actions.

Subgroups - Definition and Examples - Centralizers and Normalizers, Stabilizers and Kernels - Cyclic Groups and Cyclic Subgroups - Subgroups Generated by Subsets of a Group - The Lattice of Subgroups of a Group.

Quotient Groups and Homomorphisms - Definitions and Examples - More on Cosets and Lagrange's Theorem - The Isomorphism Theorems - Transpositions and the Alternating Group.

Group Actions: Group Actions and Permutation Representations - Groups Acting on themselves by Left Multiplication-Cayley's Theorem - Groups Acting on themselves by Conjugation-The Class Equation - Automorphisms - The Sylow Theorems - The Simplicity of A_n.

Direct and Semi-Direct Products and Abelian Groups: Direct Products - The Fundamental Theorem of Finitely Generated Abelian Groups - Table of Groups of Small Order.

Introduction to Rings - Basic Definitions and Examples - Examples: Polynomial Rings, Matrix Rings, and Group Rings - Ring Homomorphisms and Quotient Rings - Properties of Ideals - Rings of Fractions - The Chinese Remainder Theorem.

Euclidean Domains- Principal Ideal Domains and Unique Factorization Domains.

Field Theory: Basic theory – Algebraic Extensions – Splitting Fields – Algebraic Closures.

REFERENCE BOOKS:

1. David S. Dummit and Richard M. Foote, ABSTRACT ALGEBRA, Third Edition, Wiley Publishers (2017).

(Chapters: 1, 2, 3, 4, 5 (5.1 to 5.3), 7, and 13 (13.1, 13.2, 13.4) of the Text Book).

2. I.N. Herstein, Topics in Algebra, 2nd edn. Wiley Eastern Ltd, New York, 1990.
3. J.B. Fraleigh, A first course in Abstract Algebra, 2nd edn. Addison Wesley, (1967).
4. M. Artin, Algebra, Prentice Hall, 1996.
5. A. Gallian, Contemporary abstract algebra, Narosa, 1990.

MAT 5133 : REAL ANALYSIS

[4-0-0-4]
Course Outcomes:
At the end of the course students will be able to:

- Understand the basics of topological concepts.
- Appreciate compactness, connectedness and their applications
- Check for convergence and absolute convergences of numerical sequences and series
- Obtain conditions for continuity and differentiability.
- Understand evaluation and applications of Rieman-Stieltje's Integral.

Pre-requisites:
B.Sc. Mathematics background

Syllabus
Basics of topology – Finite countable and uncountable sets, Metric spaces compact sets, perfect sets, connected sets.

Numerical sequences and series. Convergent sequences , Cauchy sequence, limits, series, power series , Summation by parts, absolute convergence, addition and multiplication of series and rearrangements.

Continuity: Limits, continuity, continuity and compactness , connectedness. Discontinuity, monotonic functions, infinite limits.

Differentiation, derivatives, mean value theorems, continuity of derivatives, L'Hospital's rule, higher order derivatives and differentiation of vector valued functions.

The Rieman-Stieltje's Integral: Definition and existence of integral, Properties of integral, function of bounded variation. Integration and differentiation.

REFERENCES :

1. W.Rudin., Principle of Mathematical Analysis, edn 3. McGraw Hill Book Co. New York (1986).
2. H.L.Royden, Real Analysis(second edn.)Pearson,PHI. (2005).

3. R.R.Goldberg, Method of Real Analysis, Oxford & IBH Publishing Co.New Delhi (1970).
4. R.G.Bartle, The Element of Real Analysis, edn. 2 Wiley International Edn., New York.
5. T.M. Apostol, Mathematical Analysis, edn.2 Adison Wesly, Narosa, New Delhi.
6. W.H.Flemming, Function of Several Variables, Adison Wesly, Narosa, New Delhi.
7. E.C.Titchmarsh, The Theory of Functions, Oxford University Press, Fairlawn N.J.
8. S.C.Malik, Mathematical Analysis Weily Estern Ltd., 6th edn.
9. W.Rudin., Real and complex Analysis, edn 2. McGraw Hill Book Co. New York

MAT 5134 : LINEAR ALGEBRA

[4-0-0-4]

Course Outcomes:
At the end of the course students will be able to:

- Understand the existence and uniqueness, Geometric and Algebraic interpretation of solution of system of linear equations.
- Understand the concept of Vector spaces, bases, linear transformations and their matrix representations.
- Understand the theory and applications of determinants.
- Understand basic canonical forms, eigen values and eigen vectors.
- Understand inner product spaces and their applications.

Pre-requisites:
B.Sc. Mathematics background

Syllabus
Linear Algebra: Linear transformations, algebra of Linear transformations, characteristic roots, interpretation in terms of matrices, canonical forms (triangular, Nilplotent, Jordan and rational), trace, transpose and the determinant of linear transformations. Functionals and dual spaces, inner product spaces, orthogonal sets, Hermitian, Unitary and normal transformations, bilinear, quadratic and Hermitian forms.

REFERENCES:

1. I.N. Herstein, Topics in Algebra, 2nd edn. Wiley Eastern Ltd, New York, 1990.
2. S.Lang, Linear Algebra, Addison Wesley, (1972)
3. K. Hoffman & R. Kunze , Linear Algebra , Second Edition, PHI , 2006.

MAT 5135 : TOPOLOGY

[4-0-0-4]
Course Outcomes:
At the end of the course students will be able to:

- Identifying the sets like open, closed, interior, exterior, boundary of a set. Also basis for a Topology.
- Understand the concepts like subspaces, separation axioms, continuity and homeomorphism.

Pre-requisites:
B.Sc. Mathematics background

Syllabus

Definition of topologies in terms of open sets, closed sets, Closure operations and their equivalence, Neighbourhood systems. Limits points, interior, exterior and boundary points. Base and sub-bases of topology, Continuity and homoeomorphism, Subspaces, product and quotient spaces, metric space, continuity, convergence, compactness

Separation and Continuity axioms, Separable and Lindel of spaces. Connectedness , path connectedness, Local connectedness.

Completeness and Bair's theorem, spaces of continuous function.

REFERENCES:

1. Simmons G.F., Introduction to Topology and Modern Analysis, McGraw Hill (1968)
2. H.L Royden , Real Analysis 2nd edn, the Macmillan Co., Collier Macmillan Ltd., London.
3. J.T.Munkres, Topology, PHI, New Delhi (1998)
4. J.Dugundji, Topology, UBS Pub., New Delhi (1997)
5. Willard, General Topology, Hocking & Young Pub.

MAT 5136: Mathematical Softwares-Lab

[0-0-4-2]

Course Outcomes:
At the end of the course students will able to:

- Solve linear algebra and numerical methods problems using MATLAB.
- Plot 2D and 3D graphs using MATLAB.
- Perform matrix computations in SageMath.
- Construct graphs and perform graph computations in SageMath.
- Plot 2D and 3D graphs in SageMath.

Pre-requisites:
B.Sc. Mathematics background

Syllabus

MATLAB

Introduction to the MATLAB environment. Arithmetic operators, mathematical constants, expressions. Matrix operations and standard matrices. 2D and 3D graph plotting. Programming in MATLAB – Script files and function files. Control structures – if-else, for, while. Linear algebra in MATLAB – solution of linear systems, eigenvalues and eigenvectors. Symbolic Math Toolbox.

SageMath

Introduction to SageMath Jupyter notebook. Evaluating expressions, basic operators and functions. Matrices in SageMath – Matrix operations, eigenvalues and eigenvectors. Graph theory in SageMath – Defining and manipulating graphs. Computing graph parameters. Graph operations. Programming – control structures – if-else, for, while – defining functions. Interact widget. Graph plotting.

References

1. *MATLAB Programming Fundamentals*. The MathWorks Inc. 2019.
2. B.R. Hunt, R.L. Lipsman, J.M. Rosenburg. *A Guide to MATLAB*. Cambridge University Press. 2001.
3. *Sage Reference Manual (Release 8.9)*. SageMath. 2019.

2nd Semester

MAT 5251: MEASURE AND INTEGRATION

Course Outcomes: [4-0-0-4]
At the end of the course students will be to:

- understand the concept of measure on the real line
- understand various types of measures such as Lebesgue outer measure
- study about measure, outer measure and inner measure and Riemann integral.
- study about L^p spaces, bounded linear functionals on it and related inequalities
- understand and study about measure spaces and measurable functions
- Understand the concept of Riemann integral and Lebesgue integral to a bounded function.

Pre-requisites:
B.Sc. Mathematics background

Syllabus
Lebesgue Measure: Measure on the real line; Borel sets; Lebesgue Outer measure; Measurable sets and Lebesgue measure; Measurable functions; Littlewood's three principles.

Lebesgue Integral: The Riemann integral; Lebesgue integral of a bounded function over a set of finite measure; The integral of non-negative functions; The general Lebesgue integral.

L^p Spaces: The L^p spaces, The Minkowski and Holder inequalities; Convergence and completeness; Bounded linear functionals on the L^p spaces.

Measure and Integration: Measure spaces; Measurable functions; General convergence theorems; signed measures; The Radon-Nikodym theorem.

Measure and Outer measure**:** Outer measure and measurability; The extension theorem; The Lebesgue-Stieltjes integral; Product measure; Integral operators; Inner measure.

Reference:

1. Textbook: Royden H.L, Real Analysis, Third edition, PHI publishers, 2000
2. Walter Rudin; Real and Complex Analysis; 3rd Edition, Tata McGraw Hill
3. P.R Halmos; Measure Theory; D.Van Nostrand Co.
4. A.E Taylor; General Theory of Functions and Integrations; Blaisadel Publishing Company, New York
5. Inder k Rana; An Introduction to Measure and Integration; Narosa Publishing House, New Delhi. 1997.
6. N.L Carothers-Real Analysis Cambridge Press

MAT 5252: COMPLEX ANALYSIS [4-0-0-4]

Course Outcome:
At the end of the course students will able to:

- Explain the fundamental concepts of complex analysis and their role in modern mathematics and applied contexts.
- Demonstrate accurate and efficient use of complex integration for problem solving.
- Use the concept of residues and poles to evaluate improper integrals
- Determine whether a sequence of analytic functions converges uniformly on compact sets and to express some functions as infinite series or products.
- Demonstrate understanding and appreciation of deeper aspects of complex analysis such as the Riemann Mapping theorem.

Pre-requisites:
B.Sc. Mathematics background

Syllabus
Analytic functions**:** Functions of Complex variables, mappings, limits, continuity, derivatives, C-R equations, Mapping by elementary functions, conformal mapping
Complex Integration: Complex valued functions, contours, contour integrals, Cauchy-Goursat theorem, Cauchy integral formula, Morera's theorem, Liouvilles theorem, Fundamental theorem of algebra.
Power Series: Convergence of sequences and series, power series and analytic functions, Taylor series, Laurent's series, absolute and uniform convergence, integration and differentiation of power series, uniqueness of series representation, zeros of an analytic function classification of singularities, behaviour of analytic function at an essential singular point.
Residues and Poles: Residues, Cauchy – Residue theorem, residues at poles, evaluation of improper integrals, evaluation of definite integrals, the argument principle, Rouche's theorem, Schwarz lemma, maximum modules principle.
Spaces of analytic functions, spaces of meromorphic functions, the Riemann mapping theorem, Weirerstrass factorization theorem, Schwarz reflection principle.

REFERENCES:

1. R.V. Churchill, J.W.Brown, Complex Variables and Applications, 5th edn., McGraw Hill Series.
2. B.Choudary, The element of Complex Analysis (2nd edn) Wileys eastern Ltd.
3. L.V.Alfors, Complex Analysis, McGraw Hill, Kogakusha (1979)
4. J.S.Conway, Functions of One Complex Variable, Springer Verlag, New York (1973)
5. R.V. Churchill, J.W.Brown and R.F.Verhey, Complex Variables and Applications, 3th edn., McGraw Hill Kogakusha (1968).
6. Ian Stewart and David Tall, Complex Analysis, Cambridge Uni. Press, first edn (1963).

MAT 5253 : NUMERICAL ANALYSIS [4-0-0-4]

Course Outcomes:
At the end of the course students will able to:

- Understand the concept of single step and multistep methods for solving Initial and Boundary Value problems
- Analyze the convergence , truncation error and stability of the single and multistep methods
- Develop an efficient numerical scheme for solving boundary value problems based finite difference approach(explicit and implicit method) arising in science and engineering
- Carry out stability analysis and truncation error in various finite difference schemes

Pre-requisites:
B.Sc. Mathematics background

Syllabus
Numerical Solution of Ordinary differential equations :

Initial value problems : Introduction, Difference equations , Single step and Multi step methods methods : Taylor series method. Modified Euler and Heun's methods, Rung-Kutta methods of second and fourth order(explicit and Implicit methods), Runge-Kutta-Felberg methods.

Predictor –Corrector methods : The Adams –Bashoforth , Adams-Moulton and Milne Simpon Methods. Local and global errors, stability analysis for the above methods. Boundary Value Problems : Using Initial value problem method (Shooting Method) and cubic spline method.

Numerical solution of Partial Differential equations :

Initial and Boundary value problems : Introduction and Classification of Partial differential equations. Elliptic equations : Difference schemes for Laplace and Poisson's equations with different boundary. Parabolic equations : Difference methods for One space dimension : Schmidt, Laasonen, DufortoFrankel and Crank –Nicolson. ADE and ADI methods for two dimensional equation. Stability and Convergence analysis of the above methods

Hyperbolic equations : Difference methods for One space dimension : Explicit and Implicit schemes, D' Yakonov split and Lees ADI methods for two dimensions. Stability and Convergence analysis of the above methods

References

1. M K Jain, S R K Iyengar and R K Jain : Numerical methods for Scientific and Engineering Computations, Sixth Edition, New Age International Publishers, Atkinson K.E : An Introduction to Numerical Analysis, Edn 3, John Wiley and Sons (1989).
2. Conte S.D and Be Door , Introduction to Numerical analysis, Third Edition McGraw Hill, 1980
3. J.W. Thomas : Numerical partial differential equations : Finite difference methods, Springer, 1998.
4. M K Jain , Numerical Solution of Differential equations, New Age International Publishers, 2008
5. S Larson and V Thomee : Partial Differential equations with Numerical Methods, Springer, 2008.
6. G. D Smith, Numerical Solution of Partial Differential Equations: Finite Difference Methods (Oxford Applied Mathematics and Computing Science Series) 3rd Edition

MAT 5254: PROBABILITY THEORY AND STOCHASTIC PROCESSES

[4-0-0-4]

Course Outcomes:
At the end of the course students will able to:

- Apply the basic concepts of Probability Theory
- Determine the moments of the distributions and study their behaviour
- Study the behaviour of a random process and determine their joint and marginal distributions
- Determine the n-step transition probabilities and stability of various stochastic processes
- Apply the various concepts of stochastic processes to a general waiting time model using the birth death process.

Pre-requisites:
B.Sc. Mathematics background

Syllabus
Basic concepts of Probability Theory: Combinatorial probability, Fluctuations in Coin Tossing and Random Walks, Combination of Events, Occupancy and Matching Problems. Conditional probabilities. Urn Models. Independence.

Random Variables, discrete distributions, Expectation, variance and moments, probability generating functions and moment generating functions, Tchebychev's inequality. Characteristic functions: properties, illustrations, inversion formula, continuity theorem (without proof). Central Limit Theorem. Elements of modes of convergence of random variables and the statement of the strong law of large numbers.

Standard discrete distributions: uniform, binomial, Poisson, geometric, hypergeometric, negative binomial.
Standard Continuous d: uniform, normal, exponential, gamma, beta, Cauchy.
Joint densities and distributions. Transformation of variables, Independence of random variables. Distributions of sum, maxima, minima, order statistics, range etc. Multivariate normal (properties, linear combinations) and other standard multivariate distributions (discrete and continuous) as examples. Standard sampling distributions: t, chi-squared and F. Conditional distributions, Conditional Expectation.

Basic Concepts of a stochastic process: Markov processes and Markov chains: Chapman-Kolmogorov equations, First passage time, Classification of states. Stability of Markov chain. Birth and Death Processes: M/M/1 queue, multiserver systems, queues with phase-type laws, M/G/1 and G/M/1 queues

References:

1. Rao, C.R. (2002**),** Linear Statistical Inference and Its Applications, Second Edition, Wiley.
2. Bhat, B.R. (2014). Modern Probability Theory (An Introductory Textbook), Fourth Edition, New Age International.
3. Ash, R. B. (2010). Probability and Measure Theory, Second Edition, Academic Press, CA
4. W. Feller : Introduction to Probability Theory and its Applications, Volume 1 and 2, Third Edition, Wiley
5. P.G. Hoel, S.C. Port and C.J. Stone(1986): Introduction to Stochastic Processes. Houghton Mifflin, Boston.
6. S. Karlin and H.M. Taylor (1975): A First course in Stochastic Processes, 2nd Ed. Academic Press, Boston.
7. J. Medhi (2009). Stochastic Processes.2nd Ed. New Age International, New Delhi.
8. Ross, S.M.(2014). An Introduction to Probability Models, 11th Ed. Academic Press, CA.

5255 : ALGEBRA – II [4-0-0-4]

Course Outcome:
At the end of the course students will able to:

- Understand notion of category functors of R-mod and chain conditions
- Explore commutative ideal theory and prime ideals spaces
- Study Affine algebraic varieties and applications of Hilbert Nullstellensatz
- Apply Grobner Bases concepts for polynomials and monomials
- Understand Buchberger's algorithms and its applications

Pre-requisites:
B.Sc. Mathematics background

Syllabus
Introduction to category theory – Basic categorical concepts – Functors and natural transformations – Categories of R-mod and mod-R – Artinian and Noetherian modules – Zassenhaus' Lemma – Jordon Holder – The Krull – Schmidt Theorem – Fitting's Lemma – Completely reducible modules.

Commutative ideal theory: General Theory and Noetherian rings – Prime ideals – nil radical – localization of rings – localization of modules – prime spectrum of a commutative ring – integral dependence – Nakayama Lemma - Noetherian rings – Affine algebraic varieties – Hilbert Nullstellensatz – Primary decomposition.

Geometry, Algebra, and Algorithms - Polynomials and Affine Space - Affine Varieties – Parametrizations of Affine Varieties - Ideals - Polynomials of One Variable

Gröbner Bases - Introduction - Orderings on the Monomials in k[x1,...,xn] - A Division Algorithm in k[x1,...,xn] - Monomial Ideals and Dickson's Lemma - The Hilbert Basis Theorem and Gröbner Bases - Properties of Gröbner Bases - Buchberger's Algorithm - First Applications of Gröbner Bases.

References:

1. David A. Cox•John Little•Donal O'Shea *Ideals, Varieties, and Algorithms, 4th Edition, Springer*
2. Nathan Jacobson 'Basic Algebra - 2', Hindustan Book agency (2009).

MAT 5257: Research Methodology and Technical Communication

[3-0-0-3]

Course Outcomes:
At the end of the course students will be able to

- Explain certain key concepts in research
- Use these concepts in problem solving and data analysis
- Practice these concepts in writing thesis and research communications

Pre-requisites:
B.Sc. background

Syllabus

Introduction to Research methodology:
Types of research, Significance of research, Research framework, Experimental method, Sources of data, Data collection using questionnaire, interviewing, and experimentation. Components, selection and formulation of a research problem, Objectives of formulation, and Criteria of a good research problem. Criterion for hypothesis construction, Nature of hypothesis, Characteristics and Types of hypothesis, Procedure for hypothesis testing.

Experimental methods and data analysis:
Measurement and Scaling Techniques, Methods of Data Collection and analysis, standard deviation, coefficient of variation, Student t-test, Processing & Analysis of Data, Presentation of Figures and Tables, Interpretation of spectral data (Focus on presentation of data and their analysis), Various proof techniques.

Literature Review and Journal communications:
Importance of literature review. Performance of literature review, Sources of chemical literature, identification of research gap, defining scope and objectives of the research problem, Styles of referencing.
Preparation of conference presentations (Oral and Poster) by case study method, Effective Presentation; Journal communication: Type of articles, Journal quality criteria-Impact factor and article level matrices, Importance of copyrights, Ethics in research and publishing: Plagiarism and related issues-Case studies, Criteria for authorship, Preparation of dissertation.

References:

1. R. Kumar, Research Methodology; A Step-by-Step Guide for Beginners, SAGE 2005
2. G. R. Marczyk, D. De Matteo and D. Festinger, Essentials of Research Design and Methodology, John Wiley &Sons 2004
3. S. C. Sinha, A. K. Dhiman, Research Methodology, Vedam Books 2006
4. C. R. Kothari, Research Methodology; Methods & Techniques, New age international publishers, New Delhi 2008.
5. T. Chakraborty, L. Ledwani, Research Methodology in Chemical Sciences Experimental and Theoretical Approach, CRC Press, 2016.

3rd Semester

MAT 6101: LINEAR OPTIMIZAION

[4-0-0-4]

Course Objectives:
At the end of the course students will be able to:

- Understand the necessity and application of optimization methods.
- Understand the concepts of linear programming methods and applications.
- Understand the concepts and application of Transportation and assignment problems.
- Understand the concepts of project management by CPM and PERT, and their applications
- Understand the concept of game theory and applications.

Pre-requisites:
B.Sc. Mathematics background

Syllabus
Formulation, Linear programming - Introduction to LPP, Basic concepts, Theory of solution of a LPP, solution by graphical method, derivation of simplex method, 2-phase method Dual simplex method. Duality theory and sensitivity analysis. Advanced linear programming, Integer linear programming – branch and bound method , cut algorithms .

Transportation problem - Volgel's approximation method, MODI method, transshipment problems Assignment problem- Hungarian method and traveling sales person problems.

Project Management - Networks, Project planning and control using PERT and CPM. Project crashing.

Game theory - 2persons zero sum games, Minimax principle, games with mixed strategies. Dominance theory, solution using linear programming.

References :

1. Bronson Richard - Theory and Problems of Operations Research - Schaum series-MGH, 1983.
2. Hamdy A.Taha - operations Research (Ed.5) PHI, 1995.
3. G.Hadley , Linear Programming, Narosa, 2002.
4. Hiller and Liberman , Introduction to Operation Research, PHI , 1995.

MAT 6102 : GRAPH THEORY

[4-0-0-4]

Course Objectives:
At the end of the course students will be able to:

- Understanding types of trees ,shortest path , Eulerian and Hamiltonian graphs.
- Studying matching and related results for some class of graphs.
- Know about Planarity , covering and coloring of graphs with properties.
- Finding domination and its number in graphs.
- Representing graph in terms of matrix and studying linear algebra properties.

Pre-requisites:
B.Sc. Mathematics background

Syllabus
Trees : Spanning trees, Enumeration of trees Graph Decomposition and graceful labeling shortest paths, Eulerian graphs and Digraphs : Eulerian circuits, Directed graphs and applications.

Matchings : Matchings, Maximum matchings, Min – Max theorems, Applications and algorithms, Weighted bipartite matching.

Connectivity: K – connected graphs, Network flow problems.

Coloring: Enumerative aspects counting proper colorings, Chordal graphs.

Domination: Varieties Dominations in graphs, changing and unchanging domination. Domination complexity and algorithms

Matrices and applications to graph

REFERENCES:

1. Introduction to Graph theory - Douglas West B., Prentice Hall of India, New Delhi 2001.
2. Fundamentals of Domination in graphs – Teresa Haynes, Stephen Heteriemi and P.J.Slater, Marcel Dekker, New York.
3. J.A.Bondy and U.S.R. Murty , Graphy Theory with Applications , Macmillan Press
4. Frank Harary, Graph Theory , Narosa

MAT 6103: FUNCTIONAL ANALYSIS [4-0-0-4]

Course Objectives:
At the end of the course students will be able to:

- To explore the notion of metric spaces, function spaces and separable spaces.
- To apply the idea of contraction mapping, fixed point theorem to differential and integral equations.
- To understand the concept of nowhere dense subset and different category theorems.
- To study the different types of Hahn Banach theorems and its applications to compact transformations
- To understand the notion of inner product spaces and results related to orthonormal sets and various types of operators in Hilbert space.
- To understand the concept of Banach algebra, commutative Banach algebra and maximal ideals in it.

Pre-requisites:
B.Sc. Mathematics background

Syllabus
Metric Spaces : Definition and examples; Holder and Minkowski inequalities; l_p spcaes; L_p spaces; Function spaces; Separable spaces and complete spaces with examples; Contraction and Fixed point theorem; Applications to differential and integral equations; Category theorem; Compactness and continuity.

Banach spaces: Introduction to vector spaces and subspaces with examples; Quotient spaces; Dimension and Hamel basis; Algebraic dual and second dual; Convex sets; Hahn Banach Theorem – separation form and extension form; Banach space and dual spaces; Hahn Banach theorem in normed space; Uniform boundedness principle; Fischer - Riesz Lemma; Application to compact transformations; second dual space; Dual of l_p, Open mapping theorem; Closed graph theorem.

Hilbert spaces: Inner product with examples; Hilbert space; Triangle inequality; Cauchy-Schwartz inequality; Parallelogram law; Projection theorem; Mean Ergodic theorem; Orthonormal sets; Complete orthonormal sets; the adjoint of an operator; self – adjoint operators; normal and unitary operators, Compact operators and related results.

Banach Algebras: Introduction to Banach algebra, definitions and examples; Adjunction of identity; Commutative Banach algebra and Maximal ideals**;** Gelfand representation for algebras with identity.

References :

1. Casper Goffman & George Pedrick, FIRST COURSE IN FUNCTIONAL ANALYSIS, PHI Publishers, 1991.
2. Limaye B.V., Functional Analysis, Wiley Eastern Ltd., (1981)
3. Taylor A.E , Introduction to Functional Analysis, John Wiley & Sons, Inc., New York (1958)
4. Brown A.L. and Page A, Element of Functional Analysis, Van Nostred, London (1970).
5. Kreysizg E., Introduction to Functional Analysis with Applications, John Wiley, New York (1978)

MAT 6104 : THEORETICAL FOUNDATION FOR COMPUTER SCIENCE

[4-0-0-4]

Course Objectives:
At the end of the course students will be able to:

- Design finite automata and its types.
- Derivation of formal languages , its relations and accepting devices.
- Understanding regular sets ,regular expressions and its algebraic expressions from finite automaton.
- construction of a regular grammar generating languages for a given DFA and Vice versa.
- Derivation of parse trees ,construction of reduced grammars and understanding types of machines.

Pre-requisites:
B.Sc. Mathematics background

Syllabus
Finite automata, Moore and Melay machines, Regular Expressions, Pumping lemma, Minimizing the automata, Formal Languages, Regular languages, Context free languages (CFL), Chomsky and Greibach Normal forms, Pushdown automata (PDA), Equivalence of PDA and CFL, Turing machines, Theory of recursive functions, Complexity theory, NP – Completeness.

References:

1. Aho, Hopcraft & Ullman, Automata, Languages and Computation, Narosa, 1986.

2. Mishra and Chandrashekar, Theory of Computer Science, Prentice Hall of India, 1998.

MAT 6105 : Mid- Term Project work

[0-0-4-0]

MAT 6061: OPEN ELECTIVE - COMPUTATIONAL MATHEMATICS

[4-0-0-4]
Course Objectives:
At the end of the course students will be able to:

- Apply various interpolation methods and finite difference concepts.
- Work out numerical differentiation and integration whenever and wherever routine methods are not applicable.
- Apply numerical methods to find our solution of algebraic equations using different methods under different conditions, and numerical solution of a system of algebraic and transcendental equations.
- Approximate solutions of ordinary differential equations by numerical methods.

Pre-requisites:
B.Sc. Mathematics background

Syllabus
Interpolation: Finite differences and divided differences. Newton-Gregory and Lagrange's interpolation formulae. Newton's divided difference interpolation formula. Numerical differentiation. Numerical integration: Trapezoidal rule, Simpson's one third rule and Simpson's three eighth rule.

Solution of Algebraic and Transcendental equations: Bisection method, Method of false position, Iteration method, Newton-Raphson method. Solution of System of Non-linear equations using Newton-Raphson method.

Numerical solution of ordinary differential equations: Taylor's series method, Euler's method, Modified Euler's method, Runge-Kutta methods and Predicator corrector methods

REFERENCES:

1. B.S.Grewal, Higher Engineering Mathematics, Khanna Publishers.
2. Sastry S.S - Introductory methods of Numerical analysis, 5^{th} edn., PHI learning pvt. Ltd, 2012
3. Jain, Iyengar and Jain : Numerical methods for Scientific and Engineering Computations , New Age Publishers.

4th Semester

MAT 6201: NUMBER THEORY AND CRYPTOGRAPHY
[4-0-0-4]
Course Outcomes:
At the end of the course students will be able to:

- Understand basic concepts and computations in number theory.
- Understand the structure of finite fields and computations in finite fields.
- Understand the basic concepts of cryptography and public key cryptography.
- Have knowledge about large prime numbers and methods of factoring large numbers.
- Obtain basic knowledge about elliptic curves and their applications in cryptography.

Pre-requisites:
B.Sc. Mathematics background

Syllabus
Elementary Number theory- Divisibility and the Euclidean Algorithm, Congurences, applications to factoring.

Finite fields – Structures of finite fields, existence and uniqueness of finite fields, Quadratic residues and reciprocity, the Legendre symbol, the Jacobi symbol, square roots of residues.

Simple cryptosystems, public key cryptography, RSA, Discrete logs, The Diffie Hellman key exchange system, ElGamal cryptosystem, discrete logs in finite fields,

Primality and Factoring- Pseudoprimes, the rho method, Fermat factorization, the continued fraction method and Quadratic Sieve methods.

Elliptic curves – Basic facts, Eliiptic curve cryptosystems, Primality test and factoring

REFERENCE:

1. B.Kobltiz, A course in Number Theory and Cryptography, Springer, 1994.
2. Kenneth Ireland and Michel Rosen, A Classical Introduction to Modern Number Theory, Springer, 2013
3. Douglas R. Stinson, Cryptograpy: Theory and Practice, CRC Press, Third Edition, 2005.
4. Lawrence C. Washington, Elliptic Curves Number Theory and Cryptography, Chapman & Hall/CRCTaylor & Francis Group, 2008

MAT 6202: Project Work

The project work has to be carried out in the institution. The duration of the project work shall be of 16 weeks. The evaluation will be through mid-term presentation and end-semester presentation. The oral presentation and project report will be evaluated by the department committee for project evaluation.

MAT 60XX : ELECTIVE I

[3-0-0-3]

The department will offer three papers from the basket of electives. The students have to give their preferences. If the number of students opting for a particular elective is less than 5, such students' second preference will be considered.

MAT 60XX : ELECTIVE II

[3-0-0-3]

The department will offer three papers from the basket of electives. The students have to give their preferences. If the number of students opting for a particular elective is less than 5, such students' second preference will be considered.

ELECTIVES

MAT 6001: DESIGN AND ANALYSIS OF ALGORITHMS
[3-0-0-3]
Course Outcomes:
At the end of the course students will be able to:

- Understand Growth Functions And Their Use In Analysis Of Algorithms.
- Explore Recurrence Relations In Randomized Algorithms.
- Study Divide And Conquer Techniques In Algorithms.
- Apply Dynamic Programming To Get Efficient Algorithms.
- Analyze Approximation Algorithms.

Pre-requisites:
B.Sc. Mathematics background
Syllabus

Analysis of algorithms - Growth of functions, O, omega and theta notation, role of algorithms in computing.

Recurrence relations, solving recurrence relations, Probabilistic Analysis and Randomized Algorithms, Heaps, Analysis of Heapsort and Quicksort,Sorting in linear time, Counting sort, Radix sort, Bucket sort.

Greedy techniques – Analysis of Prim's & Kruskal's algorithms for minimum

Spanning trees, shortest paths, activity-selection problem, job scheduling with deadlines,

Divide and Conquer- General technique, maximum. and minimum., multiplying long integers, Strassen's matrix multiplication, finding the closest pair of points, computational geometry, finding convex hull.

Dynamic programming- Assembly-line scheduling, matrix chain ordering, all pairs shortest paths, Longest common subsequence

Backtracking - nqueens, graph coloring, sum of subsets, Branch and bound.

NP completeness - P, NP, NP-Complete and NP-Hard problems, Satisfiability, Clique, Node cover, edge cover, graph coloring, Approximation algorithms.

References :

1. Cormen and Leiserson and Rivest, Introduction to algorithms
2. Aho, Hopcroft and Ulmann, Design and Analysis of algorithms
3. Horowitz and Sahni, Fundamentals of computer algorithms

MAT 6002: STATISTICAL QUALITY CONTROL

[3-0-0-3]
Course Outcomes:
At the end of the course students will be able to:

- Understand the basic concepts of quality and its management and the various quality control tools
- Determine the various types of measurement and their validity
- Determine the measurement errors and their estimation.
- Draw and analyse the control charts for variables and attributes.
- Determine the sampling plan, the OC (operating characteristic) function and the average sample number.

Pre-requisites:
B.Sc. Mathematics background

Syllabus

Introduction to quality: Concept of quality and its management - quality planning, quality control and quality improvement; concept of variations and its impact, relevance of exploratory data analysis, run plot, lag plot, frequency distribution and other QC tools.
Measurement System: Types of measurement; measurement validity; measurement errors and their estimation.
Use of Control Chart: Control chart for variables and attributes - X-MR chart, X-R chart, X-s chart, p-chart, np-chart and c-chart; u- chart, CUSUM chart, EWMA chart; Process capability analysis.

Acceptance Sampling: concept of AQL, LTPD, producer's risk and consumer's risk; Single sampling plan and its OC function; acceptance rectification plan - concept of AOQ, AOQL ATI, acceptance sampling tables; concept of double and multiple sampling plan; average sample number.

References :

1. Grant, E.L., & Leavenworth, R. S.: Statistical Quality Control (Seventh Edition, 2017) McGraw-Hill, N. Y.
2. A. J. Duncan (1986): Quality Control and Industrial Statistics, Irwin, Homewood, Ill
3. D. C. Montgomery (6^{th} Edition, 2010) : Introduction to Statistical Quality Control, Wiley, N. Y.
4. J. W. Tukey(2019): Exploratory Data Analysis, Addison-Wesley
5. Jerry Banks (1989): Principles of Quality Control, John Wiley

MAT 6003 : NON- LINEAR OPTIMIZATION

[3-0-0-3]
Corse outcomes:

At the end of the course students will be able to:

- Understand and apply one variable non linear optimization by search methods.
- Understand and apply and the concepts of multivariable non linear optimization methods.
- Understand the concept of quadratic programming.
- Understand and apply the concept dynamic programmings
- Understand the concept of queuing theory and its applications.

Pre-requisites:
B.Sc. Mathematics background

Syllabus

Nonlinear programming – single variable optimization by search Techniques - Golden mean search, Three point - Intervals search, Fibonacci search.

Multivariable optimization with and without constraints, Direct and numerical methods, Quadratic programming

Dynamic programming - Deterministic Dynamic programming , and probabilistic Dynamic programming.

Queuing systems, different types of queuing models, simulation models.

Finite Markov process and Markovian birth – death processes.

References:

1. Bronson Richard - theory and Problems of Operations Research - Schaum series- MGH, 1983.
2. Hamdy A.Taha - operations Research (Ed.5) PHI, 1995
3. Hiller and Liberman , Introduction to Operation Research, PHI , 1995.

MAT 6004: GRAPHS AND MATRICES

[3-0-0-3]
Course Outcomes:
At the end of the course students will be able to:

- Prove results regarding the incidence matrix of a graph and compute its rank and generalised inverse.
- Compute the adjacency spectra of special classes of graphs and use the spectrum to deduce structural properties of the graph.
- Determine nonsingularity of trees and compute the inverse of a nonsingular tree.
- Compute the Laplacian spectra of special classes of graphs and use the spectrum to deduce structural and combinatorial properties of the graph.
- Understand the basics of homology theory using graphs and prove results on cycles and cuts in graphs.

Pre-requisites:
B.Sc. Mathematics background
Syllabus

Review of basic graph theory: Graphs, walks, paths, cycles, connectedness, complements, trees.

Review of basic matrix theory: Determinants, column, row, and null spaces, rank and nullity, minors, Cauchy-Binet formula, eigenvalues and eigenvectors.

Incidence Matrix: The $(0,1,-1)$ incidence matrix of an oriented graph, rank, minors, graph substructure and its incidence matrix. Path matrix. Moore-Penrose inverse of incidence matrix. The 0-1 incidence matrix and its rank.

Adjacency Matrix: The adjacency matrix of a graph. Adjacency spectrum of a graph. Spectra of complete graph, complete bipartite graph, cycle graph, path graph, circulant graphs. Harary's formula for the determinant of the adjacency matrix. Coefficients of the characteristic polynomial of an adjacency matrix. Spectra of bipartite graphs. Strongly regular graphs and their spectra. Nonsingular trees and their inverses. Matrix product of graphs.

Laplacian Matrix: Rank and positive semidefiniteness of the Laplacian matrix. Laplacian spectrum. Matrix-tree theorem. Bounds for Laplacian spectral radius.

Cycles, Cuts, and Graph Homology: The cycle subspace and cut subspace of a graph. Boundary and coboundary operators. Fundamental cycles and fundamental cuts. Fundamental matrices and minors. Planar graphs and duality.

References

1. R.B. Bapat. *Graphs and Matrices*, Second Edition. Springer. 2014.
2. C.Godsil and G.F. Royle. *Algebraic Graph Theory*. Springer. 2013.
3. L.W. Beineke and R.J. Wilson (Eds.). *Topics in Algebraic Graph Theory*. Cambridge University Press. 2004

MAT 6005: MATHEMATICAL MODELING

[3-0-0-3]
Course Outcomes:

At the end of the course students will be able to:

- Understand The Methods Of Mathematical Modeling.
- Apply Mathematical Modeling Concept Through The Ordinary Differential Equations.
- Obtain The Mathematical Models In Terms System Of Equations.
- Apply The Mm Concept To Engineering Problems

Pre-requisites:
B.Sc. Mathematics background

Syllabus

Introduction: Mathematical modeling through Algebra, Geometry, ordinary differential equations and systems of ordinary differential equations of first order. M through second order Ode, . Mathematical modeling through difference equations, Modeling using partial differential equations,

References:

1. J.N.Kapoor, Mathematical Modeling , 1988 Wiley Eastern
2. R.Aris, Mathematical Modeling Techniques, 1978 Pitman

MAT 6006 : FLUID DYNAMICS

[3-0-0-3]
Course Outcomes:

At the end of the course students will be able to:

- Understand the basic principles of fluid mechanics, such as Lagrangian and Eulerian approach, conservation of mass etc..
- Understand the application of Euler and Bernoulli's equations and the Conservation of mass to determine velocity and acceleration for incompressible and inviscid fluid.
- Analyse the concept of rotational and irrotational flow, stream functions, velocity potential, sink, source, vortex etc.
- Understand the simple fluid flow problems (flow between parallel plates, flow through pipe etc.) with Navier - Stoke's equation of motion.

Pre-requisites:
B.Sc. Mathematics background
Syllabus

Coordinate transformations, Cartesian tensors, Basic properties, transpose-symmetric and skew tensors, Deviatoric tensors. Gradient, Divergence and Curl of a tensor field-Integral Theorems.

Continuum Hypothesis: Configuration of a continuum –mass and density, Description of motion material and space coordinates. Material and local time derivatives. Stream lines, path lines, Vorticity and Circulation , its examples. Transport formulas, stain tensors, Principle strains, strain rate. Stress components and stress tensor. Normal and Shear stresses-Principle stresses.

Fundamental basic physical laws : Law of conservation of mass, Principles of linear and angular momenta , Balance of energy and examples

Motion of non viscous fluids : Stress tensor-Euler equation, Bernoulli's equation and its simple consequences, Helmholtz vorticity equation, Permanence of vorticity and circulation. Dimensional analysis and Non-dimensional numbers.

Motion of viscous fluids : Stress tensor-Navier-Stokes equation, Energy equation. Simple exact solutions of Navier-Stokes equation : (i) Plane Poiseuille and Hagen-Poiseuille flows (ii) Generalized plane Couette flows (iii) Steady flow between two rotating two concentric circular cylinders (iv) Stoke's first and second problems. Diffusion of vorticity and Energy dissipation due to viscocity.

Two dimensional flows of inviscid fluids : Meaning of two dimensional flow, Stream function, Complex potential, Line source and sinks, Line doublets and vortices, Images , Milne-Thomson circle theorem and applications. Blasius theorem and applications.

References:

1. Text book of fluid Dynamics, F Charlton, CBS 1986.
2. A J M Spencer : Continuum Mechanics, Longman, 1980
3. S W Yuan: Foundations of Fluid Mechanics, Prentice Hall, 1976
4. D S Chandrashekharaiah and L Debnath : Continuum Mechanics, Academic Press, 1994
5. Y C Fung : A first course in Continuum Mechanics, Prentice Hall(2nd Edition)m 1977

MAT 6007 : ADVANCED NUMERICAL ANALYSIS - FINITE ELEMENT METHOD

[3-0-0-3]
Course Outcomes:
At the end of the course students will be able to:

- Understand the Variational formulation and Weighted Residual Approximations Formulate simple problems into finite elements.
- Solve the elasticity / heat transfer problems and complicated two/three - dimensional
  problems.
- Understand the importance of finite element methods for solving real life linear and
- Nonlinear problems arising science and engineering.
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Pre-requisites:
B.Sc. Mathematics background
Syllabus

Weighted Residual Approximations : Point collocation, Galerkin and Least squres method. Use of trial functions to the solution of Differential equations.

Finite elements : One dimensional and two dimensional basis functions, Lagrange and serendipity family elements for quadrilaterals and triangular shapes. Isoparametric coordinate transformations. Area coordinates standard 2 – squares and unit triangles in natural coordinates

Finite element procedures : finite element formulations for the solutions of ordinary and partial differential equations. Calculations of element matrices, assembly and solution of linear equations.

Finite element solution of one dimensional ordinary differential equations, Laplace and Poisson equations over rectangular, nonrectangular and curved domains. Applications to some problems in linear elasticity : Torsion of shafts of a square, elliptic and triangular cross sections.

References:

1. O.C. Zienkiewiez and K. Morgan : Finite Elements and Approximations . John Wiley, 1983.
2. P.E. Lewis and J. P. Ward : The Finite Element Method – Principles and Applications, Addison Wiley, 1999.
3. L. J. Segerlind : Applied Finite Element Analysis(2^{nd} Edition), John Wiley, 1984
4. J. N. Reddy : An introduction to FEM , Mc Graw Hill, New York, 1984
5. O.C. Zienkiewiez and R. L. Taylor : The Finite Element Method Vol 1. Basic formulation and Linear problems . , Mc Graw Hill, New York, 1987.
6. S.S. Rao : The Finite Element Method in Engineering, 2^{nd} edition, Oxford Pergamon Press, 1989

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