MANIPAL UNIVERSITY
JAIPUR

Department of Mathematics and Statistics
School of Physical and Biological Sciences
Faculty of Science, Technology and Architecture

B.Sc. (Honours / Honours with Research) in Mathematics
(As per NEP 2020)

YEAR	FIRST SEMESTER							SECOND SEMESTER						
	Type	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**	**Type**	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
I	***MAJ***	MAS1110	Fundamental of Calculus	3	1	0	4	***MAJ***	MAS1212	Ordinary Differential Equations	3	1	0	4
	MIN-1	PHY1101	Mechanics	2	1	2	4	***MIN-2***	PHY1201	Waves and Optics	2	1	2	4
	MD-1	CHY1101	Atomic Structure, Bonding and Periodicity	2	1	2	4	***MD-2***	CHY1201	States of Matter and Molecular Properties	2	1	2	4
	AEC-1	LLC1110	Communicative English	2	-	-	2	***AEC-2***	PHY1240	Report writing	1	1	0	2
	SEC-1	MAS1122	Fundamentals of Computers	1	0	2	2	***SEC-2***	MAS1221	Logical Reasoning and Competitive Aptitude	1	1	0	2
	VAC-1	CHY1003	Environmental Science	2	-	-	2	***SEC-3***	MAS1222	Introduction to Python Programming	1	-	2	2
	VAC-2	PES1030	Yoga & Wellness	-	1	2	2	***VAC-3***	MAS1223	Ancient Indian Knowledge System	2	-	-	2
		Total		**12**	**4**	**8**	**20**		**Total**		**13**	**4**	**6**	**20**
		Total Contact Hours (L + T + P)		**24**					**Total Contact Hours (L + T + P)**		**23**			

YEAR	THIRD SEMESTER							FOURTH SEMESTER						
	Type	**Course Code**	**Subject Name**	**L**	**T**	**P**	**C**	**Type**	**Course Code**	**Subject Name**	**L**	**T**	**P**	**C**
II	***MAJ***	MAS2121	Real Analysis-1	3	1	0	4	***MAJ***	MAS2221	Modern Algebra	3	1	0	4
	MAJ	MAS2122	Vector Calculus	3	1	0	4	***MAJ***	MAS2222	Applied Mechanics: Statics	3	1	0	4
	MIN-3	xxxxx	xxxx	3	1	0	4	***MAJ***	MAS2223	Real Analysis-2	3	1	0	4
	MD-3	MAS2125	Multivariable Calculus	2	1	0	3	***Project***	MAS2270	Project Based Learning	0	0	0	2
	AEC-3	CHY2170	Scientific Writing	2	0	0	2	***MIN-4***	MASXXXX	Minor - 4	3	1	0	4
	SEC-4	PHY2140	Basic Instrumentation Skills	2	1	-	3	***AEC-4***	PHY2240	Scientific Translation and Linguistic Competence	2	-	-	2
		Total		**15**	**5**	**0**	**20**		**Total**		**14**	**4**	**0**	**20**
		Total Contact Hours (L + T + P)		**20**					**Total Contact Hours (L + T + P)**		**18**			

YEAR	FIFTH SEMESTER							SIXTH SEMESTER						
	Type	**Course Code**	**Subject Name**	**L**	**T**	**P**	**C**	**Type**	**Course Code**	**Subject Name**	**L**	**T**	**P**	**C**
III	***MAJ***	MAS3121	Analytical Geometry of Three-Dimensions	3	1	0	4	***MAJ***	MAS3201	Complex Analysis	3	1	0	4
	MAJ	MAS3122	Elements of Linear Algebra	3	1	0	4	***MAJ***	MAS3221	Introductory Course on PDEs	3	1	0	4
	MAJ	MAS3123	Theory of Riemann Integration and Series of Function	3	1	0	4	***MAJ***	MAS3222	Applied Mechanics: Dynamics	3	1	0	4
	MAJ	MAS3124	Introduction to MATLAB	3	0	2	4	***MAJ***	MAS3223	Linear Programming Problem and Network Scheduling	3	1	0	4
	MIN-5	xxxxxx	xxxx	-	-	-	4	***MIN-6***	xxxxxx	xxxx	3	1	0	4
			Total	**12**	**3**	**2**	**20**			**Total**	**15**	**5**	**0**	**20**
		Total Contact Hours (L + T + P)		**17**					**Total Contact Hours (L + T + P)**		**20**			

YEAR	SEVENTH SEMESTER							EIGHTH SEMESTER						
	Type	**Course Code**	**Subject Name**	**L**	**T**	**P**	**C**	**Type**	**Course Code**	**Subject Name**	**L**	**T**	**P**	**C**
IV	***MAJ***	MAS4121	A Course on Fluid Dynamics	3	1	0	4	***EC/RP***	****/ MAS4270	*Elective Courses*/ Research Project	0	0	0	12
	MAJ	MAS4122	Computational Numerical Methods	3	0	2	4	***MIN-7***	MAS4227	Research Methodology and Scientific Writing	-	-	-	4
	MAJ	MAS4123	Special Functions and Orthogonal Polynomials	3	1	0	4	***MIN-8***	MAS4228	Numerical Solution of Differential Equations	-	-	-	4
	MAJ	MAS4124	Introduction to Topology	3	1	0	4							
	MAJ	MAS4125	Integral Transforms: Laplace, Fourier, and Mellin	3	1	0	4							
			Total	**15**	**4**	**2**	**20**			**Total**	**0**	**0**	**0**	**20**
		Total Contact Hours (L + T + P)		**21**					**Total Contact Hours (L + T + P)**					

MIN-3	
MAS2123	Elements of Discrete Mathematics
MAS2124	Probability Distributions and Sampling Theory

MIN-4	
MAS2224	Introduction to Number Theory
MAS2225	Statistical Inference

MIN-5	MAS3125	Information and Coding Theory
	MAS3126	Applied Statistics
	MAS3127	Cryptography

MIN-6	MAS3224	Calculus of Variations and Integral Equations
	MAS3225	Financial Mathematics and Investment Analysis
	MAS3226	Machine Learning and Artificial Intelligence
	MAS3227	Econometrics

EC-1/2/3	Code	Course Name	Credits
1	MAS4221	Introduction to Bifurcation Theory	**4C, LTP:310**
2	MAS4222	Introduction to Celestial Mechanics	**4C, LTP:310**
3	MAS4223	Computational Methods in Fluid Dynamics	**4C, LTP:310**
4	MAS4224	Nonlinear Programming	**4C, LTP:310**
5	MAS4225	Tensor Analysis	**4C, LTP:310**
6	MAS4226	Theory of Relativity	**4C, LTP:310**
7	MAS4229	Applications of MATLAB	**4C, LTP:310**

List of Minor and Multidisciplinary Courses							
Minor (MIN)				**Multidisciplinary (MD)**			
Course Code	**Course Name**	**SEM**	**Credits**	**Course Code**	**Course Name**	**SEM**	**Credits**
MAS2124	Probability Distributions and Sampling Theory	**III**	**4C, LTP:310**	MAS2125	Multivariable Calculus	**III**	**3C, LTP:210**
MAS2225	Statistical Inference	**IV**	**4C, LTP:310**				
MAS3126	Applied Statistics	**V**	**4C, LTP:310**				
MAS3227	Econometrics	**VI**	**4C, LTP:310**				
MAS3228	Theory of Logical Mathematics	**VI**	**4C, LTP:310**				
MAS4126	Statistical Methods in Biological Sciences	**VII**	**4C, LTP:310**				
MAS4227	Research Methodology and Scientific Writing	**VIII**	**4C, LTP:310**				

Syllabus

First Semester

MAS1110: Fundamental of Calculus [3 1 0 4]

Application and graphical representations of Rolle's theorem, Lagrange's and Cauchy's first mean value theorems, Taylor's theorem (Lagrange's form), Maclaurin's theorem and expansions, convexity, concavity and curvature of plane curves, Formula for radius of curvature in Cartesian, parametric, polar and pedal Forms, Centre of curvature, evolutes and involutes, envelopes, asymptotes, singular points, cusp, node and conjugate points, tracing of standard Cartesian, polar and parametric curves; **Partial Differentiation:** First and higher order derivatives, Euler's theorem, total derivative, differentiation of implicit functions and composite functions, Taylor's theorem for functions of two variables; **Maxima & Minima:** Maxima-minima for functions of two variables, necessary and sufficient condition for extreme points, Lagrange multipliers; **Integral Calculus:** Reduction formulae, application of integral calculus, length of arcs, surface areas and volumes of solids of revolutions for standard curves in Cartesian and polar forms; Beta and Gamma Functions: Beta and Gamma functions and relation between them, evaluation of integrals using Beta and Gamma functions.

References:

1. S. Narayan and P. K. Mittal, Differential Calculus, S. Chand Publication, New Delhi, 2011.
2. P. Saxena, Differential Calculus, Tata McGraw Hill, New Delhi, 2014.
3. D. V. Widder, Calculus, PHI publication, New Delhi, 2012.
4. S. Narayanan, T. K. Manicavachagom and Pillay, Calculus I & II, S. Viswanathan Pvt. Ltd., Chennai, 2010.
5. M. J. Strauss, G. L. Bradley and K. J. Smith, Calculus, Dorling Kindersley Pvt. Ltd., New Delhi, 2007.

MAS1122: Fundamentals of Computers (FOC) [1 0 1 2]

Computer Fundamentals and Hardware Organization: Definition and purpose of computer; Data, Information, and Knowledge; Generations and Classification of computers; Basic organization of computer system; CPU fundamentals; Memory organization and storage (Memory hierarchy, Primary memory, Secondary storage); Input and Output devices.

Software, Operating Systems, and Multimedia: Software and its Types; Operating system and its Types; Windows vs Linux; Mobile operating systems; Multimedia: Definition and components, Multimedia software applications.

Computer Networks and Internet: Computer networks: introduction and applications; Types of networks; Network topologies; Network devices; Network cables; Internet: introduction and uses; Internet connectivity: Wired and Wireless; IP Addressing and Domain Name System (DNS); Website, URL, Web browser, Search engines; Introduction to HTML (purpose and uses).

Cyber Safety and Computer Usage Guidelines: Do's and Don'ts of computer usage; Email concepts and email etiquettes; Cyber security basics; Secure password formation; Internet frauds and online threats; Computer security issues; Malware: Virus, Worm, Ransomware; Social-media and its impact.

REFERENCES

1. P. K. Sinha and Priti Sinha, Computer Fundamentals, BPB Publications.
2. V. Rajaraman, Fundamentals of Computers, PHI Learning.
3. Alexis Leon and Mathews Leon, Fundamentals of Information Technology, Vikas Publishing House.
4. Anita Goel, Computer Fundamentals, Pearson Education.

Second Semester

MAS1212: Ordinary Differential Equations [3 1 0 4]

Ordinary Differential Equations: Order and degree of a differential equation, formation of differential equations, general, particular and singular solution, Wronskian, its properties and applications; Equations of First Order and First Degree: Separation of variables method, homogeneous equations, equations reducible to homogeneous form, linear equations and equations reducible to linear form, exact equations, equations reducible to exact form, orthogonal trajectories in Cartesian coordinates, **Equations of First Order and Higher Degree:** Equations solvable for x, y and p, Clairaut's and Lagrange's equation, equations reducible to Clairaut's form, Singular solution; Homogeneous linear differential equations, Simultaneous differential equations, Exact linear differential equations of nth order. Existence and uniqueness theorem. Higher Order Linear Differential Equations: Higher order linear differential equations with constant coefficients. Linear differential equation of second order with variable coefficients. Linear independence of solutions, Solution by transformation of the equation by changing the dependent variables, changing the dependent variables coefficients, Factorization of operators, Method of variation of parameter and Method of undetermined coefficients.

References:

1. J. L. Bansal, S. L. Bhargava and S. M. Agarwal, Differential Equations, Jaipur Publishing House, Jaipur, 2012.
2. M. D. Raisinghania, Ordinary and Partial Differential Equations, S. Chand & Comp., New Delhi, 2013.
3. S. L. Ross, Differential Equations, Wiley India, New Delhi, 2013.
4. E.A. Coddington, An Introduction to Ordinary Differential Equations, PHI Publication, New Delhi, 2011.
5. G. F. Simmons, Differential Equations, Tata McGraw-Hill, 2006.

MAS1221: **Logical Reasoning and Competitive Aptitude [1 1 0 2]**

Compound statements (and, or, implication, negation, contrapositive, quantifiers), Truth tables, Basic logical equivalences and its consequences, Logical arguments, Theory of Inferences, Recursive relations and its solution (characteristics polynomial), Generating function, Properties of integers, Division algorithm, Divisibility and Euclidean algorithm, Diophantine equations, GCD, LCM, Relatively prime. Applications of Numbers, Prime numbers, Statement of fundamental theorem of arithmetic, Mathematical induction.

References:

1. Goodaire, Edgar G., & Parmenter, Michael M. (2003). Discrete Mathematics with Graph Theory (2nd ed.). Pearson Education (Singapore) Pte. Ltd. Indian Reprint.
2. Lidl, Rudolf & Pilz, Günter. (1998). Applied Abstract Algebra (2nd ed.). Undergraduate Texts in Mathematics. Springer (SIE). Indian Reprint 2004.

MAS1222: Introduction to Python Programming [1 0 1 2]

Introduction to Python: History of Python, Features of Python, Install Python and Environment Setup Python Identifiers, Keywords and Indentation, Comments and Document Interlude in Python, Command Line Arguments, Getting User Input. **Data Types, Variables, Basic Input-Output**

Operations, Basic Operators: Data Types, Variables, Python User Defined Functions, Defining and Calling Function, Loops and Statements in Python, Python Modules & Packages. **Boolean Values, Conditional Execution, Loops, Lists and List Processing, Logical and Bitwise Operations:** Making decisions in Python, Python's loops, Logic and bit operations in Python, Lists - collections of data, Sorting Simple lists. **Python's Built-in Data Types:** String, List, Tuple, Set, Dictionary (characteristics and methods). **The Object-Oriented Approach:** Overview of OOP Creating Classes and Objects, Inheritance, polymorphism. **File Processing Concept of Files:** File opening in various modes and closing of a file, reading from a file, writing onto a file, some important File handling functions e.g. open (), close (), read (), readline () etc. **Python Libraries:** Pandas, Matplotlib, NUMPY. **Exception Handling:** What is Exception? Handling an exception, try...except...else, try-finally clause.

References:

1. Data Structures and Algorithms in Python, Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser, Wiley Publication.
2. D. Phillips, Python 3 Object-Oriented Programming Build robust and maintainable software with object-oriented design patterns in Python 3.8, (3e), Packt Publishing, January 2018.
3. W. J. Chun, Core Python Applications Programming, (3e), Prentice Hall Publishers, 2012.
4. Grus, Data Science from Scratch: First Principles with Python, (1e), O'Reilly Media, 2015.
5. Python Data Science Essentials: A practitioner's guide covering essential data science principles, tools, and techniques, Third Edition by Alberto Boschetti, Luca Massaron.

MAS1223: Ancient Indian Knowledge System [2 0 0 2]

Indian Knowledge System – Introduction, **The Vedic Corpus:** Introduction to Vedas; A synopsis of the four Vedas; Sub-classification of Vedas; Messages in Vedas; **Vedic Mathematics:** Introduction to Vedic mathematics, Vedic sutras, Arithmetic Computations, Multiplication: Practical Application in "Compound Multiplication", practice and proportion in Compound Multiplication. Division by the *Nikhilam* method, Division by Paravartya method, Argumental Division. Factorization (of simple & Harder Quadratic both).

References:

1. Agrawal, V. S. (2015). Vedic Mathematics. Delhi: Motilal Banarsidass Publication.
2. Bharucha D. (2023). Vedic Mathematics, Edukeen Publisher.
3. Mahadevan, B., Balasubramanian, K., & Ganesh, R. (2019). Introduction to Indian Knowledge System: Concepts and Applications, (1st ed.). PHI Learning.
4. Dalal, R. (2013). The Vedas: An Introduction to Hinduism's Sacred Texts. Penguin India.
5. Wadekar, M. L. (2016). Essentials of Vedic Literature. National Book Trust.

Third Semester

MAS2121: REAL ANALYSIS-1 [3 1 0 4]

Real Numbers: Field structure and order structure, order properties of R and Q, characterization of interval, bounded and unbounded sets, supremum and infimum, order completeness property, archimedean property, density of rational numbers in R, density theorem, characterization of intervals, absolute value of a real number, neighborhoods, open sets, closed sets, limit points of a set, Bolzano-Weierstrass theorem, isolated points, closure, nested interval, cantor nested interval theorem, cover of a set, compact set, Heine-Borel theorem, idea of countable sets, uncountable sets and uncountability of R; **Real Sequences:** Sequences, bounded sequences, convergence of sequences, limit point of a sequence, Bolzano-Weierstrass theorem for sequences, limits superior and limits inferior, Cauchy's general principle of convergence, Cauchy sequences and their convergence criterion; **Algebra of Sequences:**

Cauchy's first and second theorems and other related theorems, monotonic sequences, subsequences**; Infinite Series:** Definition of infinite series, Sequence of partial sums, convergence and divergence of infinite series, Cauchy's general principle of convergence for series, positive term series, geometric series, comparison series; Comparison Tests: Cauchy's n^{th} root test; Ratio test, Raabe's test, Logarithmic test, Cauchy's Integral test, Gauss test, alternating series and Leibnitz's theorem, absolute and conditional convergence.

References:

1. S. C. Malik and S. Arora, Mathematical Analysis, New Age Int. Pub., New Delhi, 2017.
2. Shanti Narayan, Elements of Real Analysis, S. Chand & Co., New Delhi, 2015.
3. R. G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd edition, John Wiley & Sons, 2011.
4. W. Rudin, Principles of Mathematical Analysis, 3rd edition, McGraw Hill, New York, 2013.
5. R. R. Goldberg, Methods of Real Analysis, John Wiley & Sons, 2012.

MAS2122: Vector Calculus [3 1 0 4]

Vector Algebra: Addition, scalar multiplication, scalar products, vector product, scalar and vector triple products, product of four vectors, reciprocal vectors, geometrical applications, vector equations of lines and planes, parametric representation of a curve, circle and other conic sections, notions of a vector function of a single variable.

Vector Differentiation: Differentiation of vectors, meaning of the derivative of position vector, Physical applications, Vector differential operator, Gradient, Direction and magnitude of gradient, divergence and curl, directional derivatives, Laplacian operator; their applications and related theorem and problems. Orthogonal curvilinear coordinates Conditions for orthogonality fundamental triad of mutually orthogonal unit vectors, Divergence, Curl and Laplacian operators in terms of orthogonal curvilinear coordinates, cylindrical co-ordinates and Spherical coordinates.

Vector Integration: Line Integral, Surface integral, Volume integral their applications and problems, Integration of total differentials, conservative fields, fundamental theorem on exact differentials, Gauss divergence theorem, Green's theorem, Stoke's theorem, Proof of these theorems, applications and problems based on these theorems

References:

1. M.L. Khanna, Vector Calculus, Jai Prakash Nath and Co., Eighth Edition (1986).
2. P.R. Vittal, Vector analysis, Analytical Geometry & sequences and series, Margham Publications, Chennai (2004).
3. Shanti Narayan: A Textbook of Vector Calculus. S. Chand & Co., New Delhi (2003)

Min-3

MAS2124: Probability Distributions and Sampling Theory [3 1 0 4]

Probability Theory and Random Variables: Probability (Only One Lecture), Random variables and distribution functions, probability mass function, probability density function, joint probability mass function, joint density function, marginal and conditional distribution functions, independence of random variables, moments of random variables – expectation, variance, covariance, conditional and marginal expectation. **Probability Distributions:** Binomial, Poisson, Geometric. Normal, Exponential, and Uniform distribution. **Introduction:** Concept of population and sample, need for sampling, complete enumeration versus sampling, basic concepts in sampling, sampling and non-sampling errors, acquaintance with the working (questionnaires, sampling design, methods followed in field investigation, principal findings, etc.) of NSSO and other agencies under taking sample surveys. **Simple Random Sampling with or without replacement:** Estimation of mean, total, variance, proportion, equivalence of different definitions, sample size problem. **Stratified Sampling:** Estimation of mean, total, proportion and optimum allocation, comparison with simple random sampling without replacement, post stratification.

Systematic Sampling Scheme: Linear and circular systematic sampling, comparison with SRS and stratified sampling schemes, linear trend, simple method of variance.

References:

1. Goon, A.M.; Gupta, A.K. and Das Gupta, B., Fundamental of Statistics, Vol. I, World Press, Calcutta, 1999.
2. Mood, A.M.; Greybill, F.A. and Bose D.C., Introduction to the Theory of Statistics, McGraw Hill, 1974.
3. Cochran W.G., Sampling Techniques, John Wiley and Sons, New York, 1977.
4. Sukhtme, P.V., Sukhatme, B.V., Sukhatme, S. and Asok C., Sampling Theory of Surveys with Applications, Indian Society of Agricultural Statistics, New Delhi, 1984.

MAS2123: Elements of Discrete Mathematics [3 1 0 4]

Preliminaries: Graphs, isomorphism, subgraphs, matrix representations, degree, operations on graphs, degree sequences; Connected Graph and Shortest Path: Walks, trails, paths, connected graphs, distance, cut-vertices, cut-edges, blocks, connectivity, weighted graphs, shortest path algorithms; Trees: Characterizations, number of trees, minimum spanning trees; Special Classes of Graph: Bipartite graphs, line graphs, chordal graphs; Eulerian Graph: Characterization, Fleury's algorithm, chinese-postman-problem; Hamilton Graphs: Necessary conditions and sufficient conditions independent sets, coverings; Matching: Basic equations, matchings in bipartite graphs, perfect matchings, greedy and approximation algorithms; Vertex Coloring: Chromatic number and cliques, greedy coloring algorithm, coloring of chordal graphs; Planar Graphs: Basic concepts, Eulers formula; Directed Graph: Out-degree, in-degree, connectivity, orientation, Eulerian directed graphs, Hamilton directed graphs.

References:

1. D. B. West, Introduction to Graph Theory, Prentice Hall of India, 2012.
2. N. Deo, Graph Theory with Applications to Engineering and Computer Science, Prentice-Hall, 2009.
3. G. Chatrand and Ping Zhang, Introduction to Graph Theory, McGraw Hill Education, 2017.
4. R. J Wilson, Graph Theory, Prentice Hall, 2010.

MAS2125: Multivariate Calculus [2 1 0 3]

Euclidean n space $\mathbb{R}^n$. Euclidean norm and Euclidean distance. Tangent spaces in $\mathbb{R}^n$. Open sets in $\mathbb{R}^n$. Functions from $\mathbb{R}^n$ to $\mathbb{R}^m$. Limit of sequences in $\mathbb{R}^m$. Limit and continuity of functions from $\mathbb{R}^n$ to $\mathbb{R}^m$. Partial derivatives and directional derivatives. Gradient of a function. Derivatives of functions between Euclidean space spaces. First differential and Jacobian matrix. Change of Variables. Chain Rule. Mean Value Theorem. Euler's Theorem. Inverse Function Theorem and Implicit Function Theorem. Hessian matrix, Second differentials and Taylor Series. Maxima, Minima and Saddles. Lagrange Multipliers. Integration: Fubini's Theorem. Applications to area, surface area and volume. Dirichlet's theorem, Liouville's theorem.

References:

1. T.M. Apostol: Mathematical Analysis, Narosa Publishing House, New Delhi, 1985.
2. W. Rudin: Principle of Mathematical Analysis (Thrid edition) McGraw-Hill Kogakusha, 1976, International Student Edition.
3. J.R. Munkres: Analysis on manifolds. Addison-Wesley Publishing Company, Advanced Book Program, Redwood City, CA, 1991.
4. J.J. Callahan: Advanced Calculus -A Geometric View, Springer, 2010.
5. J.R. Magnus; H. Neudecker: Matrix differential calculus with applications in statistics and econometrics. John Wiley and Sons, Third Ed. 2007.

Fourth Semester

MAS2221: MODERN ALGEBRA [3 1 0 4]

Groups, Basic properties, Symmetries of a square, Dihedral group, Order of a group, Order of an element, Subgroups, Center of a group, Centralizer of an element, Cyclic groups and properties, Generators of a cyclic group, Classification of subgroups of cyclic groups.

Normal Subgroups: Conjugate elements, characteristics subgroup normalizer of an element of a group, class equation of a group, centre of a group, conjugate subgroups, invariant subgroups, quotient groups; Isomorphism and Homomorphism of Groups: Kernel of a homomorphism; fundamental theorem on homomorphism of groups, automorphisms of a group, inner automorphisms, results on group homomorphism, maximal subgroups.

Introduction to Rings: Definition & Properties of Rings, Subrings, Integral Domains, Fields Characteristic of a Ring. Ideals, Factor Rings, Prime Ideals and Maximal Ideals - Definition and Examples of Ring Homomorphisms, Properties of Ring Homomorphisms, The Field of Quotients.

Polynomial Rings, The Division Algorithm and Consequences, Principal ideal domain, Factorization of Polynomials, Reducibility Tests, Irreducibility Tests.

Unique Factorization in Z[x].

References:

1. M. Artin: Algebra, Prentice-Hall of India, 2019.
2. I. N. Herstein: Topics in Algebra, Wiley Eastern Ltd., New Delhi, 1975.
3. David S. Dummit and Richard M. Foote, Abstract Algebra (Third Edition), John Wiley and sons, 2004.

MAS2222: Applied Mechanics: Statics [3 1 0 4]

Statics: Forces, couples, resultant of two parallel forces, moment, co-planar forces, analytical method, equation to the resultant, equivalent force and couple, two trigonometrical theorems, static equilibrium, friction, law of friction, body in limiting equilibrium on an inclined plane, least force required to pull a body up or down an inclined rough plane, equilibrium of a particle constrained to rest on a rough curve under any given forces, equilibrium of a particle on a rough curve, virtual work; position of equilibrium, principle of virtual work for a system of coplanar forces acting on a particle, unwanted force, tension and thrust, catenary; flexible string, cartesian equation of the common catenary, geometrical properties of common catenary, forces in three dimensions, reduction of a system of forces in space, invariance of the system, general conditions of equilibrium, center of gravity for different bodies, stable and unstable equilibrium.

References:

1. S. Ramsey, Statics, Cambridge University Press, 2nd edition, 2009.
2. S. L. Loney, The Elements of Statics and Dynamics Part-I, Aitbs publication, 2016.

MAS2223: REAL ANALYSIS-2 [3 1 0 4]

Metric Space: Definitions & examples, and basic properties. Open and Closed Sets: Definitions, examples, and properties within metric spaces. Neighborhoods and Convergence: Understanding neighborhoods, limit points, and convergent sequences. Topology induced by a metric. Interior, Closure, and Boundary: Definitions and their significance in metric spaces.

The subspace of a metric space. Completeness. Compactness: Heine Borel Theorem. Compactness and sequential compactness. Connectedness: Connected and disconnected sets. Path connected spaces**. Improper integrals and their convergence**. Comparison test, Beta and Gamma functions, Abel's and Dirichlet's test, Integral as a function of a parameter and its applications.

References:

1. T. M. Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi, 1985.
2. Richard Dedekind, What Are Numbers and What Should They Be? (A Classic Work) (Revised, edited and translated by H. Pogorzelski, W. Ryan and W. Snyder, Research Institute for Mathematics, Orono, Maine, 1995.
3. R. R. Goldberg, Real Analysis, Oxford & IBH Publishing Company, New Delhi, 1970.
4. S. Lang, Undergraduate Analysis, Springer-Verlag, New York, 1983.
5. W. Rudin, Principles of Mathematical Analysis, McGraw-Hill, 2023.

MIN-4

MAS2224: Introduction to Number Theory [3 1 0 4]

Linear Diophantine Equation: prime counting function, statement of prime number theorem, Goldbach conjecture, linear congruences, complete set of residues, Chinese remainder theorem, Fermat's little theorem, Wilson's theorem; Number Theoretic Functions: sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Möbius inversion formula, the greatest integer function; Euler's Phi-Function: Euler's theorem, reduced set of residues, some properties of Euler's phi-function. Order of an integer modulo n, primitive roots for primes, composite numbers having primitive roots; Euler's Criterion: the Legendre symbol and its properties, quadratic reciprocity, quadratic congruences with composite moduli, public key encryption, RSA encryption and decryption, the equation $x^2 + y^2 = z^2$, Fermat's last theorem.

References:

1. Shirali and Yog, Number Theory, Orient Blackswan Private Limited, New Delhi, 2003.
2. N. Robinns, Beginning Number Theory, Narosa Publishing House Pvt. Limited, Delhi, 2007.
3. D. M. Burton, Elementary Number Theory, Tata McGraw-Hill Edition, Indian reprint, 2007.
4. G. E. Andrew, Number Theory, Revised Edition, Dover Publications, 2012.

MAS2225: Statistical Inference [3 1 0 4]

Estimation: Parametric space, sample space. **Point Estimation:** Properties of good estimator: Consistency, unbiasedness, efficiency, sufficiency. Neymann factorization theorem, Complete sufficient statistics, Minimum – variance unbiased (MVU) estimators, exponential family of distributions and its properties, Cramer- Rao inequality, Minimum variance bound (MVB) estimators, Bhattacharya's Bounds, Rao-Blackwell theorem, Lehman Schefe's theorem and its applications in finding Uniformly Minimum Variance Unbiased Estimators. **Methods of Estimation**: Method of Maximum Likelihood, Methods of Moments, and their properties. **Interval estimation:** Confidence intervals for the parameters of various distributions, confidence intervals for difference of means and for ratio of variances. **Elements of Statistical Decision Theory:** Neymann theory of testing of hypotheses, simple and composite hypotheses, null and alternative hypotheses, two types of errors, critical region, level of significance, power of the test, unbiased tests, N-P lemma, construction of most powerful test, uniformly most powerful test, uniformly most powerful unbiased test. **Sampling Distributions:** Chi-square, Student's t and Seducer's F, Fisher's-Z distribution and their applications. **Tests of Significance:** tests of significance based on t, F and Chi-square distributions.

References:

1. Casella, G. and Berger, R.L., Statistical Inference, Second Edn. Thomson Duxbury, 2002.
2. Hogg, R.V. and Tanis, E.A., Probability and statistical inference, 3rd Edn. Macmillan Publishing Co. Inc., 1988.
3. Rohatgi, V. K., Statistical Inference, John Wiley and Sons, 1984.
4. Mukhopadhyay, P., Applied Statistics, Books & Allied (P) Ltd., 2011.

Fifth Semester

MAS3121: Analytical Geometry of Three-Dimensions [3 1 0 4]

Sphere: Definition, equation of a sphere, general equation of a sphere, great circle, equation of circle, tangent line and tangent plane of a sphere, condition of tangency for a line and equation of tangent plane, angle of intersection of two spheres, condition of orthogonality of two spheres; Cone: Cone, quadratic cone, equation of a cone, enveloping cone, condition for general equation of second degree to represent a cone, intersection with a line, tangent plane, reciprocal cone, right circular cone; Cylinder: Definition, equation of a cylinder, enveloping cylinder, equation of enveloping cylinder, right circular cylinder, equation of right circular cylinder; Central Conicoids: Conicoids, central conicoid, standard equation of ellipsoid, hyperboloid of one sheet and hyperboloid of two sheets, nature and shape of central conicoids, tangent line and tangent planes, condition of tangency.

References:

1. S. L. Loney, The Elements of Coordinate Geometry, Macmillan and Co., London, 2001.
2. P. K. Jain and Khalil Ahmad, A textbook of Analytical Geometry of Three Dimensions, Wiley Eastern Ltd, 2008.
3. N. Saran and R. S. Gupta, Analytical Geometry of Three Dimensions, Pothisala Pvt. Ltd, Allahabad, 2001.
4. Gorakh Prasad and H. C. Gupta, Textbook on Coordinate Geometry, Pothisala Pvt. Ltd., Allahabad, 2004.
5. Shanthi Narayan, Analytical Solid Geometry, New Delhi: S. Chand and Co. Pvt. Ltd., 2004.

MAS3122: Elements of Linear Algebra [3 1 0 4]

Vector spaces: Subspaces, linear dependence, independence, linear span and basis, dimension of a vector space; Linear Transformations: definition, some results on linear operator, different types of transformations, rank and nullity, singular and non-singular transformations, inverse linear transformation, isomorphism between vector spaces, linear mapping, composition of linear maps; Matrices: Symmetric, skew symmetric matrices, hermitian and skew hermitian matrices, row and column matrices, elementary operations on matrices, rank of a matrix; eigen values, eigen vectors and the characteristic equation of a matrix, Cayley Hamilton theorem and its application in finding inverse of a matrix, applications of matrices to a system of linear equations (both homogeneous and non-homogeneous), theorems on consistency of a system of linear equations; Representation of Transformations by Matrices: Introduction, determination of linear transformation for a given matrix and bases, matrix identity and zero transformations, linear operations on $M_{m\times n}$, matrix of the composition of linear transformations, polynomials of a linear transformation, rank and nullity of matrix, range of a matrix, kernel of a matrix, matrix of change of basis.

References:

1. K. B. Datta, Matrix and Linear Algebra, Prentice Hall of India Pvt. Ltd, New Delhi, 2007.
2. P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul, First course in Linear Algebra, New Age International Ltd, 2012.
3. K. Hoffman and R. Kunze, Linear Algebra, 2nd edition, Prentice Hall, Englewood Cliffs, New Jersey, 2014.
4. R. B. Dash and D. K. Dalai, Fundamentals of Linear Algebra, Himalaya Publishing house, 2008.

5. Serge Lang, Linear Algebra, 3rd edition, Springer-Verlag, New York 2005.

MAS3123: Theory of Riemann Integration and Series of Function [3 1 0 4]

Riemann Integration: Inequalities of upper and lower sums, Riemann conditions of integrability, Riemann sum and definition of Riemann integral through Riemann sums, equivalence of two definitions, Riemann integrability of monotone and continuous functions, properties of the Riemann integral, definition and integrability of piecewise continuous and monotone functions, intermediate value theorem for Integrals, fundamental theorems of Calculus; Pointwise and uniform convergence of sequence of functions; Theorems on Continuity: derivability and integrability of the limit function of a sequence of functions, Series of Functions: Theorems on the continuity and derivability of the sum function of a series of functions, Cauchy criterion for uniform convergence and Weierstrass M-Test, limit superior and limit inferior; Power series: radius of convergence, Cauchy Hadamard theorem, differentiation and integration of power series.

References:

1. G. Das and S. Pattanayak, Fundamentals of mathematics analysis, TMH Publishing Co., 2016
2. S.C. Mallik and S. Arora, Mathematical analysis, New Age International Ltd., New Delhi, 2012.
3. S. Narayan, Elements of real analysis, S. Chand & Co. 2017.
4. R. G. Bartle D.R. Sherbert, Introduction to Real Analysis, 3rd edition, John Wiley and Sons Asia, Pvt. Ltd., Singapore, 2002.
5. C. G. Denlinger, Elements of Real Analysis, Jones & Bartlett, 2011.

MA3124: Introduction to MATLAB [3 1 0 4]

Introduction to the MATLAB environment, MATLAB desktop and interface, command window and editor, variables and basic commands, script files and help system; matrices and vectors, matrix creation and manipulation, indexing and slicing, arithmetic, relational and logical operators, element-wise and matrix operations, built-in matrix functions; built-in functions and user-defined functions, function files, anonymous functions, input and output arguments, programmer's toolbox, basic debugging; selection statements (if, else, elseif, switch), looping constructs (for, while), nested loops and flow control commands; data types including numeric, logical, character and string data, cell arrays, structures, type conversion and data handling; file input and output operations, reading and writing data files, formatted input/output and file handling commands.

References:

1. Stormy Attaway, MATLAB: A Practical Introduction to Programming and Problem Solving, Elsevier.
2. Stephen J. Chapman, MATLAB Programming for Engineers, Cengage Learning.
3. Duane Hanselman and Bruce Littlefield, Mastering MATLAB, Pearson.

Minor-5

MAS3125: Information and Coding Theory [3 1 0 4]

Information Measures: Entropy; Shannon entropy; Measures of information; Self-information; Mutual information; Average information; Csiszar's f-divergence measure and their applications. **Source model and coding:** Problems of unique decipherable codes; Condition of instantaneous codes; Code word length; Kraft inequality; Noiseless coding theorem; Construction of codes: Shannon Fano; Shannon Binary and Huffman codes. **Discrete Memory less channels:** Classification of channels; Calculation of channel capacity; De-coding scheme-the ideal observer. **Continuous channels:** The time–discrete

Guassian channel; Uncertainty of absolutely continuous random variable; The converse to the coding theorem for time–discrete Gaussian Channel; The time–continuous Gaussian channel; Band–limit channels; Channels Model and Coding. **Error correcting codes:** Minimum distance principle; Relation between distance and error correcting properties of codes; The Hamming bound; Parity check coding; Bounds on the error correcting ability of parity check codes.

References:

1. R. G. Gallager (1968), Information theory and reliable communication, Wiley Publications, (Vol.2), New York.
2. M. Borda,(2011), Fundamentals in Information Theory and Coding, Scientific Publishing Services Pvt. Ltd., Chennai, India
3. F. M. Razza,(1994), An introduction to information theory, Dover Publications, New York.
4. R. B. Ash, (1990) Information Theory, Dover Publications, New York.

MAS3126: Applied Statistics [3 1 0 4]

Index numbers: Introduction and their construction, Laspeyer's, Paashce's, Marshall –Edge Worth and Fisher's index Numbers, tests for index numbers, uses of index numbers, price, quantity and value relatives, link and chain relatives, chain base index numbers, cost of living index numbers. **Analysis of Time Series**: components of time series, trend measurement by mathematical curves- polynomial, growth curves, moving average method, Spencer's formulae, effect of elimination of trend on other components of time series, various difference methods and its use for estimation of variance of the random component, measurement of seasonal fluctuations measurement of cyclical component, periodogram analysis. **Stationary Time Series**: concept, strong and weak stationary, auto covariance and auto correlation, correlogeam of auto regressive scheme, moving average scheme and a harmonic series, box Jenkin's models, estimation of parameters in ARIMA models, forecasting, exponential and adaptive smoothing models. **Statistical Quality Control**: Control Charts for variable and attributes. Acceptance Sampling by attributes- single, double, multiple and sequential sampling plans, concepts of AOQL and ATI, acceptance Sampling by variables-use of Dodge-Romig and other tables.

References:

1. M. G. Kendall, A. Stuart, The Advanced Theory of Statistics. Vol.2: Inference and Relationship, Griffin Publisher, 1973.
2. Croxton, F.E., Cowden, D.J. and Klein, S., Applied General Statistics, 3rd Edition, Prentice Hall of India (P) Ltd, 1982.
3. Duncan, A.J. and Erwin, R.D., Quality Control and Industrial Statistics, 4th Edition, Taraporewala and Sons, 1974.
4. Elhance, D. N. and Elhance, V., Fundamentals of Statistics, D.K. Publishers, 1996.
5. Saluja, M.P., Indian Official Statistical System, Statistical publication Society, Calcutta, 1972.

MAS3127: Cryptography [3 1 0 4]

Introduction to cryptography, symmetric and asymmetric cryptosystems; Classical cryptography: substitution ciphers (shift, affine, Vigenere ciphers), Hill cipher, permutation cipher, stream ciphers; cryptanalysis of classical ciphers, DES, AES, Concept of information theory, perfect secrecy, one-time pad. Euclidean algorithm and the extended Euclidean algorithm, fast exponentiation, the Chinese remainder theorem, finite fields, primitive roots, computational complexity. Introduction to public key cryptography, the discrete logarithm problem (DLP), Diffie-Hellman key exchange, the ElGamal cryptosystem, the RSA cryptosystem. Primality testing, Miller-Rabin test; Factoring algorithms: Pollard's $p-1$ algorithm, factorization via difference of squares, smooth

numbers and sieves, the quadratic sieve; Algorithms for computing discrete logarithms: Shank's algorithm, the Pohlig-Hellman algorithm, index calculus algorithm, collision algorithm, Pollard's ρ-algorithm. Cryptographic hash functions, digital signatures, RSA digital signatures, ElGamal digital signatures, the digital signature algorithm (DSA). Introduction to elliptic curves: elliptic curves over finite fields, the elliptic curve discrete logarithm problem (ECDLP), elliptic curve cryptography: elliptic Diffie Hellman key exchange, elliptic El-Gamal cryptosystem, the elliptic curve DSA; Introduction to secret sharing.

References:

1. Hoffstein J., Pipher J. and Silverman J. H.: "An Introduction to Mathematical Cryptography", Springer (2nd Ed.), 2014.
2. Stinson D. R. and Paterson M. B.: "Cryptography", CRC Press (4th Ed.), 2019.
3. Buchmann J. A.: "Introduction to Cryptography", Springer (2nd Ed.), 2004.
4. Lindell Y., Katz J.: "Introduction to Modern Cryptography", CRC Press (2nd Ed.), 2014.
5. Koblitz N.: "A Course in Number Theory and Cryptography", Springer (2nd Ed.), 1994.

Sixth Semester

MAS3201: COMPLEX ANALYSIS [3 1 0 4]

Analytic Functions: (Recapitulation) functions of complex variables, mappings, limits, continuity, derivatives, C-R equations, analytic functions; Complex Integration: Complex valued functions, contour, contour integrals, Cauchy- Goursat theorem, Cauchy integral formula, Moreras 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, behavior 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, minimum modules principle, complex form of equations of straight lines, half planes, circles, etc., analytic function as mappings; conformal maps; Transformations: Mobius transformation, cross ratio, symmetry and orientation principle, examples of images of regions under elementary analytic function.

References:

1. R.V. Churchill, J.W. Brown, Complex Variables and Applications, 8th edition, McGraw Hill Series, 2008.
2. B. Choudary, The element of Complex Analysis, 2nd edition, Wileys Eastern Ltd., 1983.
3. J. B. Conway, Functions of one complex variable, Springer International Student edition, Narosa Publishing House, 2000.
4. A. R. Shastri, An Introduction to Complex Analysis, Macmillan India Ltd., 2003.
5. W. Rudin, Real and Complex Analysis, McGraw Hill Series, 1987.

MAS3221: Introductory Course on PDEs [3 1 0 4]

Formation of Partial differential equations – by elimination of arbitrary constants – by elimination of arbitrary functions – Defines of general, particular and complete solutions - Singular integral – Lagranges method of solving the linear equation $Pp + Qq = R$.

Charpits method - Linear Partial Differential equation of second and higher order with constant coefficients.
Boundary value problems method of separation of variable transverse vibrations of string – the one dimensional heat flow equations a Cartesian form.

Reference:

1. Moorthy & Senthilvadivu, Transforms and partial differential equations VRB Publishers, (2009).
2. Veerarajan, T., Transforms and Partial differential equations, McGraw Hill Education India, 2015.
3. Murray and Longman, Introductory course in Differential equations, (1967).

MAS3222: Applied Mechanics: Dynamics [3 1 0 4]

Kinematics and kinetics: Fundamental notions and principles of dynamics; Laws of motion; Relative velocity. Kinematics: Radial, transverse, tangential, normal velocities and accelerations; Simple harmonic motion; repulsion from a fixed pint, motion under inverse square law, Hooke's law, horizontal and vertical elastic strings, motion on an inclined plane; Motion of a projectile, Nature of a trajectory, Results pertaining to the motion of a projectile, Range on an inclined plane, Maximum range on the inclined plane; Work, energy and impulse; Conservation of linear momentum & energy, Impact of a sphere, Direct and oblique impact of two smooth spheres on a plane; uniform circular motion, motion on the inside of a smooth vertical circle, motion in the resisting medium, resistance varies as velocity and square of velocity; Central Forces: Stability of nearly circular orbits, Kepler's laws, time of describing an arc and area of any orbit.

References:

1. P. S. Deshwal, Particle Dynamics, New Age International, New Delhi, 2000.
2. M. Ray and G. C. Sharma, A Textbook on Dynamics, S. Chand and Co., 2010.
3. A. S. Ramsey, Dynamics, Cambridge University Press, 2009.
4. S. L. Loney, An Elementary Treatise on the Dynamics of a Particle, Cambridge University Press, 2013.

MAS3223: Linear Programming Problem and Network Scheduling [3 0 1 4]

Linear Programming: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Case Studies of LPP, Graphical Methods to Solve Linear Programming Problems, Applications, Advantages, Limitations. **Simplex Method:** Introduction, Standard Form of LPP, Fundamental theorem of LPP, Solution of LPP – Simplex Method, The Simplex Algorithm, Penalty Cost Method or Big Method, Two Phase Method, Solved Problems on Minimization. Sensitivity Analysis.

Transportation problem: Definition- Formulation and solution of transportation problem - Initial Basic Feasible solution - Test for optimality - degeneracy in transportation problem - MODI method.

Assignment problem: Introduction - Mathematical formulation of the problem – solution methods of Assignment problems - Special cases in Assignment problems: Maximization case only.

Network Scheduling by PERT/ CPM:- Introduction - Network and basic components - logical sequences - Rules of Network constructions - Concurrent Activities - Critical path Analysis.

References:

1. G. Hadley, Linear Programming, Narosa Publishing House, 1995.
2. S. I. Gauss, Linear Programming, Methods and Applications (4th edition), Mc Graw- Hill, New York, 1975.
3. S. D. Sharma, Operations Research, Kedarnath and Ram Nath Publication, 1972.

4. Hamdy A., Taha, Operations Research, Pearson publisher, 9 th Edition,2012.

5. J K Sharma, Operations Research Theory and Applications, MacMillan publication, 5th Edition, 2012.

Min-6

MAS3224: Calculus of Variations and Integral Equations [3 1 0 4]

Calculus of Variations: Definitions and Properties of functional, Variation of a functional, Euler-Lagrange equation, Necessary and sufficient conditions for extrema. Variational methods for boundary value problems in ordinary and partial differential equations.

Linear Integral Equations: Linear integral equation of the first and second kind of Fredholm and Volterra type, Solutions with separable kernels. Characteristic numbers and eigenfunctions, resolvent kernel

References:

1. A.J. Jerri, Introduction to Integral Equations with Applications, Wiley-Interscience Publication, 1999.
2. P.C. Bhakta, Integral Transforms, Integral Equations and Calculus of Variations, Sarat, 2011.
3. A.S. Gupta, Calculus of Variations with Applications, PHI Learning, 2015.
4. F.B. Hilderbrand, Methods of Applied Mathematics, Dover Publications, 2005.
5. I.M. Gelfand, S.V. Fomin, Calculus of Variations, Dover Publications, 2000.

MAS3225: Financial Mathematics and Investment Analysis [3 1 0 4]

Basic Principles: Comparison, arbitrage and risk aversion, interest (simple and compound, discrete and continuous), time value of money, inflation, net present value, internal rate of return (calculation by bisection and Newton-Raphson methods), comparison of NPV and IRR, bonds, bond prices and yields, Macaulay and modified duration; Term Structure of Interest Rates: spot and forward rates, explanations of term structure, running present value, floating-rate bonds, immunization, convexity, putable and callable bonds, asset return, short selling, portfolio return, (brief introduction to expectation, variance, covariance and correlation), random returns, portfolio mean return and variance, diversification, portfolio diagram, feasible set; Markowitz Model: (review of Lagrange multipliers for 1 and 2 constraints), Two fund theorem, risk free assets, one fund theorem, capital market line, Sharpe index, Capital Asset Pricing Model (CAPM), betas of stocks and portfolios; Security Market Line: use of CAPM in investment analysis and as a pricing formula, Jensen's index.

References:

1. D. G. Luenberger, Investment Science, Oxford University Press, Delhi, 1998.
2. J. C. Hull, Options, Futures and Other Derivatives, 6th Ed., Prentice-Hall India, Indian reprint, 2006.
3. S. Ross, An Elementary Introduction to Mathematical Finance, 2nd Ed., Cambridge University Press, USA, 2003.

MAS3226: Machine Learning and Artificial Intelligence [3 1 0 4]

Overview of Artificial Intelligence: Introduction to Artificial Intelligence, The Turing Test, Strong AI vs Weak AI, Heuristics, Identifying Problems Suitable for AI, Applications and Methods, Early History of AI, Recent Developments in AI, AI in the New Millennium.
Uninformed Search: Search in Intelligent Systems, State-Space Representation, Blind Search Algorithms, Implementation and Comparison of Blind Search Algorithms.
Informed Search: Heuristics and Heuristic Functions, Informed Search Algorithms, Best-First Search, Beam Search, Performance Measures for Search Algorithms
Search Using Games: Game Playing in AI, Game Trees, Minimax Algorithm, Alpha-Beta Pruning, Variations of Minimax, Introduction to Game Theory
Logic in Artificial Intelligence: Logic and Knowledge Representation, Propositional Logic, Predicate Logic, Inference Mechanisms.
Production Systems: Basic Concepts, Structure of Production Systems, Inference Methods, Production Systems and Cellular Automata, Introduction to Stochastic Processes and Markov Chains
Uncertainty in Artificial Intelligence: Sources of Uncertainty, Probability Theory, Bayesian Reasoning, Fuzzy Sets, Fuzzy Logic, Fuzzy Inference Systems.
Machine Learning: Introduction to Machine Learning, Role of Feedback in Learning Systems, Inductive Learning, Learning with Decision Trees, Problems Suitable for Decision Trees, Entropy and Information Gain, ID3 Algorithm and Related Issues.
Neural Networks: Introduction to Artificial Neural Networks, Biological Motivation, McCulloch-Pitts Neuron Model, Perceptron Learning Rule, Delta Rule, Multilayer Networks and Backpropagation Algorithm, Hopfield Networks and Application Areas.
Natural Language Understanding: Introduction to Natural Language Processing, History of NLP, Syntax and Formal Grammars, Semantic Analysis, Statistical Methods in NLP, Probabilistic Models for NLP, Linguistic Data Resources for NLP.

References:

1. Stephen Lucci and Danny Kopec, Artificial Intelligence, Mercury Learning and Information, 2nd Edition, 2016.
2. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, Pearson Education, 2nd Edition, 2004.
3. Elaine Rich, Kevin Knight, and Shivashankar B. Nair, Artificial Intelligence, Tata McGraw-Hill, 3rd Edition, 2009.
4. Saroj Kaushik, Artificial Intelligence, Cengage Learning, 2011.

MAS3227: Econometrics [3 1 0 4]
Introduction: Definition and scope of econometrics, methodology of econometric research, objectives behind econometric models. **Simple Regression Models:** Straight line relationship between two variables, Gauss Markoff theorem, precision of the estimated regression, examination of the regression equation, lack of fit and pure error, fitting a straight line in matrix form, variance and covariance of b0 and *b1* from the matrix calculation, variance of Y using the matrix development, orthogonal columns in the X-matrix, partial F-Test and sequential F-tests, selection of best regression equations by step wise procedure, Bias in regression estimates, residuals, polynomial models and orthogonal polynomials. **Multiple Regression Estimation:** Introduction, the model, estimation of β and σ^2, geometry of least- squares, the model in centered form, normal model, R^2 in fixed x-regression, generalized least-square, model misspecification, tests of hypothesis and confidence intervals, model validation and diagnostics. **Multicollinearity**: concept, detection of multicollinearity, consequences and solutions of multicollinearity, generalized least squares estimation, Aitken estimators. **Heteroscedastic**: Heteroscedastic disturbances, efficiency of Aitken estimator with OLS estimator under heteroscedasticity. **Autocorrelation**: concept, consequences of autocorrelated disturbances, detection of autocorrelation, their estimation and testing, estimation using Durbin-Watson statistic.

References:

1. S.P. Singh, Anil. K, Parashar and H. P. Singh, Econometrics, S. Chand and Company Ltd, New Delhi, 1984.
2) Damodar N. Gujarati, Basic Econometrics, Fourth Edition (McGraw−Hill), New Delhi, 2004.

Seventh Semester

MAS4121: A COURSE ON FLUID DYNAMICS [3 1 0 4]

Kinematics: Euler's equations of motion, Lagrange's equations of motion, Lagrangian and Eulerian methods, equations of continuity in Lagrangian and Eulerian methods, stream line, velocity potential, path line, velocity and circulation, boundary surface, rotational and irrotational motion, equation of energy; Motion in Two Dimensions: stream function, complex velocity potential, source, sink and doublet, their image, images in two dimensions, images of a source with regard to a plane, a circle and a sphere, image of a doublet, Milne-Thomson circle theorem, theorem of Blasius; Vortex Motion: Helmholtz properties of vortices, velocity in a vortex field, motion due to circular vortex, infinite rows of vortices, Ka'rma'n vortex street; Viscous Fluid: Navier-Stokes equations; diffusion of vorticity, dissipation of energy, steady motion of a viscous fluid between two parallel planes, steady flow through cylindrical pipes.

References:

1. Y. A. Cengel and John M. Cimbara, Fluid Mechanics: Fundamentals and Applications, McGraw Hill Eduction, 4th edition, 2017.
2. M.D. Raisinghania, Fluid dynamics, S. Chand Publication, 2010.
3. J.L. Bansal, Viscous Fluid Dynamics, Oxford Publications, 2003.
4. G.K. Batchelor, An Introduction to Fluid Dynamics, Foundation Books, 2005.
5. T. F. Chorlton, and Van Nostrand Reinhold, Text Book of Fluid Dynamics, Co., London, 1990.

MAS4122: Computational Numerical Methods [3 0 1 4]

Errors in Numerical Computing: Introductions, types of errors; Numerical Solution of Algebraic and Transcendental Equations: Synthetic division method, derivative of a polynomial by synthetic division method, graphical method, Bisection method, Regula falsi method, Secant method, Iteration method, Newton-Raphson method, Newton's iteration formula for obtaining square and inverse square root., Birge-Vieta method, Bairstow's method,; synthetic division scheme; Solution of Linear System of Equations: Gauss elimination method, Gauss Jordan method, LU-decomposition method, Crout's method, Cholesky method, Gauss Jacobi method, Gauss Seidel method; Finite Differences: Finite difference operators, relation between difference operators, Lagrange and Newton-divided interpolation, Newton -Gregory forward and backward interpolation, central interpolation, Newton - forward and backward interpolation, Stirling formulae and Bessel's interpolation formula; Numerical Differentiation and Integration: Numerical differentiation formulas, Newton's Cotes-quadrature formula, numerical integration by Trapezoidal rule, Simpson's rule – 1/3rd and 3/8th rule, Weddle rule, Gaussian's integral.

References:

1. G. Haribhaskaran, Numerical Methods, Laxmi Publications, Delhi, 2008.
2. M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International, 2013.
3. H.C Saxena, Finite Differences and Numerical Analysis, S. Chand & Company Ltd., New Delhi, 2015.
4. M. K. Venkataraman, Numerical Methods in Science and Engineering, National Publishing Company, 6th Edition, 2012.
5. K. Sankara Rao, Numerical Methods for Scientists and Engineers, 2nd edition, Prentice Hall India, 2004.

MAS4123: SPECIAL FUNCTIONS AND ORTHOGONAL POLYNOMIALS [3 1 0 4]

Gauss Hypergeometric Function: Introduction and its properties, Series solution of Gauss hypergeometric equation. Integral representation, Linear and quadratic transformation formulas, Contiguous function relations, Differentiation formulae, Linear relation between the solutions of Gauss hypergeometric equation, Kummer's confluent hypergeometric function and its properties, Integral representation, Kummer's first transformation; Legendre Polynomials: Introduction, Rodrigue's formula, orthogonality, recurrence relations. Functions Pn(x) and Qn(x) and their properties; Bessel Function: Introduction, Jn(x) and its properties, recurrence relations; Generalized Hypergeometric Function: Definition, Special cases, Series, integral and contour representations, Convergence conditions of these representations, Saalssutz, Whipple theorems, Contiguous function relations, Differentiation and integral formulas, Laguerre polynomial: Introduction, recurrence relations, Properties.

References:

1. G.E. Andrews, R. Askey and R. Rose, Special Functions, Cambridge University Press, 2001.
2. R.Y. Denis and U.P. Singh, Special Function and Their Applications, Dominant Publishers, 2001.
3. N. Saran, S. D. Sharma & T. N. Trivedi, Special Functions: For Mathematical, Physical & Engineering Sciences, Pragati Prakashan, 2008.
4. N. Saran, S.D Sharma, T. N. Trivedi, Special Functions, Pragati Prakashan, 2019.

MAS4124: INTRODUCTION TO TOPOLOGY [3 1 0 4]

Basic Concepts: Definition and examples of topological spaces, comparison of topologies on a set, intersection and union of topologies on a set, neighborhoods, Interior point and interior of a set , closed set as a complement of an open set , adherent point and limit point of a set, closure of a set, derived set, properties of closure operator, boundary of a set , dense subsets, interior, exterior and boundary operators, alternative methods of defining a topology in terms of neighborhood system and Kuratowski closure operator, relative (induced) topology, base and subbase for a topology, Base for Neighborhood system, continuous functions, open and closed functions, homeomorphism. connectedness and its characterization; Connected Spaces: connected subsets and their properties, continuity and connectedness, components, locally connected spaces; Compact Spaces: Compact spaces and subsets, compactness in terms of finite intersection property, continuity and compact sets, basic properties of compactness, closeness of compact subset and a continuous map from a compact space into a Hausdorff and its consequence, sequentially and countably compact sets, Local compactness and one point compatification; Seperations Axioms: First countable, second countable and separable spaces, Hereditary and topological property, countability of a collection of disjoint open sets in separable and second countable spaces, Lindelof theorem, T0, T1, T2 (Hausdorff) separation axioms, their characterization and basic properties.

References:

1. C.W. Patty, Foundation of Topology, Jones & Bertlett, 2009.
2. Fred H. Croom, Principles of Topology, Cengage Learning, 2009.
3. G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Book Company, 1983.
4. K. Chandrasekhara Rao, Topology, Narosa Publishing House Delhi, 2009.
5. W.J. Pervin, Foundations of General Topology, Academic Press Inc. New York, 2014.

MAS4125: Integral Transforms: Laplace, Fourier, and Mellin [3 1 0 4]

Laplace transform: Definition, Basic properties, Laplace transforms for improper integral, Laplace transform of derivatives and integrals, Multiplication and division by power of independent variable, Evaluation of integrals by using Laplace transforms, Periodic functions, Initial-value and Final value theorem. Inverse Laplace transform: Definition, Basic properties, Inverse Laplace transform of derivatives and integrals, Multiplication and division by power of independent variable, Convolution theorem for Laplace transform, Evaluation of integrals by using inverse Laplace transform, Use of partial fractions, Heaviside expansion formula. **Fourier transform:** Definition and properties of Fourier complex sine, cosine and complex transforms, Inversion theorem, Relationship between Fourier transform and Laplace transform, Modulation theorem, Convolution theorem for sine, cosine and complex transforms, Parseval's identity, Fourier transform of derivatives. **Mellin transform:** Definition and elementary properties, Mellin transforms of derivatives and integrals, Inversion theorem, Convolution theorem, Inverse Mellin transform of two functions. Applications to integral transforms.

References:

1. Goyal J. K. and Gupta K. P, Laplace and Fourier Transforms, Pragati Prakashan, Meerut, 2006.
2. Vashistha A. R., Gupta, R. K. Integral Transform, Krishna Prakashan Mandir, Meerut, 2016.
3. Baidyanath Patra, An introduction to Integral transform, CRC Press Taylor & Francis Group, 2018.

Eighth Semester

EC

MAS4221: INTRODUCTION TO BIFURCATION THEORY [3 1 0 4]

Introduction to Dynamical System, **Flows on the line:** Fixed points and stability, Population growth, Linear Stability Analysis-Existence and uniqueness property. **Bifurcations:** Saddle-node, Transcritical, pitchfork, Hopf-bifurcation, Global bifurcations, Melnikov's method for homoclinic orbits. Strange attractors & fractals dimensions. Henon map and Rossler system, Box-counting, pointwise and correlation, hausdorff dimensions. Lyapunov exponent.

References:

1. Y. Kuznetsov, Elements of Applied Bifurcation Theory, Springer New York, 2013.
2. A.R Krauskopf, Alan. R Champneys, Hinke. M Osinga, J Hogan, Mario di Bernado,
3. Martin. E Homer, R. Eddie Wilson, Nonlinear Dynamics and Chaos, CRC Press, 2002.
4. S. H. Strogatz, Nonlinear Dynamics And Chaos, Sarat Book House, 2007.

MAS4222: INTRODUCTION TO CELESTIAL MECHANICS [3 1 0 4]

The Two Body Problem: Description of the two-body problem. Equation of motion in an inertial frame. Equation of Relative motion. Angular momentum and the orbit formulas. The energy law. Circular orbits ($e = 0$), Elliptic orbits ($0 < e < 1$), Parabolic trajectories ($e = 1$) and Hyperbolic trajectories ($e > 1$). **The Three Body problem:** Lagrange's solution for the motion of three bodies. Restricted three body problem. Surfaces of zero relative velocity. Double points. Stability of straight line and equilateral triangle solutions**. N-Body problem:** The ten integrals of motion of the n-body problem. Transfer of origin to one of the particles. The perturbing function virial theorem.

References:

1. R. Fitzpatrick, An Introduction to Celestial Mechanics, Cambridge University Press, 2012.

2. G. Beutler, L. Mervart, A. Verdun, Methods of Celestial Mechanics Volume I: Physical, Mathematical, and Numerical Principles, Springer Berlin Heidelberg, 2005.
3. A.E. Roy, Orbital Motion, Taylor & Francis, 2004.

MAS4223: COMPUTATIONAL METHODS IN FLUID DYNAMICS [3 1 0 4]

Introduction: Basic equations of Fluid dynamics, analytic aspects of partial differential equations classification, boundary conditions, maximum principles, boundary layer theory, finite difference and finite volume discretizations, vertex-centred discretization, cellcentred discretization, upwind discretization; Grid Analysis: Non uniform grids in one dimension, finite volume discretization of the stationary convection-diffusion equation in one dimension, schemes of positive types, defect correction, non-stationary convection diffusion equation; Stability of the system: Stability definitions, discrete maximum principle, incompressible Navier-Stokes equations, boundary conditions, spatial discretization on collocated and on staggered grids, temporal discretization on staggered grid and on collocated grid; Analytical Solutions: Iterative methods, stationary methods, Krylov subspace methods, multigrade methods, fast Poisson solvers, iterative methods for incompressible Navier-Stokes equations, Shallow-water equations – one and two dimensional cases, Godunov order barrier theorem, linear schemes, scalar conservation laws, Euler equation in one space dimension – analytic aspects, approximate Riemann solver of Roe, Osher scheme, flux splitting scheme, numerical stability, Jameson – Schmidt – Turkel scheme, higher order schemes.

References:

1. P. Wesseling, Principles of Computational Fluid Dynamics, Springer Verlag, 2000.
2. J.F. Wendt, J.D. Anderson, G. Degrez and E. Dick, Computational Fluid Dynamics: An Introduction, Springer-Verlag, 1996.
3. K. Muralidher, Computational Fluid Flow and Heat Transfer, Narosa Pub. House, 2013.
4. T.J. Chung, Computational Fluid Dynamics, Cambridge Uni. Press, 2014.

MAS4224: Nonlinear Programming [3 1 0 4]

Unconstrained Optimization: Fibonacci golden section and quadratic interpolation methods for one dimensional problems, steepest descent, conjugate gradient and variable metric methods for multidimensional problems; Nonlinear Programming: Generalized convexity, quasi and psuedo convex functions and their properties, general nonlinear programming problem, difficulties introduced by nonlinearity, Kuhun-Tucker necessary conditions for optimality, insufficiency of K-T conditions, sufficiency conditions for optimality, solution of simple NLPP using K-T conditions; Quadratic Programming: Beale's method, restricted basis entry method (Wolfe's method), proof of termination for the definite case, resolution of the semi definite case, duality in quadratic programming; Convex Programming: Methods of feasible directions, Zoutendijk's method, Rozen's gradient projection method for linear constraints, Kelly's cutting plane method to deal with nonlinear constraints.

References:

1. S.S. Rao, Optimization Theory and Applications, Wiley Eastern, 2009.
2. G. Hadley, Nonlinear and Dynamic Programming, Addison Wesley, 2018.
3. M. Bazara and Shetty, Nonlinear Programming: Theory and Algorithms, 3rd edition, John Wiley, 2006.
4. H.S. Kasana, Introductory Operation Research: Theory and Applications, Springer Verlag, 2005.
5. R. L. Rardin, Optimization in Operations research, Pearson Education, 2005.

MAS4225: Tensor Analysis [3 1 0 4]

Tensor Analysis: Notation and Definitions of Contravariant and covariant tensors of first and second order. Invariants. Contravariant, covariant and mixed tensors. The Kronecker delta. Algebra of tensors Symmetric and skew-symmetric tensors. Addition and scalar multiplication. Contraction and Quotient law for tensor. Reciprocal Tensor. Definition and properties of first and second kind of Christoffel's symbols, covariant differentiation of tensor, Ricci's theorem, Riemann- Christoffel 's tensor and its properties, Covariant curvature tensor.

References:

1. Chorlton, F., Vector and tensor methods, Ellis Horwood Publisher, 1977.
2. Spiegel, M. R., Vector analysis- An introduction to tensor analysis, McGraw Hill Book Company, 1981.
3. Joshi, A. W., Matrices and tensors in physics, Wiley, 1991.
4. Grinfeld, P., Introduction to tensor analysis and the calculus of moving surfaces, Springer, 2013. 5. Nguyen-Sch¨afer, H., and Schmidt, J. P., Tensor analysis and elementary differential geometry for physicists and engineers, Springer, 2014.

MAS4226: Theory of Relativity [3 1 0 4]]

The special theory of relativity**:** Michelson and Morley experiment and its results, Inertial frames of reference, Special Galilean Transformations, General Galilean Transformations. Relation between Space and Time**:** Principle of relativity and its postulates, Relative character of space and time. Lorentz transformations: Derivation of special Lorentz transformation equations, Composition of parallel velocities, Time dilation, Lorentz-Fitzgerald contraction formula, Lorentz contraction factor, Simultaneity. Relation between mas and energy: Variation of mass with velocity, Equivalence of mass and energy, Transformation formulae for mass, momentum and energy, Problems on conservation of mass, Momentum and energy. Tensors: Introduction, Summation convention, Transformation of coordinates, Tensor of order zero, Kronecker Delta, Contra-variant tensors, Covariant tensors, Tensors of higher order, Symmetric and skew-symmetric tensors, Addition of tensors, Outer product of tensors, Inner product of two tensors, Contraction of tensors. Differentiation, Riemann-Christoffel tensor, Ricci Tensor. Cosmology: Introduction to cosmology, Isotropy, Homogeneity, Basic equation of isotropic cosmology, Hubble constant, Cosmological principal, Gaussian coordinate system, introduction to FRW metric.

References:

1. R. K. Pathria, The Theory of Relativity (2nd edition), Hindustan Publishing Co., Delhi, 1994.
2. J. V. Narlikar, General Relativity & Cosmology (2nd edition), Macmillan Co. of India Limited, 1988.
3. Albert Einstein, Relativity the Special and General theory, General press, Shree Maitrey Printech Pvt.Ltd., Noida.2012.
4. S. K. Srivastava and K. P. Sinha, Aspects of Gravitational Interactions, Nova Science Publishers Inc. Commack, New York, 1998.
5. R. M. Wald, General Relativity, University of Chicago Press, 1984.

Minors

MAS3228: Theory of Logical Mathematics [3 1 0 4]

Properties of integers, Division algorithm, Divisibility and Euclidean algorithm, GCD, LCM, Relatively prime. Applications of Numbers, Prime numbers, Statement of fundamental theorem of arithmetic, Mathematical induction. Compound statements (and, or, implication, negation, contrapositive, quantifiers), Truth tables, Basic logical equivalences and its consequences, Logical arguments, Set theory, Operation on sets, inclusion

and exclusion principle, Types of binary relations, Equivalence relations, Congruences and its properties, Partial and total ordering, Recursive relations and its solution (characteristics polynomial and generating function), Principles of counting (inclusion/exclusion, pigeon-hole), Permutation and combinations (with and without repetition).

References:

1. Goodaire, Edgar G., & Parmenter, Michael M. (2003). Discrete Mathematics with Graph Theory (2nd ed.). Pearson Education (Singapore) Pte. Ltd. Indian Reprint.
2. Lidl, Rudolf & Pilz, Günter. (1998). Applied Abstract Algebra (2nd ed.). Undergraduate Texts in Mathematics. Springer (SIE). Indian Reprint 2004.

MAS4126: Statistical Methods in Biological Sciences [3 1 0 4]

Introduction: Definition, scope, functions, limitations, uses, types of data, types of variable, classification, tabulation, graphical representation of biological data; Measures of Central Tendency: Mean, mode, median; Measures of Dispersion: Range, standard deviation, mean deviation, co-efficient of variation, their applications, merits and demerits; Probability: Definitions of probability , additive rule, multiplicative rule, conditional probability, Bayes theorem; Random Variable and Probability Distribution: Definition, types of random variable, functions of probability distribution of random variables, expected value and variance of random variables, Binomial distribution, Poisson distribution, Normal Distribution; Correlation and Regression: Introduction, Karl Pearson's, Spearrmn's coefficient of correlation, regression equations, regression lines, regression coefficients, similarities and dissimilarities of correlation and regression; Testing of Hypothesis: Large sample tests, student 't'-test, chi square test, run test, sign test and median test.

References:

1. A.K. Sharma. Textbook of Biostatistics I. Discovery Publishing House, New Delhi, 2005.
2. B. L. Agarwal. Basic Statistics. New Age International, New Delhi, 2006.
3. M. Pandey. Biostatistics: Basic and Advanced, MV learning, 2015.
4. A.K. Irfan. A. Khanum, S. Khan. Fundamentals of Biostatistics, 5th Edition, 2018.
5. G. K. Kanji, 100 Statistical Tests, SAGE Publication, 3rd Edition, 2006.

MAS4227: Research Methodology and Scientific Writing [3 1 0 4]

Foundations of Research: Meaning, objectives, motivation, utility, empiricism, deductive and inductive theory, characteristics of scientific method , understanding the language of research; Research Process: Problem identification & formulation, research question, investigation question, measurement issues, hypothesis, qualities of a good hypothesis, types of hypothesis; Research Design: Concept and importance in research, features of a good research design, exploratory research design, descriptive research designs, experimental research design; Types of Data: Classification of data, uses, advantages, disadvantages, sources; Measurement: Concept of measurement, problems in measurement in research, validity and reliability, levels of measurement; Statistical Techniques and Tools: Introduction of statistics, functions, limitations, graphical representation, measures of central tendency, measure of dispersion, skewness, kurtosis, correlation, regression, tests of significance based on t, F, Chi-square, Z and ANOVA test; **Paper Writing:** Layout of a research paper, Scopus/Web of Science journals, impact factor of journals, when and where to publish, ethical issues related to publishing, plagiarism and self-plagiarism. Introduction to LATEX.

References:

1. C.R. Kothari, Research Methodology Methods & Techniques, New Age International Publishers, Reprint 2008.
2. R. Singh, Research Methodology, Saga Publication, 4th edition, 2014.
3. J. Anderson and M. Poole, Thesis and Assignment Writing, Wiley India 4th edition, 2011.
4. Mukul Gupta and Deepa Gupta, Research Methodology, PHI Learning Private Ltd., New Delhi, 2011.
5. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi, 1999.

MAS4228: Numerical Solution of Differential Equations [3 0 1 4]

Introduction to ODEs, Numerical Techniques for One Step Methods, Convergence and Absolute Stability, Numerical techniques for Linear Multi-Step Methods, Zero Stability, Consistency, Convergence, Predictor-Corrector methods, Absolute Stability of Predictor-Corrector methods, Stiff ODEs and its numerical methods, Finite Difference Methods to Linear and Nonlinear Boundary Value Problems, Stability and Convergence Analysis, Differential Algebraic Equations, Numerical techniques for Differential Algebraic Equations, Introduction to One dimensional Finite Element Methods, Comparison between Finite Difference Methods and Finite Element Methods, Variational formulation, Finite Element Approximation, Approximation Errors, Convergence of solution, Order of Convergence. Heat Equation: Initial and boundary value problems (Dirichlet and Neumann), Explicit and implicit methods (Backward Euler and Crank-Nicolson schemes) with consistency and stability.

References:

1. David F Griffiths and D J. Higham, Numerical Methods for Ordinary Differential Equations, Springer 2010.
2. K Atkinson, W Han, D Stewart, Numerical Solutions of Ordinary Differential Equations, Wiley Inter science, 2009.
3. J D Lambert, Computational Methods in Ordinary Differential Equations (Introductory mathematics for scientists & engineers), John Wiley & sons Inc. 1991.
4. B Bradie, A friendly introduction to Numerical Analysis, 1st edition, Pearson education, 2007.
5. J N Reddy, An Introduction to the Finite Element Method, 3rd edition, TMH, 2005.

MAS4229: Applications of MATLAB [3 1 0 4]

Introduction to the MATLAB environment, MATLAB desktop and interface, command window and editor, variables and basic commands, script files and help system; matrices and vectors, matrix creation and manipulation, indexing and slicing, arithmetic, relational and logical operators, element-wise and matrix operations, built-in matrix functions; built-in functions and user-defined functions, function files, anonymous functions, input and output arguments, programmer's toolbox, basic debugging; selection statements (if, else, elseif, switch), looping constructs (for, while), nested loops and flow control commands; data types including numeric, logical, character and string data, cell arrays, structures, type conversion and data handling; file input and output operations, reading and writing data files, formatted input/output and file handling commands.

References:

4. Stormy Attaway, MATLAB: A Practical Introduction to Programming and Problem Solving, Elsevier;

5. Stephen J. Chapman, MATLAB Programming for Engineers, Cengage Learning;
6. Duane Hanselman and Bruce Littlefield, Mastering MATLAB, Pearson.