सरदार वल्लभभाई राष्ट्रीय प्रौद्योगिकी संस्थान, सूरत

Sardar Vallabhbhai National Institute of Technology

SVNIT

The syllabi of five years Integrated M. Sc. Programme in Mathematics approved by Senate, SVNIT, Surat.

Department of Applied Mathematics & Humanities

S.V. National Institute of Technology

SURAT – 395007

Fourth year of integrated M.Sc. (Mathematics)

Fourth year of integrated M.Sc. (Mathematics)
M.Sc.-IV, Semester-VII

Sr. No.	Course	Code	Teaching Scheme Hours per Week			credit	Examination Scheme			Total Marks
			L	Tu.	Pr.		Theory	Tutorial	Practical	
1	Elements of Algebra	MM 401	3	2	0	5	100	50	00	150
2	Topology	MM 403	3	2	0	5	100	50	00	150
3	Fluid Dynamics	MM 405	3	2	0	5	100	50	00	150
4	Optimization Techniques	MM 407	3	2	0	5	100	50	00	150
5	Software Engineering	CO 421	3	1	0	4	100	25	00	125
			15	9	0		500	225	00	725
Total Contact hrs per week = 24				**Total Credit = 24**					**Total Marks = 725**	

Fourth year of integrated M.Sc. (Mathematics)
M.Sc.-IV, Semester-VIII

Sr. No.	Course	Code	Teaching Scheme Hours per Week			credit	Examination Scheme			Total Marks
			L	Tu.	Pr.		Theory	Tutorial	Practical	
1	Functional Analysis	MM 402	3	2	0	5	100	50	00	150
2	Partial Differential Equations and their Applications	MM 404	3	2	0	5	100	50	00	150
3	Higher Transcendental Functions	MM 406	3	2	0	5	100	50	00	150
4	Calculus of Variations & Integral Equations	MM 408	3	2	0	5	100	50	00	150
5	Computer Networks	CO 430	3	1	0	4	100	25	00	125
			15	9	0		500	225	00	725
Total Contact hrs per week = 24				**Total Credit = 24**					**Total Marks = 725**	

Fifth year of integrated M.Sc. (Mathematics)
M.Sc.-V, Semester-IX

Sr. No.	Course	Code	Teaching Scheme Hours per Week			credit	Examination Scheme			Total Marks
			L	Tu.	Pr.		Theory	Tutorial	Practical	
1	Elements of Statistics	MM 501	3	2	0	5	100	50	00	150
2	Differential Geometry	MM 503	3	2	0	5	100	50	00	150
3	Elementary Number Theory	MM 505	3	1	0	4	100	25	00	125
4	Mathematical Modeling & Simulation	MM 507	3	1	0	4	100	25	00	125
5	Elective- I	MM 5X0	3	1	0	4	100	25	00	125
			15	7	0	22	500	175	00	675
Total Contact hrs per week = 22			**Total Credit = 22**						**Total Marks = 675**	

Elect any one from each of Elective-I (Minimum five students)

	CODE	Elective-I
1	MM 511	Advanced Operations Research
2	MM 513	Advanced Fluid Mechanics
3	MM 515	Approximation Theory
4	MM 517	Advanced Numerical Techniques
5	MM 519	Biomathematics
6	MM 521	Sobolev Space

Fifth year of integrated M.Sc. (Mathematics)
M.Sc.-V, Semester-X

Sr. No.	Course	Code	Teaching Scheme Hours per Week			credit	Examination Scheme			Total Marks
			L	Tu.	Pr.		Theory	Tutorial	Practical	
1	Elective – II	MM 5X0	3	1	0	4	100	25	00	125
2	Project Work and Dissertation		0	0	24	12	0	0	400	400
			3	1	24	16	100	25	400	525
Total Contact hrs per week = 24			**Total Credit = 16**						**Total Marks = 525**	

Elect any one from each of Elective – II (Minimum five students)

	CODE	Elective-II
1	MM 522	Advanced Integral Transforms
2	MM 524	Computational Fluid Dynamics
3.	MM 526	Finite Element Method
4	MM 528	Cryptography
5	MM 532	Lebesgue Measure & Integration
6	MM 534	Computational Biology

M.Sc.- IV (SEMESTER – VII)

Fourth year of integrated M.Sc. (Mathematics)

		L	T	P	C
M.Sc.-IV	**Semester – VII**	**3**	**2**	**0**	**5**
MM 401	**Elements of Algebra**				

- **GROUP THEORY: (15 Hours)**
  Elementary Groups, different types of groups, definition of subgroups, types of subgroups, Lagrange's theorem, Morphism of groups, Quotient groups, Fundamental theorem on homomorphism of groups, Isomorphism, Automorphism.
  Solvable groups and theorems on them. Direct product. Conjugacy, conjugate classes, Theorems on finite groups, Cauchy's theorem, Sylow's theorem.

- **RING THEORY (15 Hours)**
  Rings. Quotient rings, subring, Homomorphism, Monomorphism, Isomorphism, Ideals (Prime and Maximal).
  Integral domain. Principal ideal domain, Unique Factorization theorem, Polynomial rings and irreducibility criteria, modules and Gabor Theory.

- **FIELD THEORY (12 Hours)**
  Fields, division ring, Skew fields, finite fields, field extensions, splitting fields and Normal extensions, Seperable extensions, Galois Theory, Norms and traces.

(Total Contact Time (Theory): 42 Hours)

BOOKS RECOMMENDED:

1. **Artin M.:** *Algebra*, Prentice-Hall of India, 1991.
2. **Chon P.M.:** *Algebra, Vols. I, II & III,* John Wiley & Sons, 1992, 1989, 1991.
3. **Fraleigh J.B.:** *First Course in Abstract Algebra*, A. Third Edition, Narosa Publishing House New Delhi 2003.
4. **Herstein I.N.:** *Topics in Algebra*, Wiley Eastern Ltd., New Delhi, 1975.
5. **Malik D.S., Mordeson J.N., and Sen M.K.:** *Fundamentals of Abstract Algebra*, Mc Graw-Hill, International Edition,1997.

Fourth year of integrated M.Sc. (Mathematics)

		L	T	P	C
M.Sc.-IV	**Semester – VII**	**3**	**2**	**0**	**5**
MM 403	**TOPOLOGY**				

- **INTRODUCTION** **(15 Hours)**
  Open sets, closed sets, neighborhoods, limit points, interiors, closures, Topological Spaces, Examples of topological spaces, subspace topology, product topology, metric topology, order topology, Quotient Topology, bases, sub bases, continuous functions, Homeomorphism, Topological manifold.

- **SEPARATION AXIOMS** **(10 Hours)**
  Seperability i.e. T_0, T_1, T_2 spaces, Regularity, Complete regularity, Normality, Urysohn Lemma, Tychonoff embedding and Urysohn Metrization Theorem, Tietze Extension Theorem.

- **COMPACTNESS** **(5 Hours)**
  Compact spaces, Heine-Borel Theorem, Local compactness, one point compactification, Tychnoff Theorem.

- ***CONNECTEDNESS*** **(5 Hours)**
  Connected spaces, connected subspaces of the real line, components and local connectedness.

- **CHARACTERIZATION** **(7 Hours)**
  Complete metric spaces and function spaces, Characterization of compact metric spaces, Ascoli-Arzela Theorem, Baire Category Theorem and its applications:

(Total Contact Time (Theory): 42 Hours)

BOOKS RECOMMENDED:

1. **Armstrong M. A.:** *Basic Topology*, Springer (India), 2004.
2. **Joshi K.D.:** *Introduction to General Topology*, New Age International, New Delhi, 2000.
3. **Kelley J.L.:** *General Topology*, Van Nostrand, Princeton, 1955.
4. **Munkres J.R.:** *Topology, 2nd Ed.,* Pearson Education (India), 2001.
5. **Simmons G.F.:** *Introduction to Topology and Modern Analysis*, McGraw-Hill, New York, 1963.

Fourth year of integrated M.Sc. (Mathematics)

M.Sc.-IV	**Semester – VII**	**L**	**T**	**P**	**C**
		3	**2**	**0**	**5**

MM 405 FLUID DYNAMICS

- **GENERAL INTRODUCTION (06 Hours)**
  Introduction to fluid dynamics, Normal and Shear stress, The concept of a fluid, Kinds of fluids, Characteristics of fluids; Density, Pressure, Viscosity, Surface tension and compressibility, Different types of flows, Visualization of flows.

- **FLUID KINEMATICS (04 Hours)**
  Lagrangian and Eulerian description of fluid motion, Stream lines and path lines, Differentiation following the motion of fluid, Vorticity equation, Vortex sheets, filaments.

- **GOVERNING EQUATIONS OF FLUID DYNAMICS (12 Hours)**
  Equation of continuity in cartesian and general vector form, Expression in cylindrical and spherical coordinates, Euler's equation of motion in general vector form, Bernoulli's equation and its application to orifice, pitot tube, venturi tube. Navier Stokes equations : General theory of stress and rate of strain in fluid flow. Nature of stresses. Transformation of stress components. Nature of strains. Transformation of rates of strain. Derivation of the Navier-stokes equations. Derivation of Euler's equations as a special case of Navier – Stokes equation.

- **POTENTIAL FLOW (08Hours)**
  Velocity potential and irrotational flow, circulation and Kelvin's theorem, theorem of Blasius. Stream function in two dimensions, Complex velocity potential, Flow net, Superposition of simple flows, Rankine's method for construction of stream lines, Boundary value problems. Indication of the use of complex analysis and conformal transformations in flow problems.

- **INCOMPRESSIBLE VISCOUS FLOW (04 Hours)**
  Flow between parallel plates – Couette flow and plane Poiseuille flow. Hagen – Poiseuille flow through pipes.

- **LAMINAR FLOW OF VISCOUS INCOMPRESSIBLE FLUIDS**
  Similarity of flows – Reynold's and Froude number. Flow between parallel plates – Couette flow and plane Poiseuille flow. Hagen – Poiseuille flow through pipes, Turbulent flow & it's characteristics.
  (08 Hours)

(Total Contact Hours: 42 Hours)

BOOKS RECOMMENDED:

1. **Bachelor G.K.:** *An introduction to fluid dynamics*, Publisher, Cambridge University Press,2000.
2. **Hermann Schlichting, Klaus Gersten, Krause E., Jr. Oertel H., Mayes C.:** *"Boundary-Layer Theory"* , 8th edition Springer 2004
3. **Kundu, Pijush K., and Cohen Ira M.: Fluid Mechanics**. 3rd ed. Burlington, MA: Elsevier, 2004.
4. **O'Neill M. E. and Chorlton F.:** *Ideal and Incompressible fluid dynamics*, Publisher: John Wiley & Sons, 1986.
5. **Yuan S. W.:** *Foundations of fluid Mechanics*, Publisher: Prentice – Hall International, 1970.

Fourth year of integrated M.Sc. (Mathematics)

M.Sc.-IV	Semester – VII	L	T	P	C
		3	2	0	5
MM 407	OPTIMIZATION TECHNIQUES				

- **LINEAR PROGRAMMING PROBLEMS** **(10 Hours)**
  Introduction, structure of L.P.P., Formulation of an L.P.P., Graphical Method of solution of L.P.P., Standard form of L.P.P., Simplex Algorithm, Simplex Tableau, Two Phase Method, Big-M Method, Types of Linear Programming solutions, Duality.

- **REVISED SIMPLEX METHOD** **(5 Hours)**
  Revised simplex method (with and without artificial variable), bounded variable technique, Dual simplex method, Modified dual simplex method.

- **SENSITIVITY ANALYSIS** **(4 Hours)**
  Change in the objective function, Change in the requirement vector, Addition of a variable, Addition of a constraint, Parametric analysis of cost and requirement vector.

- **INTEGER PROGRAMMING PROBLEMS** **(4 Hours)**
  Gomory's cutting plane algorithm, Gomory's mixed integer problem algorithm, A branch and bound algorithm

- **TRANSPORTATION PROBLEMS** **(4 Hours)**
  Mathematical Model for Transportation Problem, North-West Corner Method, Lest Cost Method, Vogel's Approximation Method, Test for optimality, Degeneracy in Transportation Problem, Variations in Transportation Problem.

- **ASSIGNMENT PROBLEMS** **(4 Hours)**
  Mathematical Model for Assignment Problem, Solution Method for Assignment Problem, Variations in Assignment Problem, Traveling Salesman Problem,

- **SEQUENCING PROBLEMS** **(3 Hours)**
  Processing of Jobs through machines: Problems with n jobs two machines, n jobs three machines and n jobs m machines.

- **PERT AND CPM** **(5 Hours)**
  Introduction, Basic difference between PERT and CPM, Steps of PERT/CPM Techniques, PERT/CPM Network components and precedence relationships, Critical path analysis, Probability in PERT analysis, Project Time-Cost, Trade-off, Updating of the project, Resource allocation-resource smoothing and resource leveling.

- **GAME THEORY** **(5 Hours)**
  Graphical Method and Bilinear Programming Methods for Rectangular Games.

(Total Contact Time: 44 Hours)

BOOKS RECOMMENDED:

1. **Beale, E. M. L. and Mackley, L. :** *"Introduction to Optimization",* John Wiley, 1988
2. **Joshi, M. C. and Moudgalya, K. :** "Optimization: Theory and Practice" Narosa, New Delhi, 2004
3. **Kanti Swarup, Gupta, P. K. and Man Mohan :** "Operations Research" Sultan Chand & Sons, New Delhi, 1980.
4. **Rao, S.S.:** *"Optimization Theory and Applications", 2nd Ed.,* Willey Eastern Ltd., New Delhi, 1985.
5. **Taha, H. A.:** *"Operations Research: An Introduction", 8th Ed,* Prentice Hall, 2006.

Fourth year of integrated M.Sc. (Mathematics)

M.Sc.-IV	Semester – VII	L	T	P	C
		3	1	0	4

CO 421 Software Engineering

- **INTRODUCTION** **(02 Hours)**
  Software Process - Software Engineering Development Life Cycle – Software Qualities - Problems with Software Production – Brooke's No Silver Bullet
- **SOFTWARE LIFE-CYCLE MODELS** **(03 Hours)**
  Build-and-Fix, Waterfall, Rapid Prototyping, Incremental, Spiral, Comparison, ISO 9000 – CMM levels – Comparing ISO 9000 and CM
- **SOFTWARE REQUIREMENTS AND ANALYSIS** **(08 Hours)**
  Techniques - Feasibility Analysis - Requirements Elicitation – Validation - Rapid Prototyping - OO Paradigms vs. Structured Paradigm - OO Analysis - CASE tools
- **SOFTWARE SPECIFICATIONS** **(10 Hours)**
  Specification Document – Specification Qualities, Uses, Classification – Operational Behavioral – DFD, UML, Petri nets – Descriptive Specifications – ER Diagrams, Logic , Algebraic Specs - Comparison of various techniques and CASE tools
- **INTRODUCTION TO FORMAL APPROACH** **(06 Hours)**
  Formal Specifications, Software Verification & Validation, Cleanroom Engineering, - Formal approaches, Model Checking – SPIN Tool for Distributed Software
- **CASE TOOLS, ISO AND CAPABILITY MATURITY MODEL** **(04 Hours)**
  CASE Tools - Stepwise Refinement - Cost-Benefit Analysis - Scope of CASE - Versions control – ISO and CMM
- **SOFTWARE TESTING PRINCIPLES** **(08 Hours)**
  Non-execution & Execution based testing – Automated Static Analysis – Test-case selection - Black-Box and Glass-Box Testing - Testing Objects - Testing vs. Correctness Proof
- **MAINTENANCE PHASE** **(01 Hours)**
- Tutorials will be based on the coverage of the above topics separately **(14 Hours)**

(Total Contact Time: 42 Hours)

BOOKS RECOMMENDED :

1. **Ghezzi, Jazayeri, Mandrioli:** "Fundamentals of Software Engineering", 2/E, Pearson Education, 2002
2. **Pankaj Jalote:**" An Integrated approach to SE", Narosa, 3/E, 2005
3. **Roger S Pressman:** "Software Engineering – A Practitioner's Approach", McGraw-Hill 6/E, 2005
4. **Sommerville:** "Software Engineering", 2006 ed, Pearson Education, 6/E, 2006
5. **Stephen R Schach:** "Software Engineering with JAVA", TMH, 1999

M.Sc.- IV (SEMESTER – VIII)

Fourth year of integrated M.Sc. (Mathematics)

M.Sc.-IV	Semester – VIII	L	T	P	C
		3	2	0	5

MM 402 FUNCTIONAL ANALYSIS

- **FUNDAMENTALS OF NORMED LINEAR SPACES (7 Hours)**
  Normed Linear Spaces, Fixed point theorem, Riesz lemma, finite dimensional spaces.

- **BOUNDED LINEAR MAPS ON NORMED LINEAR SPACES (8 Hours)**
  Examples, linear maps onfinite dimensional spaces, operator norm, Banach Spaces, Hahn-Banach theorems and its applications. Open mapping and Closed graph theorems, Uniform boundedness Principle, divergence of Fourier series.

- **DUAL SPACES AND ADJOINT OF AN OPERATOR: (6 Hours)**
  Duals of classical spaces, weak and weak * convergence, Banach Alaoglu theorem, adjoint of an operator.

- **HILBERT SPACES (7 Hours)**
  Inner product spaces, orthonormal sets, Gram-Schmidt orthogonalization, Bessel's inequality, orthonormal basis, Separable Hilbert spaces, projection and Riesz reprentation theorem.

- **BOUNDED OPERATORS ON HILBERT SPACE: (7 Hours)**
  Adjoint operator, normal, unitary, self adjoin operator, compact operator, eigen value , eigen vectors, Banach algebras.

- **SPECTRAL THEOREM (7 Hours)**
  Spectral theorem for compact self adjoint operators, spectral theorem for bounded self adjoint operators. Self adjoint, normal and unitary operators;

(Total Contact Time (Theory): 42 Hours)

BOOKS RECOMMENDED:

1. **Conway J.B.:** *A course in Functional Analysis*, Springer-Verlag, New York, 1990.
2. **Goffman C. and Pedrick G.:** *First course in in functional analysis*, Prentice Hall of India, New Delhi, 1987.
3. **Simmons G.F.:** *Topology and Modern Analysis*, Mc Graw-Hill, New York, 1963.
4. **Taylor A.E.:** *Introduction to Functional Analysis*, John Wiley & sons, New York, 1958.
5. **W. Rudin:** *Functional Analysis*, Mc Graw-Hill, New York, 1991.

Fourth year of integrated M.Sc. (Mathematics)

M.Sc.-IV	Semester – VIII	L	T	P	C
		3	2	0	5

MM 404 PARTIAL DIFFERENTIAL EQUATIONS AND THEIR APPLICATIONS

- **INTRODUCTION TO PDE** **(4 Hours)**
  Formation of PDE, order and degree of PDE, Types of PDE, Initial and Boundary conditions, Types of solution.

- **SOLUTION OF PDE**
  (i). PDE of 1^{st} order, The method of characteristics, The existence and uniqueness theorem, Cauchy problems, Lagrange's and Charpit's method, some special types of equations which can be solved easily by methods other than the general methods. **(12 Hours)**

  (ii). PDE of second and higher orders with constant coefficients, Classification of linear PDE of second order. Reduction to canonical form of PDE **(6 Hours)**

  (iii). The Sturm–Liouville problem, Adjoint and self-adjoint operator, Green's functions and integral representations **(8 Hours)**

- **METHODS OF SEPARATION OF VARIABLES** **(6 Hours)**
  Solution of heat, wave equation in one dimension and Laplace equation.

- **INTEGRAL TRANSFORM METHODS TO SOLVE PDE**. **(6 Hours)**
  Laplace and Fourier method to solve heat, wave equation in one dimension and Laplace equation

(Total Contact Time (Theory): 42 Hours)

BOOKS RECOMMENDED:

1. **Amarnath T. :** *An Elementary Course in Partial Differential Equations (2nd edition)*, Narosa Publishing House, 1997
2. **Evans L. C. :** *Partial Differential Equations, Graduate Studies in Mathematics*, Vol 19, AMS, 1998
3. **John F.:** *Partial Differential Equations, 3rd ed.,* Narosa Publ. Co., New Delhi, 1979.
4. **Prasad Phoolan, Ravindran, Renuka :** *Partial Differential Equations*, New Age International Publication, New Delhi, 2009
5. **Sneddon Ian N.:** *Elements of Partial Differential Equations*, McGraw-Hill Company, New York, 1957.

Fourth year of integrated M.Sc. (Mathematics)

M.Sc.-IV	Semester – VIII	L	T	P	C
		3	2	0	5

MM 406 HIGHER TRANSCENDENTAL FUNCTIONS

- **HYPERGEOMETRIC FUNCTIONS:** **(10 Hours)**
  Hyper geometric equation, series solution near zero, one and infinity, hypergeometric Function, Integral representation. Differentiation of Hypergeometric function. Confluent Hypergeometric function and its Integral representation.

- **THEORY OF GENERATING FUNCTIONS**: **(12 Hours)**
  Generating functions of the form G(2xt-t^2), $e^t\phi(t)$, A(t)exp[-xt/(1-t)] (1-t)$^{-q}$ ∅ [4xt/(1-t)]. Boas and Buck type, Pure recurrence relations Appell, Sheffer and 0-type characterizations of polynomial sets
- **ORTHOGONAL POLYNOMIALS:** **(10 Hours)**
  Introduction, The moment functional, and orthogonality, Existence of OPS, The fundamental recurrence formula, Zeros, Gauss quadrature, Kernel polynomials, Symmetric moment functional, Certain related recurrence relations.
- **BASIC HYPERGEOMETRIC SERIES & THEIR APPLICATIONS:** **(10 Hours)**
  Introduction to Basic Hypergeometric series, q-analogue of orthogonal polynomials, q-Gamma, and q-Beta functions.

(Total Contact Time (Theory): 42 Hours)

BOOKS RECOMMENDED:

1. **Andrews, G.E., R. Askey, and R. Roy:** *Special Functions*, Cambridge Univ. Press, 1999.
2. **Bailey W.N.:** *Generalized Hypergeometric Series*, Stechert-Hafner Service Agency, New York and London, 1964.
3. **Copson E. T.:** *Introduction to the theory of functions of a complex variable*, The English Language Book Society, London, 1978.
4. **Chihara, T. S.:** *Introduction to orthogonal polynomials*, Gordon And Breach Science Publishers Inc., New York, 1978.
5. **Saxena R.K.**, **Mathai A.M., Hans j. Haubold :** *The H – Functions*, Theory & Applications, Springer, 2010

Fourth year of integrated M.Sc. (Mathematics)

M.Sc.-IV	Semester – VIII	L	T	P	C
		3	2	0	5

MM 408 CALCULUS OF VARIATIONS & INTEGRAL EQUATIONS

- **INTRODUCTION OF CALCULUS OF VARIATIONS (10 Hours)**
  Maxima and minima, boundary condition and transition conditions, Variational notation, constraints and Lagrange multipliers, Variable and points, Sturm-Liouville Problems, Hamilton's principle, Lagrange's equations, Generalized dynamical entities, constraints in dynamical systems, small vibrations about equilibrium, normal coordinates.

- **VARIATIONAL PROBLEMS (8 Hours)**
  Variational problems of deformable bodies, useful transformations, Variational problem for Elastic plate, Rayleigh-Ritz method, semi direct method.

- **INTRODUCTION TO INTEGRAL EQUATIONS (8 Hours)**
  Relations between differential and integral equations, The Green's function, Linear Equations in cause and effect, the influence function, Fredholm equations with separable kernels, Hilbert-Schmidt theory, Iterative methods for solving equations of the second kind, The Neumann series, Fredholm theory, Singular Integral Equations, special devices.

- **METHODS TO SOLVE INTEGRAL EQUATIONS (8 Hours)**
  Iterative approximations to characteristic functions, Approximations of Fredholm equations by sets of algebraic equations, Approximate method of undetermined coefficients, The method of collocation, The method of weighting functions, The method of least squares, Approximation of the kernel

- **INTRODUCTION TO DISTRIBUTION THEORY (8 Hours)**
  Some introductory definitions, Test functions, Linear functional and Schwartz-Sobolev theory of distributions, Algebraic operations on distributions, Analytic operations on distributions, The support and singular support of a distributions.

(Total Contact Time : 42 Hours)

BOOKS RECOMMENDED:

1. **Hildebrand F. B.:** Methods of Applied Mathematics, Prentice Hall Inc., 2nd Edition, 1965.
2. **Kanwal R.P.:** Generalized Functions: Theory and Techniques, Academic Press, New York, 1983.
3. **Lovitt W. V.:** Linear Integral Equation, Dover Pub., 1st Ed., 1950
4. **Mikhlin S.G.:** Linear Integral Equation (translated from Russian), Hindustan Book Agency, 1960.
5. **Sneddon I.N.:** Mixed boundary value problems in potential theory, North Holland, 1966.

Fourth year of integrated M.Sc. (Mathematics)

M.Sc.-IV	Semester – VIII	L	T	P	C
		3	1	0	4

CO 430 COMPUTER NETWORKS

- **INTRODUCTION** **(03 Hours)**
  Overview of network and data communication, Data Communications, Computer Networking, Protocols and Standards, types of Network, Network Topology, Protocol hierarchies, and design issues of layers, Interfaces and services. Reference Model: The OSI reference model, TCP/IP reference model, network standards.
- **PHYSICAL LAYER** **(06 Hours)**
  Data and transmission techniques, Multiplexing, Transmission media, Asynchronous Communication, Wireless transmission, ISDN, ATM, Cellular Radio, Switching techniques issues.
- **DATA LINK LAYER** **(08 Hours)**
  Layer design issues, services provided to network layers, Framing, Error control and Flow control, Data link control and protocols – Simplex protocol, Sliding window protocol
- **MEDIUM ACCESS SUBLAYER** **(08 Hours)**
  Channel Allocations, Multiple Access protocols- ALOHA, CSMA, CSMA/CD protocols, Collision free protocols, Limited contention protocols, LAN architectures, IEEE 802 and OSI, Ethernet(CSMA/CD), Bus, Token Ring, DQDB, FDDI, Bridges and recent developments.
- **NETWORK LAYER** **(08 Hours)**
  Network Layer design issue, Routing algorithms and protocols, Congestion Control Algorithms, Internetworking, Addressing, N/W Layer Protocols and recent developments.
- **TRANSPORT LAYER** **(06 Hours)**
  Transport services, Design issues, transport layer protocols, Congestion Control, QOS and its improvement.
- **APPLICATION LAYER** **(03 Hours)**
  Client Server Model , DNS, SMTP, FTP, HTTP, WWW and recent development
- Tutorials will be based on the coverage of the above topics separately **(14 Hours)**

(Total Contact Time: 42 Hours + 14 Hours = 56 Hours)

BOOKS RECOMMENDED:

1. **Comer Douglas E.:**" Internetworking with TCP/IP Volume – I", 3/E Pub. PHI,1991
2. **Forouzan B. :**" Data Communication And Networking ", 5/E,TMH,1997
3. **Stevens W. Richard:** "TCP/IP Illustrated Volume-I", Pub. Addison Wesley,1994
4. **Tanenbaum :** "Computer Network" ,4/E, PHI ,1996
5. **William Stalling:** "Data and Computer Communication", 8/E, Prentice Hall, 2006

M.Sc.- V (SEMESTER – IX)

Fifth year of integrated M.Sc. (Mathematics)

M.Sc.- V	**Semester – IX**	**L**	**T**	**P**	**C**
		3	**2**	**0**	**5**

MM 501 ELEMENTS OF STATISTICS

- **INTRODUCTION (6 Hours)**
  Reorientation of Axiomatic Definition of Probability, Independent events and Independent random variables, Bayes Theorem.

- **BASIC DISTRIBUTION (8 Hours)**
  Discrete random variable distribution: binomial, Poisson, geometric, Negative binomial, hypergeometric.
  Continuous random variable distribution: normal, uniform, gamma, Weibull, Chi Square, t and F.(univariate and multivariate); Expectations and moments ,moment generating function, marginal and conditional distribution in case of multivariate, covariance matrix. Coefficients of skewness &kurtosis.

- **CORRELATION & REGRESSION (8 Hours)**
  Correlation between two variables partial correlation, Karl Pearson's method, Spearmen's rank coefficient of correlation ,Repeated rank, Concurrent deviation method, Regression, coefficients of regression, their properties ,multiple regression and it applications

- **ESTIMATION (10 Hours)**
  least square approa ch, maximum likelihood method, moment estimation. Test of significance for large sample, Null hypothesis, Alternative hypothesis, Test of hypothesis Types of errors, Reliability of sample, confidence limits, Small sample, Chi Square Test, t-Test, F-Test.and their applications.

- **TIME SERIES ANALYSIS (10 Hours)**
  Analysis of time series, Elementary methods of its analysis, trend, Method of moving average, Method of least square , Short term fluctuation ,Random fluctuations.

(Total Contact Time (Theory): 42 Hours)

BOOKS RECOMMANDED:

1. **Blake I:** *An Introduction to Applied Probability*, John Wiley & Sons, 1979.
2. **Catttergee, S** and **Price, P:** *Regression analysis by examples*, Second edition, John Weily & Sons, 1991.
3. **David Stirzaker:** *Elementary Probability,* Cambridge University press, 1994.
4. **Des Raj and Chandak:** *Sampling theory*, Narosa publishing, 1998.
5. **Murphy M N.:** *Sampling theory and methods*, Statistical publishing society, Calcutta, 1995

Fifth year of integrated M.Sc. (Mathematics)

M.Sc.- V	**Semester – IX**	**L**	**T**	**P**	**C**
		3	**2**	**0**	**5**

MM 503 DIFFERENTIAL GEOMETRY

- **THEORY OF CURVES (15 Hours)**

  Curves in R^3 , Curvature and Torsion, Frenet-Serret formulae, Representation of a curve by its curvature, Fundamental, Existence and Uniqueness theorem for space curves, Surfaces, Tangent vectors to surfaces, The First fundamental form and arc length, Normal curvature, Geodesic curvature, Gauss's formulas, Geodesics. Parallel vector Fields along a curve and parallelism, The second fundamental form and the Weingarten map, Principal, Gaussian, Mean and normal curvatures.

- **THEORY OF SURFACES (12 Hours)**

  Riemannian curvature and Gauss's theorem Egregium, Isometries and Fundamental theorem of surfaces, Surfaces of constant curvature, Fenchel's Theorem, The Fary-Milnor Theorem, Simple curvature results for surfaces, Geodesic Coordinate patches, Orientability and angular variation of surfaces, The Gauss-Bonnet Formula, The Gauss-Bonnet Theorem and Euler Characteristics.

- **THEORY OF MANIFOLDS (15 Hours)**

  Definition and examples of topological manifolds, Differentiable manifolds, Differentiable functions, Rank of a mapping, Immersions, Sub manifolds, Lie Groups, Tangent vectors and the Tangent space, Vector fields, The Lie Algebra of Vector Fields on a Manifold, Frobenius Theorem, An application of Frobenius Theorem.

(Total Contact Time (Theory): 42 Hours)

BOOKS RECOMMANDED:

1. **Boothby W. M.:** *An introduction to differentiable manifolds and Riemannian geometry*, (Revised Second Edition), Academic Press.
2. **Millman R.S. and Parker G.D.:** *Elements of Differential Geometry*, Prentice- Hall Inc.
3. **Pressley:** *Elementary Differential Geometry*, Springer Undergraduate Text Series, Springer Publications.
4. **Thorpe J. A.:** *Introduction to Differential Geometry*, Springer-Verlag.
5. **Tu L. W.:** *An introduction to Manifolds*, Springer Publications.

Fifth year of integrated M.Sc. (Mathematics)

M.Sc.- V	**Semester – IX**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

MM 505 ELEMENTARY NUMBER THEORY

- **INTRODUCTION (6 Hours)**
  Divisinbility, Greatest Common Divisor(gcd), Euclidean Algorithm, Primes and their elementary properties, Fundamental theorem of Arithmatic.

- **CONGRUENCE RELATION (12 Hours)**
  Congruence and their basic properties, Chinese Remainder Theorem, Euler's phi – function,Fermat's Little Theorem, Wilson's Theorem, Euler's theorem and its application in Cryptography.

- **ARITHMATIC FUNCTIONS (12 Hours)**
  Graetest integer function, Arithmatic functions, Mobius inversion formula, Fibonacci numbers, Representation of an intehger as sum of two and four squares,
  Diophantine Equations: $ax + by = c$, $x^2 + y^2 = z^2$ and $x^4 + y^4 = z^4$.

- **RESIDUES (12 Hours)**
  Residue classes and Residued residue classes, Quadratic residues, Legendre symbol, Gauss's Lemma about Legendre symbol, law of quadratic reciprocity, Jacobi symbol, primitive roots and indices.

(Total Contact Time : 42 Hours)

BOOKS RECOMMENDED:

1. **Apostol T.:** "Introduction to Analytic Number Theory", Springer-Verlag, 1976
   Baker A.: "A Concise Introduction to the Theory of Numbers", Cambridge University Press, 1990.
2. **Burton D.M.:** "Elemmentary Number Theory", 6th Edition, McGraw-Hill, 2007.
3. **Hardy G. H. and Wright E. M.:** "An Introduction to the Theory of Numbers" 4th Edition, OUP, 1975.
4. **Niven I. , Zuckerman H. S. and Montgomery L.:** "An Introduction to the Theory of Numbers",6th Ed., Wiley, New York, 2003.

Fifth year of integrated M.Sc. (Mathematics)

M.Sc.-V	Semester – IX	L	T	P	C
		3	0	2	4

MM 507 MATHEMATICAL MODELING & SIMULATION

- **MATHEMATICAL MODELING**

  INTRODUCTION: (8 Hours)
  Introduction to mathematical modeling, types of models, characteristics of MM, framework of MM, validation of Mathematical model.

  SOME CASE STUDIES (12 Hours)
  Models based on system of algebraic equations, Models based on ordinary differential equations, Models based on system of 1^{st} order ordinary differential equations.

- **SIMULATION**

  INTRODUCTION (12 Hours)
  Introduction to simulation, types of simulation, simulation methodology, random number generation, monte- carlo simulation, simulation of continuous system, discrete event simulation. Design of experiments, Validation

  SOME CASE STUDIES (10 Hours)
  Simulation of queuing system, water reservoir system, inventory control and forcasting, PERT network, regression analysis.

(Total Contact Time (Theory) : 42 Hours)

BOOKS RECOMMENDED:

1. **Caldwell J., Douglas K. S. Ng, Caldwell Jim:** *Mathematical Modelling: Case Studies and Projects (Texts in the Mathematical Sciences)*, Springer Netherlands, 2004.
2. **Deo Narsingh**: *System Simulation with Digital Computer*, PHI New Delhi, 2006.
3. **Frank L. Severance:** *System Modeling, and Simulation: An Introduction*, John Wiley, 2001.
4. **Gordon Geoffrey:** *System Simulation*, PHI, India, 2007
5. **Kapoor J.N.:** *Mathematical Modeling*, New Age International (p) Limited, 1998.
6. **Kapoor J.N.:** *Mathematical Models in Biology and Medicine*, East-West Press, New Delhi, 2000.

Fifth year of integrated M.Sc. (Mathematics)

M.Sc.- V	**Semester – IX**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

MM 511 ADVANCED OPERATIONS RESEARCH

- **INTRODUCTION** **(3 Hours)**
  Nature and scope of Operations Research, Convex sets and convex functions and their Properties.

- **NON-LINEAR PROGRAMMING** **(12 Hours)**
  Kuhn-Tucker conditions, Lagrange's theory, Duality theory, Search techniques - one variable and several variables, Pontryagin's maximum principle and its applications.

- **DYNAMIC PROGRAMMING AND ITS APPLICATIONS** **(5 Hours)**
  Introduction, Nature of dynamic programming, Deterministic processes, Non-Sequential discrete optimization, Allocation problems, Assortment problems, Sequential discrete optimization, Long-term planning problem, Multi-stage decision process, Application of Dynamic Programming in production scheduling and routing problems.

- **QUEUING THEORY** **(7 Hours)**
  Basic Structures of queuing models, Poisson queues –M/M/1, M/M/C for finite and infinite queue length, Non-Poisson queue -M/G/1, Machine Maintenance (steady state).

- **INVENTORY MODELS** **(7 Hours)**
  Inventory control -Deterministic including price breaks and Multi-item with constraints, Probabilistic (with and without lead time)

- **GOAL PROGRAMMING** **(5 Hours)**
  Introduction, Difference between LP and GP approach, Concept of Goal Programming, Graphical solution-method of Goal Programming, Modified simplex method of Goal Programming.

- **GEOMETRIC PROGRAMMING** **(5 Hours)**
  Geometric programming (both unconstrained and constrained)

(Total Contact Time: 44 Hours)

BOOKS RECOMMENDED:

1. **Beale, E. M. L. and Mackley, L.:** *"Introduction to Optimization"*, John Wiley, 1988
2. **Hiller, F. S. and Lieberman:** *"Introduction to Operations Research", 6th Ed.,* McGraw-Hill International Edition, Industrial Engineering Series, 1995.
3. **Rao, S.S.:** "*Optimization Theory and Applications*", *2nd Ed.,* Willey Eastern Ltd., New Delhi, 1985.
4. **Taha, H. A., "***Operations Research: An Introduction", 8th Ed.,* Prentice

Fifth year of integrated M.Sc. (Mathematics)

M.Sc.- V	**Semester – IX**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

MM 513 ADVANCED FLUID MECHANICS

- **REVIEW OF FUNDAMENTAL EQUATIONS (06Hours)**
  Equation of Continuity, Euler's equation of motion, Bernoulli's equation, Momentum equation, Nature of stresses in fluids, viscosity, Navier-Stokes equations, The equations of motion expressed in Cylindrical and Spherical polar coordinates, Equation of state for gases.

- **VISCOUS FLOW PHENOMENA (12 Hours)**
  Laminar and turbulent motion, Flow between two coaxial rotating Cylinders, Unsteady flows with plane boundary, Plane Coutte flow with porous wall, Steady Flow caused by a rotating plane, Reynolds and Froud's numbers, Flow at low Reynold's number, Dimensionless form of the Stokes equation, uniqueness theorem for Stokes flow, Minimum-dissipation-of-energy theorem, The Lorentz Reciprocal theorem, Boundary conditions at a Fluid- Fluid Interface, Liquid droplet falling under gravity.

- **VISCOUS FLOW AT HIGH REYNOLD'S NUMBER (08Hours)**
  Observed charcter of the flow: Boundary Layers, Flow past a Semi-infinte flat plate, Flow in the Wake of a Flat Plate, Boundary layers equations for a curved wall, Similarity solutions, Approximate solutions, Basics of Jet flow.

- **COMPRESSIBLE FLUID FLOW (08Hours)**
  Internal energy of a gas, Specific Heats of a substance: Case of a Perfect Gas, Functions of State: Entropy and other Thermodynamics Notions, Compressibility Effects in real Fluids, The speed of a sound in a gas, Equations of motion of an Inviscid Gas.

- **WATER WAVES (08Hours)**
  Occurrence of waves , The mathematical description of Wave motion , Gravity waves, Wave energy, Effect of Surface Tension, Standing waves, Waves in a canal, Waves on the surface of a Uniform stream.

(Total Contact Time: 42 Hours)

BOOKS RECOMMENDED:

1. **Fay, James A.:** *Introduction to fluid mechanics*, Cambridge, MA: MIT Press, 1994.
2. **Kundu, Pijush K., and Cohen Ira M.: Fluid Mechanics**, 3rd ed. Burlington, MA: Elsevier, 2004.
3. **O'Neill M. E. and Chorlton F. :** *Ideal and Incompressible fluid dynamics*, Publisher: John Wiley & Sons, 1986
4. **O'Neill M. E. and Chorlton F. :** *Viscous and compressible fluid dynamics*, Publisher: John Wiley & Sons, 1986
5. **Tritton***: D.* ***Physical Fluid Dynamics,*** 2nd Ed. New York, NY: Oxford University Press, 1988.

Fifth year of integrated M.Sc. (Mathematics)

M.Sc.- V	**Semester – IX**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

MM 515 APPROXIMATION THEORY

- **INTRODUCTION AND PRELIMINARY OBSERVATION (8 Hours)**
  Concept of best approximation in a Normed linear space, Existence of best Approximation, Uniqueness problem, Uniform convexity, strict convexity, continuity of best approximation operator.

- **WEIERSTRASS THEOREM AND BERNSTEIN POLYNOMIAL (5 Hours)**
  The Weierstrass Theorem., Bernstein polynomials, Bernstein Constructive proof of convergence

- **OPERATORS & TOOLS (7 Hours)**
  Monotone operators, Korovkin theorems, Modulus of continuity and its properties, Lipschitz class & their properties**.**

- **BEST UNIFORM APPROXIMATION (10 Hours)**
  Sufficient Conditions for Uniqueness of the Best Approximation, Characterization of the Best Approximation in the Uniform Norm, Jackson Theorems and It's Applications, characterization theorem, Haar conditions, Alternation theorem.

- **MORE THEOREMS ON APPROXIMATION (12 Hours)**
  Markoff systems, Theorem of de la Valle Poussin, Strong Unicily theorem, Haar's theorem, The convergence of the Jackson theorems, Bernstein inequality, Bernstein theorems, Zygmund theorem**.**

(Total Contact Time (Theory) : 42 Hours)

BOOKS RECOMMENDED:

1. **Korovkin P. P.:** *Linear Operators and Approximation Theory*, Hindustan Publishing Corporation, 1960.
2. **Lorentz G. G.:** *Berstein polynomials*, Univ. of Toronto Press, Toronto 1953.
3. **Mhaskar H. N., Pai D. V.:** *Fundamentals of Approximation theory*, Narosa Publishing House, Delhi, 2000.
4. **Natanson I. P.:** *Constructive Function Theory*, Vol. – 1: Uniform Approximation, NY: Frederick Ungar 1st edition, 1964.
5. **Powell M.J.D.:** *Approximation Theory & Methods*, Cambridge Univ. Press, 1981.

Fifth year of integrated M.Sc. (Mathematics)

M.Sc.- V	**Semester – IX**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

MM 517 ADVANCED NUMERICAL TECHNIQUES

- **SYSTEM OF LINEAR EQUATIONS (5 Hours)**
  Condition number and ill conditioned systems. Matrix and vector norms. Error bounds. Wilkinson's algorithm for ill-conditioned systems. Tridiagonal and pentagonal system of equations.

- **COMPUTING OF EIGENVALUE AND EIGEN VECTOR (5 Hours)**
  Given's, Householder, Q-R and Inverse Method, Stability Analysis

- **NUMERICAL SOLUTION OF ODE (6 Hours)**
  Initial Value Problems for Ordinary Differential Equations: multi-step methods, predictor and corrector scheme, stability and convergence analysis.

- **FINITE DIFFERENCE METHOD TO SOLVE ODE (6 Hours)**
  Difference approximation to derivatives, Shooting methods, Difference schemes, Boundary conditions of different kind. Convergence of difference scheme,

- **FINITE DIFFERENCE METHOD TO SOLVE PARABOLIC PDE (6 Hours)**
  Explicit and implicit Difference schemes in one and two space dimensions. Consistency, stability and convergence of difference scheme.

- **FINITE DIFFERENCE METHOD TO SOLVE ELLIPTIC PDE (6 Hours)**
  Dirichlet, Neumann and mixed problems. Direct factorization methods and successive over-relaxation (S.O.R.). ADI and conjugate gradient methods.

- **FINITE DIFFERENCE METHOD TO SOLVE HYPERBOLIC PDE (8 Hours)**
  First order hyperbolic systems in one and two space dimensions-stability and convergence. Second order equations in one and two space dimensions. Stability: matrix method, Von-Neumann and energy methods, Lax-Richtmyer equivalence Theorem, consistency and convergence results

Total Contact Time (Theory): 42 Hours)

BOOKS RECOMMENDED:

1. **Atkinson K.E.:** *An Introduction to Numerical Analysis*, Wiley, 1989
2. **Jain M. K., Iyenger S.R.K., Jain R. K.:** *Numerical Methods for Scientific and Engineering Computation*, New Age Publication, New Delhi, 2009
3. **Jain M. K.:** *Numerical Solution of Differential Equations*, New Age Publication, New Delhi, 2008.
4. **Mitchell R. and Griffiths S. D. F.:** *The Finite Difference Methods in Partial Differential Equations*, Wiley and Sons, NY, 1980.
5. **Smith G.D.***: Numerical Solutions of Partial Differential Equations*, 3rd Edition, Calrendorn Press, Oxford, 1985.

Fifth year of integrated M.Sc. (Mathematics)

M.Sc.- V	**Semester – X**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

MM 570 BIO-MATHEMATICS

- **MATHEMATICAL EPIDEMICS** **(09 Hours)**
  Epidemic Models; Deterministic models with and without Removal, General Deterministic Models with removal and Immigration. Control of and Epidemic, Stochastic Epidemic Model without removal.
- **MODELLING GENETICS** **(09 Hours)**
  Models in Genetics; Basic models for Inheritance, Further Discussion of Basic Model for Inheritance of Genetic Characteristics, Models for Genetic Improvement: Selection and Mutation, Models for Genetic Inbreeding.
- **MODELLING BIODIFFUSION** **(07 Hours)**
  Pharmaco-Kinetics, Compartmental Models in terms of System of Differential Equations. Bio-Diffusion, Diffusion of Drugs. Trans-Capillary Exchange. Oxygenation and De Oxygenating of Blood. Cardio Vascular Flow Patterns. Temperature regulation in Human Subjects.
- **BIOLOGICAL DATA ANALYSIS** **(08 Hours)**
  Curve Fitting and Biological Modeling; Fitting curves to Data, The Method of Least Squares, Polynomial curve Fitting.

(Total Contact Time (Theory): 42 Hours)

REFERENCE BOOKS:

1. **Allman Elizabeth S. and Rhodes John A*.:*** *Mathematical Models in Biology*, An Introduction, 2004.
2. **Cullen*:*** *Linear Models in Biology (Pharmacy)*, Cambridge University Press, December, 2004.
3. **Fung F.C.:** *Fluid Mechanics*, Tata McGraw-Hill, 2005.
4. **Kapur J.N.:** *Mathematical Models in Biology and Medicine*, New Delhi, East-West Press, 1981.
5. **Kleinstreuer Clement:** *Bio-Fluid Dynamics*, CRC Taylor and Francis, 2006.

Two year of M.Sc. (Mathematics)

M.Sc.- II	**Semester – III**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

MM 521 SOBOLEV SPACE

- **DISTRIBUTION** **(4 Hours)**
  Test function spaces and distributions, convergence distribution derivatives.

- **FOURIER TRANSFORM** **(6 Hours)**
  L^1 –Fourier Transform, Fourier transform of a Gaussian, L^2 -Fourier transform, Inversion formula, L^p - Fourier transform, Convolutions.

- **SOBOLEV SPACES** **(8 Hours)**
  The Spaces $W_{\infty}^{l,p}(\Omega)$ and $W^{l,p}(\Omega)$,their simple characteristic properties, density results, Min and Max of $W^{l,P}$ -Functions, The space $H^1(\Omega)$ and its Properties, Density results. Dual Spaces, Fractional Order Sobolev Spaces, Trace spaces and Trace Theory.

- **IMBEDDING THEOREM** **(6 Hours)**
  Continous and compact imbeddings of sobolev spaces into Lebesgue Spaces, Sobolev imbedding Theorem, Rellich-Kondrasov Theorem.

- **WEIGHTED SPACES** **(8 Hours)**
  Definition, motivation, examples of practical importance, Special weights of power type, General Weights .Weighted Lebesgue Space $P(\Omega,\sigma)$ weighted Sobolev Spaces, $W^{k,p}(\Omega,\sigma)$, $W_0^{k,p}(\Omega,\sigma)$ and their properties.

- **INEQUALITIES** **(10 Hours)**
  Methods of local co-ordinates, the classes $C^0, C^{0,k}$,Holder's condition, partition of unity, the class K(x_0) including cone property. Hardy inequality, Jensen's inequality, Young's inequality, Hardy-Littlewood-Sobolev inequality, Sobolev inequality and its various versions.

(Total Contact Hours: 42 Hours)

BOOKS RECOMMANDED:

1. **Adams R. A.:** *Sobolev Spaces*, Academic Press, Inc. 1975.
2. **Kesavan S.:** *Topics in Functional Analysis and Applications*, Wiley Eastern Limited, 1989.
3. **Kufner A.:** *Weighted Sobolev Spaces*, John Wiley & Sons, Ltd., 1985.
4. **Lieb E. H. and Loss M.:** *Analysis,* Narosa Publishing House, 1997.
5. **Pathak R. S.:** *A Course in Distribution Theory and Applications*, Narosa publishing House, 2001.

M.Sc. – V (SEMESTER – X)

Fifth year of Five years Integrated M. Sc.(Mathematics)

M. Sc. V, Semester – X	**L**	**T**	**P**	**C**
	3	**1**	**0**	**4**

MM 522 ADVANCED INTEGRAL TRANSFORMS

- **FINITE LAPLACE TRANSFORMS**: **(06 Hours)**
  Introduction, Definition of finite Laplace transforms with examples, Basic operational properties of finite Laplace transforms, Application of finite Laplace transforms and Tauberian theorem.

- **FINITE FOURIER COSINE AND SINE TRANSFORMS:** **(08 Hours)**
  Introduction and definition of finite cosine and sine transforms with examples, Basic properties of finite Fourier cosine and sine transforms, Application of finite Fourier cosine and sine transforms.

- **HILBERT AND STIELTJES TRANSFORMS (HST):** **(08 Hours)**
  Introduction and definition of HST with examples, Basic operational properties of HST, Hilbert transform in the complex plane and its applications, Inverse theorem for Stieltjes transform and its application, Asymptotic expansion of the one sided Hilbert transform, The generalized Stieltjes transform, Basic properties of the generalized Stieltjes transforms with applications.

- **Z-TRANSFORMS:** **(08 Hours)**
  Introduction, Dynamic linear systems and Impulse response, Definition of the Z-transforms and examples, Basic operational properties, The inverse Z-transform and examples, Application of Z-transforms to finite difference equations.

- **FRACTIONAL CALCULUS AND ITS APPLICATIONS** **(06 Hours)**
  Introduction, Historical Comments, Fractional Derivatives and Integrals, Applications of Fractional Calculus

- **WAVELETS AND WAVELET TRANSFORMS** **(06 Hours)**
  Continuous Wavelet Transforms The Discrete Wavelet Transform, Examples of Orthonormal Wavelets.

(Total Contact Time (Theory): 42 Hours)

BOOKS RECOMMENDED:

1. **Boas M. L.:** *Mathematical methods in Physical Sciences*, John Wiley & Sons, 1983.
2. **Davies B.:** *Integral Transforms and their Applications*, Springer-Verlag, Vol. 25, 1978.
3. **Debnath L., Dambaru Bhatta:** Integral Transforms and their Applications, CRC Publication, 2007.
4. **Gupta P. K.:** *Integral Transforms*, Krishna Prakashan, Meerut, 1990.
5. **Sneddon I. N.:** *The Use of integral Transforms*, by. Tata McGraw Hill, 1979.

Fifth year of integrated M.Sc. (Mathematics)

M.Sc.- V	**Semester – X**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

MM 524 COMPUTATIONAL FLUID DYNAMICS

- **GOVERNING EQUATIONS OF FLUID DYNAMICS (10 Hours)**
  The Continuity equation, The Momentum equation, The energy equation, Physical boundary conditions, Bernoulli's theorem, Kelvin's circulation theorem and potential flow, Equations for viscid flow (the Navier-Stokes equations),Equations for Inviscid flow(the Euler's equations), Convection-diffusion equation.

- **RE-ORIENTATION OF PARTIAL DIFFERENTIAL EQUATIONS (04 Hours)**
  Introduction, Classification of Quasi-linear partial differential equations, General behaviour of Hyperbolic, Parabolic and Elliptic equations

- **BASIC ASPECTS OF DISCRETIZATION (04 Hours)**
  Introduction, Introduction to finite differences, Difference equations, Explicit and Implicit approaches, Errors and an analysis of stability.

- **SOME SIMPLE CFD TECHNIQUES (12Hours)**
  Introduction, Lax-Wendroff Technique, MacCormack's Technique, Application to unsteady, two dimensional inviscid flow(the Euler's equation), Relaxation Technique and its application to inviscid, incompressible, two dimensional irrotational flow.

- **NUMERICAL SOLUTIONS TO PARTIAL DIFFERENTIAL EQUATIONS (12 Hours)**
  Techniques of numerical discretization; The Finite Difference Method, The Finite Element Method, The Finite Volume Method, Numerical discretization of simple equation using Finite Difference, Finite Elements and Finite Volumes, Comparison of the discretization techniques, Producing a solution from the discrete equations; convergence and stability, Solving the simultaneous equations.

(Total Contact Hours: 42 Hours)

BOOKS RECOMMENDED:

1. **Anderson John David:** *Computational Fluid Dynamics: The Basics with Applications*, Publisher: McGraw Hill, 1995, **Edition:** 6.
2. **Chung T.J.:** *Computational Fluid dynamics*, Publisher: Cambridge University Press,2002.
3. **Ferziger Joel H. and Milovan Peric:** *Computational Methods for Fluid Dynamics*, Publisher: Springer Verlag, Edition:2Pub., 1999,
4. **Pieter Wesseling:** *Principles of Computational Fluid Dynamics***,** Publisher Springer Verlag Pub., 2001
5. **Shaw C.T.**: *Using Computational Fluid Dynamics*, Publisher Prentice Hall, 1992.

Fifth year of Five years Integrated M. Sc.(Mathematics)

M. Sc. V,	**Semester – X**	**L**	**T**	**P**	**C**
		3	**2**	**0**	**5**

MM 526 FINITE ELEMENT METHOD

- **INTRODUCTION** **(04 Hours)**
  Basic concept of Finite Element Method, Approximation of the Circumference of a circle, Approximate determination of the centre of mass, Temperature variation in a composite cylinder consisting of two coaxial layers in perfect thermal contact

- **INTEGRAL FORMULATIONS AND VARIATIONAL METHODS** **(10 Hours)**
  Introduction, Boundary value problem, Initial value problem, Boundary and Initial value problem, Integral relations, Functionals, Weak formulation of Boundary value problems, Rayleigh-Ritz, Method, Method of Weighted Residuals; Petrov-Galerkin method, Galerkin method, Least squares method, Collocation method, Applications to solving simple problems from ODEs

- **FINITE ELEMENT ANALYSIS OF ONE-DIMENSIONAL PROBLEMS** **(12 Hours)**
  Introduction, Basic steps of Finite Element Analysis for Model Boundary value problem; Discretization of the domain, Weak form, Approximation of the solution, Finite Element Model, Connectivity of elements, Imposition of boundary conditions, Solution of equations, Application to temperature distribution in the wall with three different sets of boundary conditions.

- **FINITE ELEMENT ANALYSIS OF TWO-DIMENSIONAL PROBLEMS** **(10 Hours)**
  Model Boundary value problem, Finite Element Discretization, Weak form, Finite Element Model, Interpolation functions, Evaluation of Element matrices for Linear triangular element and Linear Rectangular element, Assembly of element equations, Finite element analysis of the Poisson equation in a square region.

- **PROGRAMMING ASPECTS** **(06 Hours)**
  Mesh generation, Element equations, Assembly , Modification of equations with the help of boundary conditions, Solution and comparison with closed form solutions

(Total Contact Time (Theory): 42 Hours)

BOOKS RECOMMENDED:

1. **Hutton David V.:** *Fundamentals of Finite Element Analysis*, McGraw-Hill companies,Inc.2004
2. **Lewis R. W., Nithiarasu P. and Seetharamu K. N.:** *Fundamentals of the Finite Element Method for Heat and Fluid Flow*, John Wiley & Sons, Ltd, 2004.
3. **Reddy J.N.:** *An introduction to the Finite Element Method*, Publisher: Mc-Graw-Hill, Inc., 1984.
4. **White R.E.:** *An introduction to the Finite Element Method with applications to Nonlinear problems*, publisher: John Wiley & Sons,1985.
5. **Zienkiewicz O.C., Taylor R.L., Nithiarasu P.:** *The finite element method for fluid dynamics*, Elsevier, 2009.

Fifth year of integrated M.Sc. (Mathematics)

M.Sc.- V	**Semester – X**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

MM 528 CRYPTOGRAPHY

- **INTRODUCTION** **(10 Hours)**
  Mathematical background, Complexity theory, Modular arithmetic, finite fields.

- **SYMMETRIC KEY ENCRIPTION** **(12 Hours)**
  Introduction to stream ciphers, design of LFSR based stream ciphers, block cophers. Substitution- permutation networks (SPN), linear attack on SPN, Introduction to Data Encryption Standards (DES) and Advanced Encryption Standards (AES).

- **CRYPTOGRAPHIC HASH FUNCTIONS** **(10 Hours)**
  Security of hash functions, the random oracle model, iterated hash functions, The Merkle Damgard construction, message authentication codes, probabilistic signatures.

- **PUBLIC KEY CRYPTOGRAPHY** **(10 Hours)**
  The RSA cryptosystem and factoring integers, attacks on RSA, digital signatures, the secure application of RSA encryption.

(Total Contact Time: 42 Hours)

BOOKS RECOMMENDED:

1. **Hans D. and Helmut K.:** "*Introduction to Cryptography, Principles and Applications*, Springer, 2nd Edition, 2007.
2. **Koblitz N. :** *A course in number theory and cryptography*, Springer, 2nd Edition, 1994**.**
3. **Menezes A., Oorschot P. and Vanstone S.:** "*Handbook of Applied Cryptography*", CRC Press, 1997.
4. **Stinson D:** "*Cryptography: Theory and Practice", 2nd Edition*, Chapman & Hall, 2002
5. **William Stallings:** "*Cryptography and Network Security – Principles and Practice*", 4th Edition, Pearson Education,2005.

Fifth year of integrated M.Sc. (Mathematics)

M.Sc.- V	**Semester – X**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

MM 532 LEBESGUE MEASURE AND INTEGRATION THEORY

- **REVIEW : RIEMANN AND RIEMANN-STIELTJES INTEGRAL (6 Hours)**
  Necessary and Sufficient conditions for existence of Riemann-Stieltjes Integrals, Change of Variable in a Riemann-Stieltjes Integral, Mean-value theorems for Riemann Stieltjes Integrals, Fundamental theorem of Integral calculus.

- **MEASURABLE SETS (8 Hours)**
  σ-algebras of Sets, Borel subsets of R, Lebesgue outer measure and its properties, σ-algebra of measurable sets in R, Non-measurable set, Example of measurable set which is not a Borel Set, Lebesgue Measure and its properties,

- **MEASURABLE FUNCTIONS AND CONVERGENCE THEOREMS (9 Hours)**
  Measurable functions and their properties, Convergence theorems- Egoroff theorem, Fatou's Lemma, Dominated convergence theorem, Littlewood's three principles, Comparison of Lebesgue and Riemann integrals.

- **DIFFERENTIATION (7 Hours)**
  Differentiation of monotone functions, Dini's Derivaties, Functions of Bounded variation, Absolute continuity, Differential of an integral.

- **L^P-SPACES (7 Hours)**
  Introduction to L^p-spaces, Holder's and Minkowski's inequalities, Completeness of L^p-spaces, Convergence in mean, Bounded linear functions on L^p-spaces, Riesz Representation theorem

- **SIGNED MEASURE (5 Hours)**
  Measure spaces, Signed measure, decompotion theorem, The Radon-Nikodym Theorem and its applications.

(Total Contact Time (Theory): 42 Hours)

BOOKS RECOMMENDED:

1. **Barra G. D.:** *Measure theory and Integration*, New Age International, 1987.
2. **Halmos, P.R.:** *Measure Theory*, Van Nostrand, Princeton, New Jersey, 1950.
3. **Jain, P.K. and Gupta, V. P.:** *Lebesgue Measure and Integration*, New Age International (P), New Delhi, 1986 (Reprint 2000).
4. **Rana, I. K.:** *An introduction to measures and Integration*, Narosa Pub. 2000.
5. **Royden, H. L.:** *Real Analysis*, second edition, Macmillan, New Yark 1968.

Fifth year of integrated M.Sc. (Mathematics)

M.Sc.- V	**Semester – X**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

MM 534 COMPUTATIONAL BIOLOGY

- **BIOINFORMATICS**
  chronological history of Bioinformatics, evolution of Bioinformatics, information networks, protein and genome information resources, DNA sequence analysis, pairwise alignment techniques, multiple alignment techniques, secondary databases, analysis packages.

- **MODELING MOLECULAR EVOLUTION**
  Background of DNA, An Introduction to Probability, Conditional Probabilities, Matrix Models of Base Substitution, Phylogenetic distances. Marcov Chains and Hidden Marcov Models; Marcov Chains, Hidden Marcov Models, Parameter Estimation for HMMs, HMM Model Structure, More Complex Marcov Chains, numerical Stability of HMM Algorithms.

- **PAIRWISE SEQUENCE ALIGNMENT**
  Introduction, The Scoring Model, Alignment algorithm, Dynamic Programming with more Complex Models, Heuristic Alignment Algorithms, Linear Space Alignment.

- **MULTIPLE SEQUENCE ALIGNMENT METHODS**
  What a Multiple Alignment Means, Scoring a Multiple Alignment, Multidimensional Dynamic Programming, Progressive alignment Methods, multiple Alignment by Profile HMM Training.

- **PHYLOGENETICS**
  Building Phylogenetic Trees; the Tree of Life, Background on Trees, Making a Tree from Pairwise distances, Parsimony, Assessing the Trees: the Bootstrap. Simultaneous Alignment and Phylogeny.Probabilistic Approach to Phylogeny; Introduction, Probabilistic Models of Evolution, Calculating the Likelihood for ungapped Alignment.

(Total Contact Time (Theory): 42 Hours)

BOOKS RECOMMENDED:

1. **Attwood T.K. and Parry Smith:** *Introduction to Bioinformatics*, 1st Edition Pearson Education Limited, England, 1999.
2. **Baxevanis and Ouelette B.:** *Bioinformatics, A practical Guide to the analysis of Genes and Proteins*, Wiley- Interscience, 1998.
3. **Krane and Raymer:** *Fundamental Concepts in Bioinformatics*, Pearson Publication, 2003
4. **Lesk Arthur M.:** *Introduction to Bioinformatics,* 3rd Edition, Oxford University Press, NY, 2008.
5. **Waterman M.S.:** *Introduction to Computational Biology*, Chapman & Hall, 1995.