RAJIV GANDHI UNIVERSITY

(A Central University)

RONO HILLS :: DOIMUKH

Arunachal Pradesh, India

DEPARTMENT OF MATHEMATICS

Semester wise Course Structure

M. A./M. Sc.

Mathematics & Computing

w.e.f. 2019-20

M. A./M. Sc. Mathematics Course Structure: 2019-20 (CBCS)

Semester	*Paper Code*	*Course Title*	*Credit Distribution (T:P)*	*Total Credit*	*Contact Hour*
I-SEM	***MATC –401***	*Number Theory*	*5:0*	***25***	***250***
	MATC –402	*Real Analysis*	*5:0*		
	MATC –403	*Algebra*	*6:0*		
	MATC–404	*Mechanics*	*5:0*		
	MATC –405	*Programming In C*	*3:1*		
II-SEM	***MATC–411***	*Complex Analysis*	*5:0*	***25***	***250***
	MATC –412	*Linear Algebra*	*5:0*		
	MATC–413	*Differential Equations*	*4:1*		
	MATC –414	*Topology*	*5:0*		
	MATC –415	*Numerical Computations*	*4:1*		
III-SEM	***MATC–501***	*Fluid Mechanics – I*	*4:0*	***24***	***240***
	MATC–502	*Functional Analysis*	*4:0*		
	MATE–503	*Elective Theory Paper –I**	*4:0*		
	MATE–504	*Elective Theory Paper-II**	*4:0*		
	MATO–50x	***Open Elective Course****	*4:0*		
	MAT-P–509	***Project-I*****	*4:0*		
IV-SEM	***MAT-C –511***	*Fluid Mechanics – II*	*4:0*	***26***	***260***
	MAT-C –512	*Graph Theory*	*4:0*		
	MAT-E –513	*Elective Theory Paper-III**	*4:0*		
	MAT-E –5xx	*Elective Theory Paper-IV**	*4:0*		
	MAT-E–5xx	*Elective Theory Paper-V**	*4:0*		
	MAT-P–525	***Project-II*****	*6:0*		
	Total Credit/Contact Hour			***100***	***1000***

The **Elective papers I, II, III, IV, V will be decided based on the specialization chosen by the student.*

******The Elective Open Course****: Student has to select an open course from the list of open courses offered by various departments other than Mathematics.*

Project-I* *and* ***Project-II****: A student shall be asked to choose a Supervisor/guide at the beginning of the session (notified by the department) III – Semester. After consulting with guide, the students shall be asked to finalize a topic (preferably within first month) for his/her project, and*

finally the students must submit a progress report to the department with a presentation (as notified by the department). The students shall continue with the same project (same topic and same guide) in IV semester, and finally must have to submit a final report in the form of a dissertation with a viva-voce in presents of an external. ***The students are needed to take an Industry and Technical Institutes tour so that they get familiar with the applications of Mathematics in present day Research and Development works, and its recent trends of applicability.*** *Total credit for the* ***Project-I and Project-II is 10 (4+6).*** *Total credit for the* ***Project-I and Project-II is 10(4+6).*** *Doing a project in master degree level will enhance the capacity of the students in solving problems and, further, the students can decide about their future prospects.*
T-Theory, P-Practical, Pt-Project

Open Elective Course in 3rd Semester:

1. *Students have to select any one* ***Open Elective course*** *from following table of* ***3rd Semester****.*

Elective courses in 3rd Semester and 4th Semester:

1. *Students have to select any two* ***Elective courses*** *from following table of* ***3rd Semester****.*
2. *Students have to select any three* ***Elective courses*** *from following table of* ***4th Semester.***

3rd Semester		
Elective Courses ***Any two papers can be selected***		
Semester	***Paper Code***	***Course Title***
III-SEM	***MATE –503***	*Mathematical Methods*
	MATE–504	*Mathematical Programming*
	MATE –505	*Continuum Mechanics*
	MATE –506	*Mathematical Statistics*
	MATE –507	*Differential Geometry*
	Open Elective Course (To be offered to the students of other Departments of Rajiv Gandhi University, Rono Hills)	
	MATO–508A	*Introduction to Mathematics Education*
	MATO–508B	*Computer Fundamentals*
4th Semester (Elective Courses) Any three papers can be selected		
Semester	***Paper Code***	***Course Title***
IV-SEM	***MATE –513***	*Wavelets and Applications*
	MATE –514	*Fuzzy Set Theory and Applications*
	MATE –515	*Operation Research*
	MATE –516	*Measure Theory*
	MATE –517	*Space Dynamics*
	MATE –518	*Algebraic Topology*
	MATE –519	*Stochastic Processes*
	MATE–520	*Rings and Modules*
	MATE–521	*Advanced Functional Analysis*
	MATE–522	*Theory of Distribution and Sobolev Spaces*
	MATE–523	*Biomechanics*
	MATE-524	*Computational Fluid Dynamics*

(*Approved by the BPGS in Mathematics held on 16 May 2019*)

FIRST SEMESTER

MATC – 401: NUMBER THEORY

Maximum marks	: 100 (Terminal–80, Sessional–20)
Term end	: 80
Contact hour per week	: 05
Credits	: 05
Terminal Examination duration	: 3 hours

Outcomes: Number theory is an excellent introduction to history and present day development in mathematics. The students shall able to understand with different methods of proof in the context of elementary number theory and partition theory of analytic number theory.

Unit	Contains	Marks
I	*Arithmetic functions; Examples and properties of some arithmetic functions; Multiplicative arithmetic functions; Dirichlet product of arithmetic functions; Moebius inversion formula; Group properties of arithmetic functions; Completely multiplicative functions.*	**16**
II	*Quadratic congruence; Quadratic residue; Euler's criterion for quadratic residue; Legendre symbol and properties; Quadratic reciprocity law; Jacobi symbol and properties; Polynomial congruence.*	**16**
III	*Linear Diophantine equations; Diophantine equations of second degree; Fermat's Last theorem. Primitive roots and Indices; Fibonacci numbers and their properties; Binet's formula for Fibonacci numbers.*	**16**
IV	*Representations of integers as Sum of two squares; Difference of two squares; Sum of three squares; Sum of four squares.*	**16**
V	*Partitions of integer; Graphical representation and conjugate partition; Partitions into odd parts, partitions into distinct parts, partitions into even parts; Generating functions for partitions; Euler's pentagonal number theorem; Jacobi's triple product identity.*	**16**

Text / Reference Books:

1. *I. Niven, H.S. Zuckerman and H.L. Montgomery: An Introduction to the Theory of Numbers (6th edition); John Wiley and Sons. The New York 2003.*
2. *D. M. Burton: Elementary Number Theory (4 Ed.) Universal Book Stall, New Delhi; 2002.*
3. *T. M. Apostol: Introduction to Analytic Number Theory, Springer International Student Edition, Narosa Publishing House, Fourth Reprint, 1993.*
4. *M. Rosen and K. Ireland: A classical Introduction of Number Theory, Springer, 1982.*
5. *L.E. Dickson: History of the Theory of Numbers (Vol- II, Diophantine Analysis); CPC, New York, 1971.*
6. *N. Koblitz: A course in Number theory and Cryptography, Springer, 2000.*
7. *G.A. Jones and J.M. Jones: Elementary Number Theory; Springer – Verlag, 1998.*
8. *G. E. Andrews: Number Theory, Hindustan Publishing Corporation, New Delhi, 1992.*
9. *S. G. Telan: Number Theory, Tata McGraw Hill Publishing Company Limited, New Delhi, 1996.*

FIRST SEMESTER

MATC – 402: REAL ANALYSIS

Maximum marks	: 100 (Terminal–80, Sessional–20)
Term end	: 80
Contact hour per week	: 05
Credits	: 05
Terminal Examination duration	: 3 hours

Outcomes: Real analysis is the branch of mathematical analysis that studies the behavior of real numbers, sequences and series of real numbers, and real functions. The course includes foundation and some advanced topics.

Unit	Contains	Marks
I	*Uniform convergence, sequence and series of functions, point-wise and uniform convergence, Cauchy's criterion for uniform convergence of a series, uniform convergence and continuity, integration and differentiation. Weirstrass's approximation theorem.*	**20**
II	*Definition and existence of Riemann-Stieltjes integral, properties of R-S integral, integrations and differentiations.*	**10**
III	*Lebesgue exterior measure, Lebesgue measure of sets, theorems on measurable sets. Definition of measurable functions, properties of measurable functions and simple functions.*	**20**
IV	*Lebesgue integral of bounded function, definition and theorem involving Lebesgue integral, relationship of Lebsegue and Riemann integral. Fatou's Lemma, monotone convergence theorem, the general Lebesgue integral, Lebesgue convergence theorem.*	**20**
V	*Functions of bounded variation, basic properties of functions of bounded variation, bounded variation and absolute continuity, differentiation of an integral, integral of the derivative***.**	**10**

Text / Reference Books

1. *H. L. Royden: Real Analysis; PHI, 1995.*
2. *W. Rudin: Principles of Mathematical Analysis, Mcgraw Hills.*
3. *P. K. Jain and V. P. Gupta : Lebesgue measure and integration, Wiley*
4. *Charles Swartz: Measure, Integration and Function spaces, World Scientific*
5. *T. M. Apostol: Mathematical Analysis; Narosa Publishing House, New Delhi, 1985.*
6. *Robert Wrede and Murray R. Spiegel: Advanced Calculus; Schaum's Outline Series, McGraw Hills.*

FIRST SEMESTER

MATC – 403: ALGEBRA

Maximum marks : 100 (Terminal–80, Sessional–20)

Term end : 80
Contact hour per week : 05
Credits : 05
Terminal Examination duration : 3 hours

Outcomes: Students will able to Identify and analyze different types of algebraic structures such as Algebraically closed fields, Splitting fields, Finite field extensions to understand and use the fundamental results in Algebra

Unit	Contains	Marks
I	*Conjugacy class, Normalizer, Centralizer, Centre of a group, class equations, Cauchy Theorem, Sylow's Theorems, Applications of Sylow's theorems.*	**16**
II	*Direct products of finite numbers of groups, Decomposable groups. Normal and Subnormal series of groups, Composition series, Schreier's Refinement Theorem, Jordan Holder theorem, Commutators, Derived subgroups, Solvable groups.*	**16**
III	*Ideals, Principal and Prime ideals. Integral domain and quotients of an integral domain, Divisibility in Commutative rings. PID, UFD and their properties, Eisenstein's irreducibility criterion.*	**16**
IV	*Field theory- Extension of fields. Algebraic and Transcendental numbers, Splitting field. Perfect fields. Existence of finite fields.*	**16**
V	*Galois group, Fundamental theorem of Galois Theory, Galois Group of the general equation, Galois group of a quadratic, cubic and quartic equation. Solvability of equations by radicals, Constructability of regular polygons.*	**16**

Text / Reference Books:

1. *N. Herstein: Topics of Algebra: 2nd edition, Wiley Eastern 1975.*
2. *M. Artin: Algebra, Prentice Hall of India 1994.*
3. *D. S. Dummit and R.M. Foote: Abstract Algebra, John Wiley and Sons Inc. 2nd Edition 1999.*
4. *I. Stewart: Galois Theory, Academic Press 1989.*
5. *F. Loonstra: Introduction to Algebra, McGraw Hill, London, 1969.*
6. *D.S. Mali, Jhon N. Mordeson and M.K.Sen: Fundamentals of Abstract Algebra.*
7. *P. M. Cohn: Basic Algebra, Springer Publ. 2003.*
8. *T. W. Hungerford: Algebra, Springer-Verlag 1981.*
9. *Charles C. Pinter: A book of Abstract Algebra, McGraw Hill Publ.*

FIRST SEMESTER

MATC – 404: MECHANICS

Maximum marks : 100 (Terminal–80, Sessional–20)
Term end : 80
Contact hour per week : 05
Credits : 05
Terminal Examination duration : 3 hours

Outcomes: Students shall be able to define and understand various basic concepts and apply the principles of mechanics for solving practical problems related to equilibrium of rigid bodies and particle in motion.

Unit	Contains	Marks
I	***Planetary Orbits:*** *Equation of Central orbits, Motion under Inverse Square Law, Newton's Law of Gravitation, Kepler's Law of Planetary motion and applications, Time for describing an arc of a Parabolic and Elliptic Orbit.*	**20**
II	***Moments and products of inertia:*** *Definitions, Parallel axes theorem, Theorem of six constants, D' Alembert's Principle, The Momental Ellipsoid, Equimomental system, Principal axes, Moment of Momentum.*	**20**
III	***Conservation of Momentum and Energy:*** *Principle of Conservation of Linear Momentum and angular momentum under Finite and Impulsive Forces; Conservation of energy, Conservative Forces.*	**20**
IV	***Lagrange's Equations:*** *Generalized coordinates, Degrees of Freedom, Holonomic system, Lagrange's equations of motion for finite forces, Conservative forces, Small oscillation.*	**20**
V	***Hamilton's Equations of motion:*** *Generalised Velocities, Lagrangian and Generalised Momentum, Hamilton's canonical equations, Hamilton's Principle and Principle of least action.*	**20**

Text / Reference Book:

1. *S. L. Loney: Dynamics of a Particle and Rigid bodies, Cambridge University Press (1913).*
2. *F. Chorlton: Text book of Dynamics, CBS Publishers & Distributors Pvt. Ltd., New Delhi (2004).*
3. *E. T. Whittaker: Mechanics, Edmund Tayl Hardpress Publishing.*
4. *Brahma Nand, B. S. Tyagi, B. D. Sharma: Dynamics of Rigid Bodies, Kedar Nath Ram Nath Publication.*
5. *M. R. Spiegel: Theoretical Mechanics-Schaum's Outline Series, McGraw Hills.*
6. *Classical Mechanics: H. Goldstein.*
7. *Ramsey: Dynamics part-II, CBS* Publishers *& Distributors Pvt. Ltd. (2005).*
8. *S. N. Gupta: Classical Dynamics, Cengage; 5 edition (17 December 2012).*
9. *A. R. Vasistha: Statics, Krishna Prakashan Media (P) Ltd.*
10. *L. N. Hand and J. Finch.: Analytical Mechanics, Cambridge University Press (1998).*
11. *N. C. Rana and P. S. Juag : Clasical Mechanics, Tata McGraw-Hill Education Pvt. Ltd.*

FIRST SEMESTER

MATC – 405: PROGRAMMING IN C

Maximum marks	: 100 (Terminal–50, Sessional–20, Practical–30)
Term end	: 50
Practical	: 30
Contact hour per week	: 05
Credits	: 05
Terminal Examination duration	: 2 hours

Outcomes: Firstly, students will be acquainted with programming language C. Secondly; it will help the students to under the complex logics that are using in Computer Science and Engineering. It will also help the students to solve numerical problem easily through programming.

Unit	Contains	Marks
I	*Problem Solving Techniques: Algorithm, Flow-chart, Decision Table, Programming Languages, C, Basic features of C in programming, Data type and variables, Identifier, Expression and operations. Control statements: Do statement, While statement, For statement, Nested loops, If-then-else statement, Switch statement, Go to, and break and continue statement.*	**20**
II	*Arrays and pointer in C, Structure and union in C, Storage mechanism for arrays and pointer in C, String and file handling in C programming language.*	**15**
III	*Use of function in C language. Parameter passing mechanism in C, Recursive function. Library function in C. Concept of preprocessing and preprocessor directives. Concept and use of macro.*	**15**

Unit – IV : PRACTICAL : **Marks – 30**

Computer programming in consonance with the materials covered in theseunits.

Contact Hours Per Week	1
Examination Duration	1 & ½ hours
Maximum Marks	30 (Expt-20, Viva-5, Record-5)

Experiments through C – Programming (Simple programs**)**

1. *Programming using Do statement, While statement, For statement, Nested loops, If-then-else statement.*
2. *Conversion from Centigrade to Fahrenheit;*
3. *Summation of series;*
4. *Solution of quadratic equations;*
5. *Addition and multiplication of matrices.*
6. *Inverse of a matrix*
5. *Sorting, Measure of central tendencies;*
6. *Standard Deviation, Correlation, Regression etc.;*

7. *Swapping.*

Text / Reference Books:

1. *B. S. Gottfried: Programming with C, Schaum's Outlines Series, Tata McGraw Hill.*
2. *E. Balaguruswamy: Programming in ANCI C, Tata McGraw Hill, New Delhi, 2001.*
3. *A. Kelley and Ira Pohl, A Book on C, Pearson Education Asia.*
4. *V. Rajaraman: Computer Programming in C, Prentice Hall India, 1994.*
5. *B. Kernighan and D. Ritche: The C Programming Language, Prentice Hall India, New Delhi, 2001.*
6. *Yashavant P. Kanetkar: Let us C, BPB Publishers, New Delhi, 2002.*

SECOND SEMESTER

MATC – 411: COMPLEX ANALYSIS

Maximum marks : 100 (Terminal–80, Sessional–20)
Term end : 80
Contact hour per week : 05
Credits : 05
Terminal Examination duration : 3 hours

Outcomes: Using complex number theory many mathematical concepts can be unified and generalized and widely applied in physics, engineering and other fields of science and technology.

Unit	Contains	Marks
I	*Complex Integration: Cauchy's theorem, Cauchy-Goursat theorem, Cauchy's integral formula, Higher order derivatives, Cauchy's inequality, Morera's theorem, Liouville's theorem, Gauss Mean value theorem, Maximum modulus theorem.*	**15**
II	*Power series, Absolute convergence, Uniform convergence of power series, Weierstrass M-test, Domain and Radius of convergence. Taylor's expansion theorem, Laurent's expansion theorem.*	**15**
III	*Zeros of analytic functions, Singularities, Poles, types and properties of singularities, singularities at infinity. Rational and Meromorphic function, Argument principle, Rouche's theorem.*	**15**
IV	*Residue, calculation of residues, Cauchy's residue theorem, Evaluation of definite integrals, special theorems used in evaluating integrals, Mittag-Leffler's expansion theorem.*	**15**
V	*Elementary Transformation: rotation, translation, stretching, inversion, Jacobian of a transformation, Conformal and isogonal transformations, bilinear transformation, cross-ratio, fixed points and normal form of bilinear transformation, inverse points and critical points. Some special bilinear transformations: real axis onto itself, half plane onto unit circular disc, circular disc onto circular disc.*	**20**

Text / Reference Books:

1. *J. W. Brown and R. V. Churchil: Complex Variables and Applications, Tata McGraw Hill.*
2. *S. Ponnusamy and H. silverman: Complex Variables with applications, Birkhauser.*
3. *J. B. Conway: Function of Complex Variable, Springer-Verlag.*
4. *Emil G. Milewski: The Complex variables problem solver, Research and Education Association, New York.*
5. *L.V. Ahlfors: Complex Analysis, 3rd edition, Tata Mc.Graw Hill.*
6. *M.R. Spiegel: Complex variables; Schaum's Series, Tata McGraw Hill.*
7. *J. H.Mathews and R.W. Howell: Complex Analysis for Mathematics and Engineering, 3rd edition, Narosa.*
8. *E.B. Staff and A. D.Suider: Fundamenntals of Complex Analysis: for Mathematics, Science and Engineering, Prentice Hall of India.*

SECOND SEMESTER

MATC – 412: LINEAR ALGEBRA

Maximum marks : 100 (Terminal–80, Sessional–20)
Term end : 80
Contact hour per week : 05
Credits : 05
Terminal Examination duration : 3 hours

Outcomes: Linear Algebra is a continuous form of mathematics and is applied throughout science and engineering because it allows you to model natural phenomena and to compute them efficiently.

Unit	Contains	Marks
I	*Linear Transformations and its matrices, Eigenvalues and Eigenvectors, Characteristic and minimal polynomial, Cayley-Hamilton theorem, Real quadratic form, Matrix of a quadratic form, Criterion positive definiteness, Trace and transpose.*	**16**
II	*Canonical forms, Invariant subspaces, Cyclic subspaces, Direct sum decomposition and Primary decomposition theorem.*	**16**
III	*Dual basis, Dual spaces, Second dual spaces, Annihilators, Transpose of a linear mapping.*	**16**
IV	*Inner product spaces, Projections and its Applications, Orthogonal vectors and Subspaces, Orthogonal Bases, Gram-Schmidt Process, Adjoint, Normal, Unitary and Self-adjoint operators.*	**20**
V	*Bilinear, Quadratic, Hermitian Forms, Definition and examples, The matrix of a bilinear form, Orthogonality, Classification of bilinear forms.*	**12**

Text / Reference Book:

1. *K. Hoffman and R. Kunze: Linear Algebra, Prentice Hall Of India (1996).*
2. *Seymour Lipschutz: Theory and Problems of Linear Algebra, Tata McGraw Hill.*
3. *Gilbert Strang: Linear Algebra and its Applications, Cengage Learning, India Edition.*
4. *G. Schay: Introduction to Linear Algebra, Narosa (1997).*
5. *G. C. Cullen: Linear Algebra with Applications, 2nd Edition, Addison Wesley.*
6. *S. Axler: Linear Algebra Done Right, 2nd Edition, UTM, Springer (1997).*
7. *K. Janich: Linear Algebra, UTM, Springer (1994).*
8. *David C. Lang: Linear Algebra and its Applications, 3rd Edition, Pearson.*

SECOND SEMESTER

MATC – 413: DIFFERENTIAL EQUATIONS

Maximum marks : 100 (Terminal–60, Sessional–20, Practical–20)
Term end : 60
Contact hour per week : 05
Credits : 05
Terminal Examination duration : 3 hours

Outcomes: This course will help to illustrate the mathematical aspects that contribute to the solution of various physical problems of applied sciences, namely, mechanical and civil Engineering. The techniques of solving DE's will help further to pursue research work in applied sciences. It will also help the students to understand how a physical can be modeled through mathematical equations, and their solutions in order to understand physical phenomena.

Unit	Contains	Marks
I	***IVP of first order ODE*****:** *Picard's method of successive approximation, Existence theorems for a system of first order ODE, Wronskian***.**	**10**
II	***Linear partial differential equation of first order* :** *Various forms of first order partial differential equations, Lagrange's method.* ***Non-linear partial differential equations of first order* :** *Use of standard forms for solution of non-linear partial differential equations. Charpit's method.*	**15**
III	***PDE of 2nd order*:** *Second order Differential equations with constant and variable coefficients, Canonical Forms.*	**15**
IV	***Strum-Liouville Problems*:** *Orthogonality of characteristic functions, Expansion of a function in Series of Orthonormal Functions.* ***Boundary Value Problems*:** *Heat Equation, Wave Equation, Laplace Equation, Examples.*	**20**

Unit – V: Practical: ***Marks – 20***

Computer programming in consonance with the materials covered in these units.

Contact Hours Per Week 1 hour
Examination Duration 1 and ½ hours
Maximum Marks 20 (Expt–10, Viva–5, Record–5)

Experiments through C – Programming / Mathematica / Matleb

1. *Program to find the solution of IVP of first order ODE by Picard's method.*
2. *Program to find the Wronskian of functions.*
3. *Program to find the solution of first order linear PDE.*
4. *Program to find the solution of first order non-linear PDE.*
5. *Program to find the solution of 2nd order PDE.*

6. *Program to find the solution of Heat Equation, Wave Equation, Laplace Equation.*

4. *Program to find the solution of ODE by Euler's Method, RK method.*

5. *Program for integration by Trapezoidal Rule, Simpson's rules.*

Text / Reference Book:

1. *S. L. Ross: Differential Equations, III Edition, John Wiley & Sons, Inc.*
2. *Ian Snedden: Elements of partial differential equations. Tata McGraw Hill.*
3. *M. D. Raisinghannia: Advanced Differential Equations – S. Chand. & Co. Ltd.*
4. *E. L. Ince: Orinary Differential Equations, Dover Publication Inc. (1956).*
5. *W. Boyce and R. Diprima: Elementary Differential Equations and Boundary Value Problems, III Edition, New York (1977).*
6. *E. A. Coddington: An Introduction of to Ordinary Differential Equations, II Edition, Prentice Hall of India Pvt. Ltd., Delhi (1974).*
7. *Frank Ayres Jr: Theory and Problems of Differential Equations. Schaum's Outline Series. Tata McGraw Hill.*

SECOND SEMESTER

MATC – 414: TOPOLOGY

Maximum marks : 100 (Terminal–80, Sessional–20)
Term end : 80
Contact hour per week : 05
Credits : 05
Terminal Examination duration : 3 hours

Outcomes: The objective of the course on Topology is to provide the knowledge of Topological Spaces and their importance. To acquaint students with the concept of homeomorphism and the topological properties and important mathematical concepts this can be generalized in topological spaces, so that students may learn and appreciate the nature of abstract Mathematics.

Unit	Contains	Marks
I	*Definition of topological space, Neighbourhood, Interior point, Interior, Closure and closure point, Limit point, Derived sets, Bases, Sub bases, First and second countable space, Relative topology, Continuity, Uniform continuity with examples, Weak topology, Quotient space and product space.*	**16**
II	*Compactness, Basic properties of compactness, Tychconoff's theorem, Locally compact space, Lindelof space, Sequentially and countably compact, Lebesgue covering lemma, Ascoli's theorem.*	**16**
III	*Separations axioms, T_0, T_1-space, Hausdroff space, Regular space, Normal space, Completely regular space, Urysohn's lemma, Tietze extension theorem, Urysohn's metrization's theorem.*	**16**
IV	*Connectedness, Totally disconnected, Locally connected, Components, locally and path connectedness.*	**16**
V	*Nets and filters, Convergence in terms of nets and filters, Ultrafilters and compactness, Para compactness, Characterization in regular spaces, Metrization based on paracompactness.*	**16**

Text / Reference Book:

1. *J. R. Munkers, Topology a First Course, Prentice Hall of India, 1998.*
2. *G. F. Simmons, Introduction to topology and Modern Anlysis, Tata McGraw Hills, 1990.*
3. *Sheldon W. Davis, Topology, Tata McGraw-Hiil, 2006.*
4. *J. L. Kelley, General Topology, Springer-Verlag (1995).*
5. *K. D. Joshi, Introduction to General Topology, Wiley Eastern Ltd. (1993).*
6. *Colin Adams and Robert Fran Zosa, Introduction to topology Pure and Applied, Pearson, 2009.*
7. *M. A. Armstrong, Basic Topology, Springer (2004).*
8. *Wilson A. Sctherrland, Introduction to Metric and Topological Spaces, 2nd Ed Oxford University Press.*
9. *Nicolas Bourbaki, Topological Vector spaces, Springer Publ.*
10. *Geraled B. Folland, Real Analysis, Modern Techniques and Their Applications 2nd Ed, John Wiley & Sons Inc.*
11. *Jewgmei H. Dshalalow, Real Analysis, An Introduction to the Theory of real functions and Integration, Chapman and Hall/ CRC.*

SECOND SEMESTER

MAT–C–415: NUMERICAL COMPUTATIONS

Maximum marks	100 (Terminal- 60, Sessional- 20, Practical – 20)
Term end	60
Contact hour per week	05
Credits	05
Terminal Examination duration	3 hours

Outcomes: With the knowledge of numerical computations, students may understand how to find the eigen values and eigenvectors of different engineering fields and they use concept of matrices in the development of programming languages.

Unit	Contains	Marks
I	***Non-linear equations:*** *Bisection method, Newton-Raphson method Secant and Regula-Falsi method.*	**10**
II	***Systems of linear equations:*** *Gauss elimination, Pivoting, LU decomposition, Cholesky factorization, Ill-conditioning and condition number.*	**15**
III	***The Eigenvalue problem:*** *Power method, Householder method, Reduction to tridiagonal form, QR method.*	**15**
IV	***Numerical Solution of Differential:*** *Euler's Method, RK method of 2^{nd} and 4^{th} orders.* ***Numerical Solution of Integral Equations:*** *Newton's General Quadrature formula, Trapezoidal Rule, Simpson's rules.*	**20**

Unit – V: Practical: *Computer programming in consonance with the materials covered in these units.*

Contact Hours Per Week	2 hours
Examination Duration	1 and ½ hours
Maximum Marks	20 (Expt–10, Viva–5, Record–5)

Experiments through C – Programming / Mathematica / Matleb

1. *Program to find the solution of non-linear equations of one variable.*
2. *Program to find the solution of System of equations.*
3. *Program to find the Eigenvalues and Eigenfunctions for a given matrix.*
4. *Program to find the solution of ODE by Euler's Method, RK method.*
5. *Program for integration by Trapezoidal Rule, Simpson's rules.*

Text / Reference Book:

1. *S. D. Conte and Cde Boor: Elementary Numerical Analysis. Tata McGraw Hill.*
2. *M. K. Jain, S.R.K. Iyengar and R. K. Jain: Numerical Methods for Scientific and Engineering Computation, New Age International (P) Limited, Publishers (1995).*

3. *V. Rajaraman: Computer oriented Numerical Methods, Prentice Hall India.*

4. *K. E. Atkinson: Introduction to Numerical Analysis, 2nd edition, John Wiley (1989).*

5. *M. T. Health: Scientific computing: An introductory survey, McGraw Hill (2002).*

6. *C. F. Gerald and P.O Wheatley: Applied Numerical Analysis, 5th edition, Addison Wesley (1994).*

7. *B. S. Grewal: Numerical methods in Engineering and Science with programs in FORTRAN 77, C and C++, Khanna Publishers, 2002.*

8. *C. E. Froberg: Introduction to Numerical Analysis: 2nd Edition Wesley.*

9. *R.L. Burden, J.D. Fairs: Numerical Analysis, Brooks/Cole.*

10. *J. J. Akai: Applied Numerical Methods for Engineers, John Wiley and Sons.*

11. *M. B. Allen III, E.L. Isaacson: Numerical Analysis for Applied Science, John Wiley.*

THIRD SEMESTER

MATC – 501: FLUID MECHANICS – I

Maximum marks	100 (Terminal- 80, Sessional- 20)
Term end	80
Contact hour per week	05
Credits	05
Terminal Examination duration	3 hours

Outcomes: This course is intended to provide a treatment of advanced topics in fluid mechanics where the students will be able to apply the techniques to predict physical parameters that influence the flow of fluid mechanics and to impart knowledge of the fluid mechanics and their application to real world problems.

Unit	Contains	Marks
I	***Tensors:*** *Transformation of laws of covariant, covariant derivatives and contravariant tensors, Mixed tensors, rank of tensors, symmetric and anti – symmetric tensors, Algebraic operations on tensors.*	**20**
II	***Different kinds of fluids:*** *Material, local and convective derivatives, Equation of Continuity, Rotational and Irrotational motion, Stream and Path lines, Velocity Potential, Boundary surfaces.*	**20**
III	***Equation of motion of inviscid fluids:*** *Euler's equation of motion, Bernoulli's equation, Conservative field of forces, Helmholtz equation.*	**20**
IV	***Motion in two dimension:*** *Stream function, Complex potential, Source, Sink, Doublet, Complex potential and images with respect to straight line and Circle, Blasius theorem.*	**20**
V	***Vortex motion:*** *Vorticity vector, vortex line, Vortex tube, Properties of vortex, Strength of the vortex, Rectilinear Vortices, Velocity components, Centre of vortices, Vortex doublet.*	**20**

Text / Reference Book:

1. *L. P. Echenhart: Riemann Geometry, AMS Chelsea Publishing.*
2. *C. E. Weatherburn: An introduction to Riemannian Geometry & Tensor Calculus, Cambridge University Press (1950).*
3. *M. D. Raisinghania: Fluid Dynamics, S. Chand and Co. Ltd.*
4. *S. W. Yuan: Foundation to Fluid Mechanics, Prentice-Hall, Englewood Cliffs, NJ (1967).*
5. *J. L. Bansal: Viscous Fluid Dynamics Oxford and IBH Publishing Co. Calcutta.*
6. *W. H. Besant and A.S. Ramsay: A treatise on Hydrodynamics Part-II, CBS Publishers, Delhi.*
7. *G. K. Batchelor: An Introduction to Fluid Dynamics, Cambridge University Press (1970).*
8. *M. Ray and Sharma: A text book of Fluid –Dynamics, S .Chand & Co Ltd.*

THIRD SEMESTER

MATC – 502: FUNCTIONAL ANALYSIS

Maximum marks	100 (Terminal- 80, Sessional- 20)
Term end	80
Contact hour per week	05
Credits	05
Terminal Examination duration	3 hours

Outcomes: Understanding basic ideas and fundamental theorems of Normed Linear Space, Hilbert space and different operators defined on these spaces.

Unit	Contains	Marks
I	*Normed linear spaces, Banach spaces and examples. Quotient space.Continuous functions and bounded linear operators. Finite dimensional normed linear spaces. Equivalent norms. Riesz Lemma.*	**16**
II	*Fundamental Theorems: Hahn-Banach theorem, Open mapping theorem, Closed graph theorem, Uniform boundedness theorem. Adjoint operator. Weak and Weak*- convergence in Banach spaces.*	**16**
III	*Hilbert space and basic properties. Schwarz inequality. Orthogonal complements. Orthogonal sets. Bessel's inequality. Conjugate space. Riesz representation theorem.*	
IV	*Eigenvalue, Eigenvectors, Spectrum, Spectral properties of bounded self adjoint , self-adjoint, positive, normal, unitary linear operators.*	**16**
V	*Definition and examples of Banach algebra. Complex homomorphisms. Basic properties of Spectra. Gelfand spectral radius formula; Gelfand-Mazur theorem; Group of invertible elements.*	**16**

Text / Reference Book:

1. *W. Rudin: Functional Analysis: Tata McGraw Hill (1991).*
2. *R. G. Douglas: Banach Algebra Techniques in Operator Theory, Academic Press (1972).*
3. *G. F. Simmons: Introduction to Topology and Modern Analysis; McGraw Hills (1963).*
4. *B.V. Limaye: Functional analysis; New Age International Ltd. (1996).*
5. *K. Yosida: Functional Analysis; Springer (1995).*
6. *J.B. Conway: A Course in Functional Analysis; Springer (2006)*
7. *Robert E. Magginson: An Introduction to Banach Space Theory; Springer.*

THIRD SEMESTER

MAT–E–503: MATHEMATICAL METHODS

Maximum marks	100 (Terminal- 60, Sessional- 20, Practical – 20)
Term end	60
Contact hour per week	05
Credits	05
Terminal Examination duration	3 hours

Outcomes: Through this course, one can apply the techniques of various methods to solve the problems in Science and Engineering field. Moreover, it is beneficial course for utilization in research.

Unit	Contains	Marks
I	***Variation Problems:*** *Variation of a functional, Admissible function, Euler-Lagrange equation, Necessary and sufficient conditions for extremum, Variational methods, Isoperimetric problems and applications.*	**20**
II	***Fredholm equation:*** *Reduction of boundary value problem of an ordinary differential equation to an integral equation. Equation of the first and second kind, Solution by the method of successive approximation.*	**20**
III	***Volterra equation:*** *Equation of the first and second kind, Solution by the method of iterated kernel, existence and uniqueness of solution, Resolvent Kernel, Examples.*	**20**
IV	***Finite Difference Method:*** *Difference, Formation of difference equation, reduction of ordinary differential to difference equations. Applications.*	**20**

Unit – V: ***Practical:*** *Computer programming in consonance with the materials covered in these units.*

Contact Hours Per Week	2 hours
Examination Duration	1 and ½ hours
Maximum Marks	20 (Expt–10, Viva–5, Record–5)

Experiments through C – Programming / Mathematica / Matleb

1. Program to find the solution of Euler-Lagrange equation.
2. Program to find the solution of Fredholm equation.
3. Program to find the solution of Volterra equation.
4. Program for difference equations (Cramers rule, Gauss elimination and Gaus-Seidal methods).
5. Program for integration by Trapezoidal Rule, Simpson's rules.
6. Program to find the Eigenvalues and Eigenfunctions for a given matrix.

Text / Reference Book:

1. *Courant Hilbert: Methods of Calculus of Variations, Vol. II, Interscience Publishers, New York.*
2. *M. D. Raisinghania: Integral Equations, S. Chand and Co.*
3. *A.S. Gupta: Calculus of Variation. Prentice Hall of India.*
4. *M. K. Jain, S. R. K. Iyenger & R. K. Jain: Numerical Methods for Scientific and Engineering Computation, New Age International Publishers (2012).*
5. *M. K. Jain: Numerical Solution of Differential Equations, John Wiley & Sons (16 May 1984).*
6. *Francis B. Hildebrand: Calculus of Variation, Prentice-Hall Inc.*
7. *R.P. Kanwal: Linear Integral Equations. Theory and Techniques. Academic press, New York.*
8. *Li. G. Chanbers: Integral Equation, International text book company Ltd, 1976.*

THIRD SEMESTER

MAT–E–504: MATHEMATICAL PROGRAMMING

Maximum marks	100 (Terminal- 60, Sessional- 20, Practical – 20)
Term end	60
Contact hour per week	05
Credits	05
Terminal Examination duration	3 hours

Outcomes: After going through this module, the students will understand how mathematics helps in solving problems in businesses, in industries, in supply and chains, and in defense.

Unit	Contains	Marks
I	*Simplex method, two-phase method, Big-M method, Revised simplex method, solution of linear programming problem by revised simplex method.*	**12**
II	*Duality, Fundamental theorem of duality, Dual simplex method, comparison of solution of primal and its dual.*	**12**
III	*Transportation problems, North–West corner rule, Vogel's approximation method, Optimality test, Assignment problems.*	**12**
IV	*Game theory: Two Person Zero Sum Game, Max-mini and Minimax Principles, Mix Strategies, Graphical and General Solutions of Games.*	**12**
V	*Inventory Control: Deterministic inventory problems with no shortages, Deterministic inventory problems with shortages, EOQ problems with price breaks, Multi-item Deterministic problems.*	**12**

Unit* – VI: *Practical: *Computer programming in consonance with the materials covered in these units.*

Contact Hours Per Week	2 hours
Examination Duration	1 and ½ hours
Maximum Marks	20 (Expt–10, Viva–5, Record–5)

Experiments through C – Programming / Mathematica / Matlab

1. *Solution of Linear Programming Problems using graphical methods.*
2. *Solution of Linear Programming Problems using simplex methods.*
3. *Solution of Transportation and assignments Problems.*

Text / Reference Book:

1. *R. Fletcher: Optimization, Academic Press, (1969).*
2. *Kanti Swarup, P.K. Gupta and Mon Mohan: Operation Research, Sultan Chand & Sons.*
3. *S. I. Gauss: Linear programming, Tata McGraw Hill.*
4. *Mittal and Sethi: Linear Programming; Pragati Prakashan.*
5. *F. S. Hillier and G.J. Lieberman: Introduction to Operation Research: (6th edition) McGraw Hill. International edition: Industrial Engineering Series (1995).*
6. *D. G. Luenberger: Introduction to Linear and Non linear Programming, Addison Wesley (1973).*
7. *N. S. Kambo: Mathematical Programming Techniques, East West Press (1997).*

THIRD SEMESTER

MAT–E–505: CONTINUUM MECHANICS

Maximum marks	100 (Terminal–80, Sessional–20)
Term end	80
Contact hour per week	05
Credits	05
Terminal Examination duration	3 hours

Outcomes: Numerically model and analyze the stresses and deformations of simple geometries under an arbitrary load in both solids and liquids.

Unit	Contains	Marks
I	*Analysis of stress: The continuum concept, Homogeneity, Isotropy, Mass Density, Force and moment of equilibrium, Stress transformation laws, Stress quadric of Cauchy, Principal stresses, stress invariants, Stress ellipsoid.*	**20**
II	*Deformation and Strain : Continuum Configuration, Deformation and flow concepts, Lagrangian and Eulerian descriptions, Deformation and displacement gradients, Deformation tensors, Finite strain tensors, Small deformation theory, Relative displacement, Linear rotation tensor, Rotation vector, Stretch ratio, Finite strain interpretation, Principal strains, Strain invariants, Cubical Dilatation.*	**20**
III	*Motions and Flow : Material derivative, Velocity, Acceleration, Instantaneous velocity, field, Path lines and stream lines steady motion, Rate of deformation tensor, Velocity tensors and their physical interpretation.*	**10**
IV	*Fundamental laws of Continuum Mechanics: Conservation of mass, Continuity equation, Linear momentum principle, Equation of motion, Equilibrium equations, Moment of momentum principle, Conservation of energy, Energy Equation.*	**10**
V	*Linear Elasticity : Generalized Hook's law, Strain energy function, Isotropy, Anisotropy, Elastic symmetry, Isotropic media, Elastic constants, Navier-Cauchy equations and Beltrami – Michell equations.*	**20**

Text / Reference Book:

1. *George E Mase : Continuum Mechanics- Schaum's outlines series, Tata McGraw-Hill, Publishing Company limited, New Delhi.*
2. *Rabindranath Chatterjee: Mathematical theory of Continuum Mechanics-, Narosa Publishing House, New Delhi.*
3. *D.S. Chandrasekhararіah and Loknath Debnath: Continuum Mechanics-, Academic Press, New York.*

THIRD SEMESTER

MAT–E–506: MATHEMATICAL STATISTICS

Maximum marks	100 (Terminal–80, Sessional–20)
Term end	80
Contact hour per week	05
Credits	05
Terminal Examination duration	3 hours

Outcomes: After going through this module, the students will understand to solve problems related to probability and statistics.

Unit	Contains	Marks
I	*Probability: Mathematical and statistical definition, axiomatic approach, sample space, probability as a set function, additional and multiplication theorem on probability, conditional probability, repeated trials, Baye's theorem, random variable and distribution function, joint probability distribution.*	**16**
II	*Mathematical expectation, expectation of sum and product of random variables, conditional expectation and conditional variance, Tshebysheff lemma, weak law of large numbers, Bernoulli's theorem, moment generating function, characteristic function, central limit theorem.*	**16**
III	*Probability distribution: Binomial distribution, Negative binomial distribution, Poisson distribution, normal distribution, hyper geometric distribution, Exponential, Weibul, Gamma distribution.*	**16**
IV	*Regression, regression curves, Correlation: Correlation-simple, multiple and partial, regression and the theory of least squares, Cauchy-Schwarz's inequality and limits of correlation coefficient, Multiple regression using matrix.*	**16**
V	*Sampling distribution and test of significance: Sampling distributions; mean and standard error, level of significance, confidence intervals, test of significance, test using Fisher's Z- transformation, t,* χ^2 *and F – distributions.*	**16**

Text / Reference Book:

1. *Gupta and Kapoor: Fundamentals of Statistics, S. Sand. And Co. Ltd.*
2. *Gun, Gupta and Das Gupta: An outline of Statistics Volume – I, S. Sand. And Co. Ltd.*
3. *P. Mukhapadhya: Mathematical Statistics, S. Sand. And Co. Ltd.*
4. *Gupta and Kapoor: Fundamentals of Statistics, S. Sand. And Co. Ltd.*
5. *Gun, Gupta and Das Gupta: An outline of Statistics Volume – I, S. Sand. And Co. Ltd.*
6. *P. Mukhapadhya: Mathematical Statistics, S. Sand. And Co. Ltd*

THIRD SEMESTER

MAT–E–507: DIFFERENTIAL GEOMETRY

Maximum marks	100 (Terminal–80, Sessional–20)
Term end	80
Contact hour per week	05
Credits	05
Terminal Examination duration	3 hours

Outcomes: Students will able to Understand principal directions and curvatures, asymptotic lines and then apply their important theorems and results to study various properties of curves and surfaces.

Unit	Contains	Marks
I	*Curves in space; Arc length, Order of contact, Tangent, Normal, Binormal, Osculating plane, Serrent-Frenet formulae, Curvature and torsion.*	**15**
II	*Curves in space (Continued); Osculating circle and osculating sphere, Helix, Bertand curves, Spherical indicatrix, Evolute and envolute, Behaviour of a curve in the neighbourhood of a point.*	**15**
III	*Concept of a surface, Envelope and developable surface, Parametric curves, Family of the surfaces, Edge of regression, Ruled surfaces, Central points.*	**15**
IV	*Fundamental forms and curvature of surfaces; First fundamental form, Second fundamental form of the surfaces of revolution, Weingarten's equations, Direction coefficients, Family of curves.*	**15**
V	*Local non-intrinsic properties of a surface, Normal curvature, Principal directions, Principal curvatures, Minimal surface, Lines of curvature, Rodrigues and Monge's theorem, Euler's theorem, Joachimisthal's theorem, Dupin's indicatrix, Third fundamental form.*	**20**

***Text / Reference Book*:**

1. *T. J. Willmore: Differential Geometry.*
2. *C. E. Weathrburn: Differential Geometry of three dimensions.*
3. *R. S. Millman and G. D. Parket: Elements of Differential Geometry.*
4. *A. Goctz: Introduction to Differential Geometry.*

THIRD SEMESTER

MAT–O–508A: INTRODUCTION TO MATHEMATICS EDUCATION

Maximum marks	100 (Terminal–50, Sessional–20, Project–30)
Term end	50
Contact hour per week	04
Credits	04
Terminal Examination duration	2 and 1/2 hours

Outcomes: To understand mathematics education as an academic and research field. To appreciate need and scope of interdisciplinary research in Mathematics Education.

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Unit	Contains	Marks
I	***Foundation of Mathematics Education:*** *History of Mathematics with reference to Indian Mathematics, Modern Views of Mathematics, The concept of the importance of Mathematics Education in today's complex society, Methods used for Teaching Mathematics at elementary and secondary level.*	**20**
II	***Technology in Mathematics Teaching and Learning:*** *Use of Technology in Teaching and Learning Mathematics, Construction of Mathematical ideas through Technology, Mathematics on World Wide Web (WWW): Technology Principle and Standards, Role of IT in Mathematics Learning, Preliminary idea about Mathematical Software like SPSS, MATLAB etc. Use of Spreadsheets (MS Excel) in geometry and Algebra.*	**15**
III	***Statistical Tools Used in Social Science Research through SPSS:*** ***Research issues:*** *Research questions and Null hypotheses. Questionnaires, Sampling, Data Collection, Data Analysis and Interpretation of Data.* ***Uses of SPSS in Research****: Inputting Data, Reliability and Validity of Data, Descriptive Statistics, Variance, Standard Error, Correlation analysis. Regression Analysis, T-test: Paired t- test, Chi-Square Test, Analysis of Variance (ANOVA).*	**15**

***Unit – IV*: *Project* :**
Project-cum-Survey Report in consonance with the course covered by this course

Contact Hours Per Week	1 hours
Examination Duration	1 and ½ hours
Maximum Marks	30 (Presentation–10, Viva–5, Project Report–15)

***Text / Reference Book*:**

Unit-I:

1. *L. Mishra: Teaching of Mathematics (2008), A.P.H. Publishing Corporation, New Delhi.*
2. Meaning in Mathematics, *July 14, 2011, John Polkinghorne, Oxford University Press.*
3. *C. S. Seshadri:* Studies in the History of Indian Mathematics (Culture and History of Indian Mathematics), *15 Aug 2010, Hindustan Book Agency.*

Unit-II:

1. *P. Kupar & K. Nissinen: Background factors behind mathematics achievement in Finnish education context. Available on line http://www.iea.nl/fileadmin/user_upload/IRC/IRC_2013/Papers/IRC-2013_Kupari_Nissinen.pdf*

2. *Abedi, Jamal: Lord, Carol. and Hofstetter, Carolyn. (1998): IMPACT OF SELECTED BACKGROUND VARIABLES ON STUDENTS' NAEP MATH PERFORMANCE. Available online https://www.cse.ucla.edu/products/reports/TECH478.pdf*
3. *A. Cuoco, E. P. Goldenberg & J. Mark: Habits of mind; an organizing principle for mathematics curriculum. (E. A. Maher, Ed.) Journal of Mathematical Behavior , 15, 375-402 (1996).*
4. *NCERT. (2005).National Curriculum Framework, New Delhi.*

Unit-III:

1. *Technology in Teaching and Learning Mathematics. Available online www.nctm.org/.../**Technology-in-Teaching-and-Learning-Mathematics***
2. *Role of Technology in Teaching-learning Mathematics. Available on line http://www.ncert.nic.in/pdf_files/use%20of%20technology%20in%20%20teaching%20-learning%20mathematics%20-pratimanayak.pdf*
3. *Kiran Pandya, SmrutiBulsari, Sanjay Sinha; SPSS in Simple Steps, Willey India*
4. *ASTHANA: Statistics for Social Sciences (With SPSS Applications).*
5. *Aljandali, Abdulkader: Quantitative Analysis and IBM® SPSS® Statistics- A Guide for Business and Finance; Springer.*
6. *James O. Aldrich: Using IBM® SPSS® Statistics: An Interactive Hands-On Approach.*
7. *Alan C. Elliott: IBM SPSS by Example: A Practical Guide to Statistical Data Analysis*

REFERENCE BOOKS:

1. *Dr. Anice James and Dr. P. S. Balasubramanium: Teaching of Mathematics, Neel Kamal Pub. Pvt. Ltd.*
2. *Kulbir Singh Sidhu, The Teaching of mathematics, Sterling Publishers Pvt. Ltd.*
3. *Dr. Anice James and Dr. JeyanhiAlwan, Skills and Strategies of Technology, Neel Kamal Pub. Pvt. Ltd.*1.

THIRD SEMESTER

MAT–O–508B: COMPUTER FUNDAMENTALS

Maximum marks	100 (Terminal–50, Sessional–20, Project–30)
Term end	50
Contact hour per week	04
Credits	04
Terminal Examination duration	2 and 1/2 hours

Outcome: The students will be enabled to know important and need of security computer applications and operations in their real field.

Unit	Contains	Marks
I	***Introduction to number system:*** *Binary, Octal, Decimal and Hexadecimal Number system and their conversion, Two's complement, 1's Complement and 2's Complement Arithmetic.* ***Computer System:*** *History of computer; Input and Output Devices; CPU: ALU, Memory units, Control Unit; Block Diagram of Computer; Different generation of Computer; Microprocessors; Characteristic of various types of memories, Peripheral.*	**15**
II	*Permutations and Combinations, Sum and Product rules, Mathematical Logic, Statements, Variables, Logical Operators, Truth Table, Boolean algebra, logic diagrams, logical expressions/functions.*	**15**
III	*Ms Word, Ms Excel, Ms Power Point, Ms Publisher.*	**20**

***Unit – IV*: *Project* :**
Project Report in consonance with the course covered by these units.

Contact Hours Per Week	1 hours
Examination Duration	1 and ½ hours
Maximum Marks	30 (Presentation–10, Viva–5, Project Report–15)

Experiments

1. Preparing professional looks documents using MS-words and EXCEL.
2. Applications of EXCEL sheet (Graphs, Salary Tables, Frequency Tables etc.).
3. Power point presentations for a particular work.

Text / Reference Book:

1. *R. Fletcher: Optimization, Academic Press, (1969).*
2. *Kanti Swarup, P.K. Gupta and Mon Mohan: Operation Research, Sultan Chand & Sons.*
3. *S. I. Gauss: Linear programming, Tata McGraw Hill.*
4. *Mittal and Sethi: Linear Programming; Pragati Prakashan.*
5. *F. S. Hillier and G.J. Lieberman: Introduction to Operation Research: (6^{th} edition) McGraw Hill. International edition: Industrial Engineering Series (1995).*
6. *D. G. Luenberger: Introduction to Linear and Non linear Programming, Addison Wesley (1973).*
7. *N. S. Kambo: Mathematical Programming Techniques, East West Press (1997).*
8. *Morris M. Mano: Computer System Architecture.*
9. *V. Rajaraman: Fundamental of computers.*
10. *John P. Hayes: Computer Architecture and Organization.*

FOURTH SEMESTER

MATC–*511: Fluid Mechanics – II*

Maximum marks	100 (Terminal–80, Sessional–20)
Term end	80
Contact hour per week	05
Credits	05
Terminal Examination duration	3 hours

Outcomes: Knowing this course, students may involve in research in fluid dynamics, which is basically incorporated with linear and non-linear differential equations. It is a huge research domain in any Engineering sciences and it's an interdisciplinary research with mainly Physics and Biology.

Unit	Contains	Marks
I	***Kinematics of fluids in motion and stress analysis:*** *Vortex lines, Strain, small deformation theory, stress vector and stress tensor, constitutive equations, Reynolds transport formula, conservation law and mathematical forms.*	10
II	***Viscosity:*** *Newton's Law of Viscosity, Navier-Stokes equations of motion, Energy equation for viscous fluid, and Energy dissipation due to viscosity.*	15
III	***Dimensional analysis:*** *Buckingham- π -theorem, and its applications, Non-dimensional parameters and their importance.*	15
IV	***Exact solution of Navier Strokes Equation:*** *Steady laminar Flow between plates, Plane Poiseuille flow, Hagen-Poiseuille Flow, Palsatile flow between parallel surfaces, Unsteady motion of flat plate.*	20
V	***Boundary Layer Theory:*** *Prandtl's boundary layer theory and its importance, Boundary layer thickness, displacement thickness, Momentum thickness, Energy thickness, Drag and Lift, Boundary layer equations in two dimensional flows, The Blasius solution.*	20

***Text / Reference Book*:**

1. *H. Schilchting: Boundary Layer Theory. McGraw Hill Book Co., New York.*
2. *Chatterjee, R, Mathematical Theory of Continum Mechanics, Narosa Publishing House, 2005.*
3. *L.M.M. Thomson, Theoritical Hydrodynamics, Dova Publication, 2011.*
4. *A. Schilchting and K. Gersten, Boundary Layer Theory, Springer, 2016.*
5. *Frank Chorlton: Text book of Fluid Dynamics, C.B.S Publishers, Delhi.*
6. *J. L. Bansal: Viscous Fluid Dynamics Oxford and IBH Publishing Co. Calcutta.*
7. *W. H. Besant and A.S. Ramsay: A treatise on Hydrodynamics Part-II, CBS Publishers, Delhi.*
8. *G. K. Batchelor: An Introduction to Fluid Dynamics, Cambridge University Press (1970).*
9. *M. D. Raisinghania: Fluid Dynamics, S. Chand and Co. Ltd.*

FOURTH SEMESTER

MATC–512: GRAPH THEORY

Maximum marks	100 (Terminal–80, Sessional–20)
Term end	80
Contact hour per week	05
Credits	05
Terminal Examination duration	3 hours

Outcomes: Graph theory is a branch of mathematics which has wide application in other area of mathematics as well as in other branches such as computer science, operation research, chemistry, physics, etc. The course provides the foundation.

Unit	Contains	Marks
I	*Graphs, Vertex and Degree, Sub graphs, Walks, paths and circuits, Digraphs, Connected graphs, Paths connected, disconnected graphs and components; Vertex Degrees and graphic sequences, Bipartite graphs, Operations on graphs.*	**16**
II	*Cut points, bridges and blocks, Weighted graphs, Block graphs and cut point graphs, Trees, Binary Trees, spanning trees, spanning trees in a weighted graph.*	**16**
III	*Eulerian and Hamiltonian graphs, Line graphs. Factorizations: 1– Factorizations, 2 – Factorization, Covering and critical points.*	**16**
IV	*Planner graphs, Outer planer graphs, Euler's polyhedron Formula, Kuratowski's Theorem, The chromatic number. Five color theorem, Four color Conjecture.*	**16**
V	*Matrix representation of graphs: Adjacency matrix, incidence matrix, Circuit matrix. Fundamental Circuit matrix and rank. Application to a switching Network. Cut set Matrix.*	**16**

Text / Reference Book:

1. *N. Deo: Graph Theory with applications to Engineering and Computer Science; PHI.*
2. *Harary: Graph Theory; Narosa Pub. House.*
3. *D. B. West: Introduction to Graph Theory (2nd ed.) Narosa Pub House, New Delhi.*
4. *Gary Chartranel and Ring Zhang: Introduction to Graph Theory; Tata McGraw Hill Ed.*
5. *K. R. Parthasarthy: Basic Graph Theory, Tata Mac Graw Hill (1994).*
6. *R. J. Wilson: Introduction to Graph Theory (4 ed.) Pearson Education Singapore (2003).*

FOURTH SEMESTER

MAT–E–513: WAVELETS AND APPLICATIONS

Maximum marks	100 (Terminal–80, Sessional–20)
Term end	80
Contact hour per week	05
Credits	05
Terminal Examination duration	3 hours

Outcomes: Students are able to understand that it's a remarkable tool in the signal processing toolbox for smoothing noisy signals and performing data compression on data streams and images.

Unit	Contains	Marks
I	*Fourier Analysis: Fourier transforms in $L^1(R)$, Basic properties of Fourier transforms, Fourier transforms in $L^2(R)$, Poisson's Summation formula, The Shannon sampling theorem and Gibbs's phenomenon, Heisenberg's uncertainty principle.*	**16**
II	*Definition and examples of wavelets, Continuous wavelet transforms, Basic Properties of Wavelet transforms, continuous wavelet transform and Holder continuity.*	**16**
III	*The Discrete wavelet transforms, Frames and Frame Operators, Orthonormal Wavelets.*	**16**
IV	*Multiresolution Analysis: Definition of Multiresolution Analysis and Examples, Properties of scaling functions and Orthonormal wavelet Bases.*	**16**
V	*Construction of wavelets, cardinal B-splines, Franklin wavelet, Battle- Lemarie wavelet, Daubechies' wavelets.*	**16**

Text / Reference Book:

1. *Lokenath Debnath: Wavelet Transforms and Their Applications, Birkhaus.*
2. *Ingrid Daubechies: Ten lectures on wavelets, SIAM: Society for Industrial and Applied Mathematics.*
3. *A. Boggess, and F. J. Narcowich: A First Course in Wavelets with Fourier Analysis, Wiley; 2 edition (September 8, 2009).*
4. *C.K. Chui: An Introduction to Wavelets, Academic Press.*
5. *Eugenio Hernandez, Guido L. Weiss: A first Course on Wavelets, CRC Press.*
6. *David F. Walnut: An Introduction to Wavelet Analysis, Birkhauser.*
7. *P. Wojtaszczyk: A Mathematical Introduction to Wavelet, CRC Press.*

FOURTH SEMESTER

MAT–E–514: FUZZY SET THEORY AND APPLICATIONS

Maximum marks	100 (Terminal–80, Sessional–20)
Term end	80
Contact hour per week	05
Credits	05
Terminal Examination duration	3 hours

Outcomes: It will enable the students to develop the skill in basic understanding on fuzzy sets and fuzzy logics. It will also help the students how the automation industries are running.

Unit	Contains	Marks
I	*Internal arithmetic, Multi-level interval numbers. Fuzzy Sets: Basic definitions, α - level sets, Basic operations on Fuzzy sets, Types of fuzzy sets, Extension principle for fuzzy sets, t- norms; t- conorms, Fuzzy numbers, Arithmetic with Fuzzy numbers.*	**16**
II	*Fuzzy relations: Basic properties of fuzzy relations, Fuzzy relations and approximate reasoning, Properties of the Min-Max composition, Fuzzy relation equations, Fuzzy graphs; special fuzzy relations. Fuzzy functions on fuzzy sets.*	**16**
III	*Probability theory: Fuzzy measures, Evidence theory, Belief measure, Plausibility measure and necessity, Measures, Possibility distribution, Possibility theory, Probability of Fuzzy events, Possibility theory versus probability theory.*	**16**
IV	*An overview of classical logic, Maltivalued logics, Linguistic variables, Linguistic modifiers, Truth, Propositions of fuzzy logic, Fuzzy quantifiers. Approximate reasoning, Fuzzy implications.*	**16**
V	*Fuzzy decision making, multi criteria decision making, Multi stage decision making, Fuzzy ranking methods, Fuzzy controllers, Defuzzification.*	**16**

***Text / Reference Book*:**

1. *George J. Klir and Bo Yuan: Fuzzy Sets and Fuzzy Logic Theory and Applications: PHI (1997).*
2. *H. J. Zimmermann: Fuzzy Set Theory and its Applications: 2ed, Kluwer Academic Publishers (1996).*
3. *George Bojadzieve and Maria Bozadzieve: Fuzzy Sets, Fuzzy Logic Applications: World Scientific (1995).*
4. *L. H. Tsoukalas and R.E. Uhring: Fuzzy and Neural Approaches in Engineering; John Wiley and Sons (1997).*
5. *H. T. Nguyen, N.R. Prasad, C.L. Walker and E.A. Walker: A First Crouse in Fuzzy and Neural Controls; Champan and Hall/ CRC Press, Taylor and Francis Group (2003).*
6. *J. Harris: Fuzzy Logic Application in Engineering Science; Springer (2006).*

FOURTH SEMESTER

MAT–E–515: OPERATION RESEARCH

Maximum marks	100 (Terminal–80, Sessional–20)
Term end	80
Contact hour per week	05
Credits	05
Terminal Examination duration	3 hours

Outcomes: The students will able to explain the meaning of operations research know the various techniques of operations research; use operations research to solve various transportation problems

Unit	Contains	Marks
I	*Non-linear Programming: General Non-Linear Programming Problem, Constrained Optimization with Equality Constraints, Constrained Optimization with Inequality Constraints, Kuhn-Tucker Conditions for General NLPP with m(<n) Constraints, Quadratic Programming, Wolfe's Modified Simplex Method, Beale's Method.*	**16**
II	*Dynamic Programming: The recursive Equation Approach, Characteristics of Dynamic Programming, Dynamic Programming Algorithm, Solution of Discrete D.P.P., Solution of L.P.P. by Dynamic Programming.*	**16**
III	*Queueing Theory: Queueing System, Elements of Queueing System, Operating Characteristics of Queueing System, Probabillity Distributions in Queueing System, Classification of Queueing Models, (M/M/1, ∞/FIFO), (M/M/1, C/FIFO), (M/M/N, ∞/FIFO) (M/M/1, GD/FIFO), Definition of Transient and Steady States, Poisson Queueing System.*	**20**
IV	*Network Scheduling by PERT/CPM:Network and Basic Components, Logical Sequencing, Rules of Network Construction, Critical Path Analysis, Probability Considerations in PERT, Distinction between PERT and CPM.*	**12**
V	*Information Theory: A Measure of Information, Entropy- The Expected Information, Entropy as a Measure of Uncertainty, Some Properties of Entropy Function, The Communication System, Channel Probabilities, Joint and Conditional Entropies, Mutual Information, Encoding.*	**12**

***Text / Reference Book*:**

1. *Kanti Swarup, P. K. Gupta and Mon Mohan: Operations Research, Sultan Chand & Sons.*
2. *Hamdy A. Taha: Operations Research: An Introduction, Pearson.*
3. *F. S. Hillier and G.J. Lieberman: Introduction to Operation Research: (6th edition) McGraw Hill. International edition: Industrial Engineering Series (1995).*
4. *R. Fletcher: Optimization, Academic Press (1969).*
5. *D. G. Luenberger: Introduction to Linear and Non linear Programming, Addison Wesley (1973).*
6. *N. S. Kambo, Mathematical Programming Techniques, East West Press (1997).*
7. *M. S. Bazarra and C. M. Shetty: Nonlinear Programming Theory and Algorithms, Wiley (1979).*

FOURTH SEMESTER

MAT–E–516: MEASURE THEORY

Maximum marks	100 (Terminal–80, Sessional–20)
Term end	80
Contact hour per week	05
Credits	05
Terminal Examination duration	3 hours

Outcomes: Students will able to understand the classical theory of Riemann integration. The course will be a reasonably, standard introduction to measure theory with some emphasis upon geometric aspects.

Unit	Contains	Marks
I	*Algebras and sigma – algebras, measures, measurable space, outer measures, measurable sets, Lebesque measure and its properties, non-measurable sets.*	**10**
II	*Measurable functions and their properties, Egoroff's theorem.*	**10**
III	*Lebesgue integration; simple functions, integral of bounded functions over a finite measure, bounded convergence theorem, integral of non negative functions, Fatou's Lemma, monotone convergence theorem, the general Lebesgue integral, Lebesgue convergence theorem.*	**20**
IV	*Signed measures, Hahn and Jordan Decompositions, absolute continuity, Radon Nikodyn theorem, derivatives of signed measures.* L_p *– spaces and their dual.*	**20**
V	*Product measures, construction, Fubini's theorem and its applications. Finite and infinite dimensional product spaces. Locally compact spaces, regular measures. Haar measure.*	**20**

***Text / Reference Book*:**

1. *P. R. Halmos: Measure Theory; D. Van Nostrand Company; 1962*
2. *D. L. Cohn: Measure Theory, Birkhauser, 1994.*
3. *G. De Barra: Measure Theory and Integration; New Age International, 1981.*
4. *H.L. Royden: Real Analysis, PHI.*

FOURTH SEMESTER

MAT–E–517: SPACE DYNAMICS

Maximum marks	100 (Terminal–80, Sessional–20)
Term end	80
Contact hour per week	05
Credits	05
Terminal Examination duration	3 hours

Outcomes: This course will provide the idea of flight mechanics and rocket technology.

Unit	Contains	Marks
I	*Basic formulae of a spherical triangle - The Two-body problem: The motion of the centre of mass, The relative motion. Kepler's equation. Solution by Hamilton Jacobi theory. The Determination of Orbits: Laplace and Gauss Methods.*	**16**
II	*The Three Body problem: general three Body Problem. Restricted Three Body Problem. Jacobi integral. Curves of zero velocity. Stationary solutions and their stability. The n-body problem : The motion of the centre of Mass. Classical integrals.*	**16**
III	*Perturbation: Equation of motion under perturbative force and the results of the perturbed elements. Osculating orbit, perturbing forces. Secular and Periodic perturbations.*	**12**
IV	*Flight Mechanics: rocket performance in Vacuum, vertically ascending paths. Gravity twin trajectories. Multi-stage rocket in a vacuum. Definitions pertinent to single stage rocket, performance limitations of single stage rockets. Definitions pertinent to multi stage rockets. Analysis of multi-stage rockets neglecting gravity. Analysis of multi-stage rockets including gravity.*	**20**
V	*Rocket performance with Aerodynamic forces. Short-range non-lifting missiles. Ascent of a sounding rocket, some approximate performance of rocket powered ait-craft.*	**16**

Text / Reference Book:

1. *J.M.A. Dandy : Fundamentals of Celestial Mechanics; The Macmillan Company (1962).*
2. *E. Finlay Freudlich : Celestial Mechanics; The Macmillan Company (1958).*
3. *Ralph Deutsch: Orbital Dynamics of Space Vehicles; Prentice Hall INC. Engle Wood Cliff. New Jersey (1963).*
4. *Theodre E. Sterne : An Introduction of Celestial Mechanics; Intersciences Publishers. INC (1960).*
5. *Angelo Miele : Flight Mechanics Vol-I: Theory of Flight Paths; Addition Wiley Publishing Company INC (1962).*

FOURTH SEMESTER

MAT–E–518: ALGEBRAIC TOPOLOGY

Maximum marks	100 (Terminal–80, Sessional–20)
Term end	80
Contact hour per week	05
Credits	05
Terminal Examination duration	3 hours

Outcomes: The students will be familiarized with homotopy theory and homology theory so that theory will be able to connect topological concepts with algebraic concepts.

Unit	Contains	Marks
I	*Fundamental Group, Homotopy of maps between topological spaces, Homotopy equivalence, Contractable and Simply. Connected spaces, Fundamental Groups of* S^1 *and* $S^1 \times S^1$**.**	**15**
II	*Calculation of Fundamental Groups of* S^n*, n>1 using Van- Kampen's theorem, Brouwer Fixed Point theorem, Fundamental theorem of Algebra, Vector fields on planar sets, Frobenius theorem for 3×3 matrices.*	**20**
III	*Covering spaces, Unique Path Lifting theorem. Covering Homotopy theorems, Group of covering transformations, Criterion of lifting maps in terms of Fundamental Groups, Universal covering and its existence, spherical cases of manifolds and topological groups.*	**20**
IV	*Singular Homology, Reduced Homology, Eilenberg- Steenrod axioms of Homology (no proof for homotopy invariance axiom, excision axiom and exact sequence axiom) and their application, Relation between Fundamental Group and First homology Group.*	**15**
V	*Calculation of Homology Groups of* S^n*, Brouwer Fixed Point theorem for* $f: \Gamma^n \to \Gamma^n$*, Application to Spheres, Vector Fields.*	**10**

Text / Reference Book:

1. *M. Greenberg and J. R. Harper: Algebraic Topology : A first course, Addision Wesley Publishing Co.*
2. *W. S. Massey: Algebraic Topology: An Introduction, Harcourt, Brace and World Inc.*
3. *Allen Hatcher: Algebraic Topology*

FOURTH SEMESTER

MAT–E–519: STOCHASTIC PROCESSES

Maximum marks	100 (Terminal–80, Sessional–20)
Term end	80
Contact hour per week	05
Credits	05
Terminal Examination duration	3 hours

Outcomes: It will help the student to understand how statistics help to predict some events, earthquakes, Tsunami etc.

Unit	Contains	Marks
I	*Generating Functions, Laplace Transformations, Stochastic Process: Introduction, specification of Stochastic Processes, Recurrent Events, Random walk models: gambler's ruin model, Markov Chain.*	**16**
II	*Markov Processes in continuous time: introduction, Poisson process, Simple birth process, Simple death process, the simple birth and death process.*	**16**
III	*The Polya process, Brownian Motion Process. Weiner Process, Introduction to Epidemic Processes: simple epidemics, general epidemics.*	**16**
IV	*Introduction to Rennewal Processes, Renewal equation, Renewal theorems, Delayed and Equilibrium renewal process. Introduction to discrete Branching processes: Galton-Watson branching process.*	**16**
V	*Queueing process: Basic characteristics of queueing system, different performance measures. Steady state solution of Markovian queueing models: M/M/1, M/M/C. Introduction to diffusion processes: Diffusion limit of random walk, diffusion limit to a discrete branching process.*	**16**

Text / Reference Book:

1. *Norman T.J. Bailey: The elements of Stochastic Processes- with applications to the natural sciences. John Wiley & Sons, New York (1990).*
2. *J. Medhi.: Stochastic Processes. Wiley Eastern Ltd. New Delhi (1994).*
3. *W. Feller: An Introduction to Probability Theory and its Applications. Vol. I, John Wiley, New York (1968).*
4. *S. M. Ross: Stochastic Process, Wiley, New York (1983).*

FOURTH SEMESTER

MAT–E–520: Rings and Modules

Maximum marks	100 (Terminal–80, Sessional–20)
Term end	80
Contact hour per week	05
Credits	05
Terminal Examination duration	3 hours

Outcomes: Knowing this module, if someone wants to do research works on algebra, especially in- commutative and non-commutative algebra, category theory, Goldie dimension, algebraic geometry, lie groups, algebraic graphs theory, theoretical computer science etc., then this module will certainly guides the students.

Unit	Contains	Marks
I	*Preliminaries on rings and ideals; Primeness; Local and Semi Local Rings; Artiinian and Noetherian Rings; Nil Radical and Jacobson Radical.*	**20**
II	*Modules (Definition and Examples), Direct Sums, Free Modules.*	**10**
III	*Quotient Modules, Homomorphisms, Simple Modules, Modules over PID's.*	**10**
IV	*Finitely Generated Modules; Exact Sequences; Chain Conditions; Ascending Chain Conditions on Modules; Maximal Condition; Noetherian Modules; Descending Chain Condition; Minimal Condition, Artinian Modules; their properties.*	**20**
V	*Essential Extensions; Injective Hulls; Semisimple Modules; The Singular Submodules.*	**20**

Text / Reference Book:

1. *M. F. Atiyah and I. G. Macdonald: Introduction to Commutative Algebra; Addition Wesley (2000).*
2. *C. Musili, Introduction to Rings and Modules, Narosa Publishing House, New Delhi (1999).*
3. *K. R. Goodearl Rings and Modules, Marcel Dekker Inc, New York (1976).*
4. *M. Reid: Undergraduate Commutative Algebra; London, Math. Soc. (1995).*
5. *S. Lang: Algebra: Addison-Wesley Publishing Company, London (2000).*
6. *H. Matsumura: Commutative Algebra; Benjamin/ Cummings Pub. Company (1980).*
7. *A.W. Chatters and C.R. Hajarnavis: An Introduction Course in Commutative Algebra; Oxford University Press (1998).*
8. *David Eisenbud: Commutative Algebra; Springer (1960).*
9. *C. Musili, Introduction to Rings and Modules, Narosa Publishing House, New Deelhi (1999).*

FOURTH SEMESTER

MAT–E–521: ADVANCED FUNCTIONAL ANALYSIS

Maximum marks	100 (Terminal–80, Sessional–20)
Term end	80
Contact hour per week	05
Credits	05
Terminal Examination duration	3 hours

Outcomes: To enable the students for further study in functional analysis. To identify the concepts of Hilbert spaces, Numerical range of an operator, symmetric and self adjoint linear operators.

Unit	Contains	Marks
I	*Topological vector space, separation properties, boundedness and continuity, seminorms and local convexity, Quotient spaces. Weak topology of a topological vector space, weak*-topology of a dual space, Banach-Alaoglu theorem, Krein-Milman theorem, Milman theorem.*	**16**
II	*Uniform, strong and weak convergences. Compact linear operators on normed linear spaces; the separability of the Range and spectral properties of a compact operator; operator equations involving compact operators.*	**16**
III	*Bounded operators on Hilbert spaces; spectral properties of bounded self adjoint linear operators; positive operators and their square root; projection operators; spectral representation of a bounded self adjoint linear operator.*	**16**
IV	*Spectral measure; spectral theorem for bounded normal operators. Functional calculus and spectral mapping theorem for analytic functions; Riesz decomposition theorem. Numerical range of an operator; spectral radius; subnormal and hyponormal operators; partial isometries; polar decomposition.*	**16**
V	*Unbounded linear operators and their Hilbert adjoint operators; symmetric and self adjoint linear operators; spectral properties of self adjoint linear operators; closed linear operators; closable operators and their closures; spectral representation of unitary and self adjoint linear operators; multiplication operator and differentiation operator.*	**16**

Text / Reference Book:

1. Kreyszig, Erwin, Introductory functional analysis with applications, John Wiley and Sons (1978).
2. Rudin, W., Functional Analysis, McGRAW-Hill (1991).
3. Douglas, R.G., Banach Algebra Techniques in Operator Theory, Academic Press (1972).
4. P. R. Halmos: Introduction to Hilbert spaces and theory of spectral multiplicity, Chelsea Publishing Co., New York (1957).
5. G. Bachman and L. Narici: Functional Analysis, Academic Press, New York (1966).
6. J. B. Conway: A course in Functional Analysis, Springer Verlag, New York (1985).
7. Peter A. Fillmore: Notes on operator theory, Van Nostrand Reinhold Company, New York (1970).
8. Mischa Cotlar and Roberto Cignoli, An Introduction to Functional Analysis, North-Holland Publ. Company.
9. Ruth F. Curtain and A.J. Pritchard, Functional Analysis in Modern Applied Mathematics, Academic Press, London (1977).
10. Terry J. Morrison, Functional Analysis: An Introduction to Banach space theory, John Wiley and Sons Publ.
11. Charles Swartz, An Introduction to Functional Analysis, Marcel Dekker Inc.

FOURTH SEMESTER

MAT–E–522: THEORY OF DISTRIBUTION AND SOBOLEV SPACES

Maximum marks	100 (Terminal–80, Sessional–20)
Term end	80
Contact hour per week	05
Credits	05
Terminal Examination duration	3 hours

Outcomes: Explain the importance of mathematics and its techniques to solve real life problems and provide the limitations of such techniques and the validity of the results.

Unit	Contains	Marks
I	*Test Function and distribution: Definition, operations with distributions, convolution of distributions, Fourier transform of tempered distributions.*	**16**
II	*Sobolev spaces: Definition and properties, extension theorem, imbedding and completeness theorem, fractional order Sobolev spaces, trace theory.*	**16**
III	*Distributions in Locally convex spaces and distributions on Manifolds.*	**16**
IV	*Application to Elliptic Problems: Weak solution of elliptic boundary value problem (BVP),regularity of weak solutions, maximum principle, eigenvalue problems, fixed point theorems and their application in semilinear elliptic BVP.*	**16**
V	*Some techniques from nonlinear analysis: Banach, Brouwer, Schauder and Schaeffer fixed point theorems, The Galerkin methods, Monotone Iterations, Variational Methods, Pohozaev's Indentity.*	**16**

Text / Reference Book:

1. *S. Kesavan: Topics in Functional Analysis and Applications, Wiley Eastern Ltd., New Delhi (1989).*
2. *R. S. Pathak: A Course in Distribution Theory and Applications, Narosa Publications (2009).*
3. *R. A. Adams: Sobolev Spaces, Academic Press (1975).*
4. *J. T. Oden and J. N. Reddy: An Introduction to Mathematical Theory of Finite Elements,Wiley Interscience (1976).*
5. *Brennan, K. E. and Scott., R.., The Mathematical Theory of Finite Element Methods Springer-Verlag, Berlin (1994).*
6. *Elliot H. Lieb and Michel. Loss: Analysis, Narosa Publishing House, New Delhi (1997).*
7. *Robert S. Strihartz: A guide to Distribution Theory and Fourier Transforms, (Studies in Advanced Mathematics), CRC Press, USA (1994).*

FOURTH SEMESTER

MAT–E–523: BIOMECHANICS

Maximum marks	100 (Terminal–80, Sessional–20)
Term end	80
Contact hour per week	05
Credits	05
Terminal Examination duration	3 hours

Outcomes: Ability to use computer calculations as a tool to carry out scientific investigations and develop new variants of the acquired methods, if required by the problem of blood flow through Artery etc.

Unit	Contains	Marks
I	*Biomechanics, Method of approach, Tools of investigation, Stresses and rates of strain, Constitutive equations, Newtonian viscous fluid, Hookean elastic solid, Visco elasticity, Biological transport process, Basic momentum, Heat and mass transport concepts.*	**22**
II	*Conservation laws; mass conservation, Momentum conservation, Energy conservation.*	**12**
III	*Biofluid dynamics concept, Transport phenomena and the cardiovascular system.*	**12**
IV	*Biofluid mechanics of organ systems, The lungs, The Kidneys and the lever.*	**12**
V	*Micro-circulation, Pressure distribution in micro vessels, Pressure in the intesstitial space, Velocity distribution in micro vessels, The velocity-Hemotocrit relationship, mechanics of flow at very low Reynold numbers.*	**22**

Text / Reference Book:

1. *Y. C. Fung: Biomechanics, Springer-verlag.*
2. *Clement Kluinstreuer: Biofluid Dynamics Taylor and Francis.*
3. *S. A.Levin: Frontier in Mathematical Biology.*
4. *Ricciardi: Biomathematics.*

FOURTH SEMESTER

MAT–E–524: COMPUTATIONAL FLUID DYNAMICS

Maximum marks	100 (Terminal–80, Sessional–20)
Term end	80
Contact hour per week	05
Credits	05
Terminal Examination duration	3 hours

Outcomes: It has beautiful outcomes through numerical models of fluid flow in different modern applied sciences of engineering in the real world

Unit	Contains	Marks
I	***Computational Fluid Dynamics:*** *What, When, and Why?, CFD Applications.* ***Introduction:*** *Brief introduction of boundary layer flow, incompressible and compressible flows, finite difference and finite volume method, example of , parabolic and hyperbolic systems and time discretization technique, explicit and implicit methods, upwind and central difference schemes, stability, dissipation and dispersion errors.*	**15**
II	***Solution of Simultaneous Equations****: point iterative/block iterative methods, Gauss-Seidel iteration (concept of central coefficient and residue, SOR), different acceleration techniques. Approximate solution of differential equations through variational formulation, Boundary conditions in the variational form: Primary and secondary variables, Essential and natural boundary conditions, Properties of variational form.*	**15**
III	***Fundamentals of Discretization:*** *Preprocessing, Solution, Postprocessing, Finite Element Method, Finite difference method, Well posed boundary value problem, Possible types of boundary conditions, Conservativeness, Boundedness, Transportiveness, Finite volume method (FVM), Illustrative examples: 1-D steady state heat conduction without and with constant source term.*	**20**
IV	***Finite Volume Method:*** *Some Conceptual Basics and Illustrations through 1-D Steady State Diffusion Problems: Physical consistency, Overall balance, FV Discretization of a 1-D steady state diffusion type problem, Four basic rules for FV Discretization of 1-D steady state diffusion type problem, Source term linearization, Implementation of boundary conditions.*	**15**
V	***Discretization of Unsteady State Problems:*** *1-D unsteady state diffusion problems: implicit, fully explicit and Crank-Nicholson scheme.*	**15**

Text / Reference Book:

1. *K. Muralidhar, T. Sundararajan, Computational Fluid Flow and Heat Transfer, Second Edition, Narosa, 2011.*
2. *T. J. Chung, Computational Fluid Dynamics, Cambridge University Press, 2003.*
3. *Tapan K. Sengupta, Computational Fluid Dynamics, University Press, 2005.*
4. *C. Hirch, Numerical Computation of Internal and External Flows, Elsevier, 2007.*
5. *S. V. Patankar, Numerical Heat Transfer and Fluid Flow, Hemisphere Series on Computational Methods in Mechanics and Thermal Science.*
6. *O. Zikanov, Essential Computational Fluid Dynamics by, Wiley 2010.*
7. *P. S. Ghoshdastidar, Computer Simulation of Flow and Heat Transfer, 4th Edition, Tata McGraw-Hill, 1998.*