arise. awake. achieve

VIVEKANANDA GLOBAL UNIVERSITY

(Established by Rajasthan State Legislature and covered u/s 2(f) of the UGC Act, 1956)

FACULTY OF BASIC AND APPLIED SCIENCES

SCHEME & SYLLABUS

FOR

BACHELOR OF SCIENCE (HONORS)

MATHEMATICS

(Implemented from Academic Session 2018-19 and for the students of batch 2017-18)

Sem	I	II	III	IV	V	VI	Total
Credits	22	24	24	26	24	24	144

SESSION: 2018-19

VIT Campus, Sector-36, NRI Road, Sisyawas, Jagatpura, Jaipur (Raj.)-303012
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SCHEME OF TEACHING AND EVALUATION

B.Sc. HONORS MATHEMATICS SCHEME EFFECTIVE FROM 2018-19						
SEMESTER I						
Course Code	**University Course Category**	**Course Title**	**Teaching Scheme**			
			L	**T**	**P**	**C**
MAT121	Core Theory	Calculus	4	0	0	4
MAT122	Core Theory	Algebra	5	1	0	6
MAT185	Core Practical	Calculus Lab	0	0	4	2
CHY103	Ability Enhancement course	Environmental Science	2	0	0	2
MAT183 MAT190	Skill Enhancement Course 1	**(Choose one)** 1.Logic and Sets 2. Computer Graphics	2	0	0	2
PHY109	Generic Elective 1	Mechanics	4	0	0	4
PHY110		Mechanics Lab	0	0	4	2
TOTAL			**17**	**1**	**8**	**22**

B.Sc. HONORS MATHEMATICS SCHEME EFFECTIVE FROM 2018-19						
SEMESTER II						
Course Code	**University Course Category**	**Course Title**	**Teaching Scheme**			
			L	**T**	**P**	**C**
MAT124	Core Theory	Mathematical Analysis	5	1	0	6
MAT125	Core Theory	Differential Equations and Modeling	4	0	0	4
MAT186	Core Practical	Differential Equations Lab	0	0	4	2
ENG 106	Ability Enhancement Course	Professional Communication	2	0	0	2
ENG 107		Communication Technique Lab	0	0	2	1
MAT133 MAT191	Skill Enhancement Course 2	**(Choose one)** 1. Graph Theory 2. Operating System: Linux	2	0	0	2
PHY111	Generic Elective 2	Electricity and Magnetism	4	0	0	4
PHY112		Electricity and Magnetism Lab	0	0	4	2
SEP 200	Skill Enhancement Practical	Extra-Curricular Activity (NSS/NCC/Scouting/Club Activity)	0	0	2	1
TOTAL			**17**	**1**	**12**	**24**
B.Sc. HONORS MATHEMATICS SCHEME EFFECTIVE FROM 2018-19						

SEMESTER III						
Course Code	**University Course Category**	**Course Title**	**Teaching Scheme**			
			L	**T**	**P**	**C**
MAT127	Core Theory	Theory of Real Functions	5	1	0	6
MAT128	Core Theory	Group Theory I	5	1	0	6
MAT129	Core Theory	PDE and Systems of ODE	4	0	0	4
MAT187	Core Practical	PDE and Systems of ODE Lab	0	0	4	2
PHY113	Generic Elective 3	Thermal Physics and Statistical Mechanics	4	0	0	4
PHY114		Thermal Physics and Statistical Mechanics Lab	0	0	4	2
TOTAL			**18**	**2**	**8**	**24**

B.Sc. HONORS MATHEMATICS SCHEME EFFECTIVE FROM 2018-19						
SEMESTER IV						
Course Code	**University Course Category**	**Course Title**	**Teaching Scheme**			
			L	**T**	**P**	**C**
MAT130	Core Theory	Numerical Methods	4	0	0	4
MAT131	Core Theory	Riemann Integration and Series of Functions	5	1	0	6
MAT132	Core Theory	Ring Theory and Linear Algebra I	5	1	0	6
MAT188	Core Practical	Numerical Methods Lab	0	0	4	2
PHY115	Generic Elective 4	Waves and Optics	4	0	0	4
PHY116	Generic Elective 4	Wave and Optics Lab	0	0	4	2
BCS 203	Skill Enhancement	Computer Application lab	0	0	4	2
TOTAL			**18**	**2**	**12**	**26**

B.Sc. HONORS MATHEMATICS SCHEME EFFECTIVE FROM 2018-19						
SEMESTER V						
Course Code	**University Course Category**	**Course Title**	**Teaching Scheme**			
			L	**T**	**P**	**C**
MAT136	Core Theory	Multivariate Calculus	5	1	0	6
MAT137	Core Theory	Group Theory II	5	1	0	6
MAT140 MAT141 MAT142	Discipline Specific Elective 1	**(**Choose one) 1. Portfolio Optimization 2. Number Theory 3. Analytical Geometry	5	1	0	6
MAT143 MAT144 MAT145	Discipline Specific Elective 2	**(Choose one)** 1. Industrial Mathematics 2. Boolean Algebra and Automata Theory 3. Probability and Statistics	5	1	0	6
TOTAL			**20**	**4**	**0**	**24**

B.Sc. HONORS MATHEMATICS SCHEME EFFECTIVE FROM 2018-19						
SEMESTER VI						
Course Code	**University Course Category**	**Course Title**	**Teaching Scheme**			
			L	**T**	**P**	**C**
MAT138	Core Theory	Metric Spaces and Complex Analysis	5	1	0	6
MA139	Core Theory	Ring Theory and Linear Algebra II	5	1	0	6
MAT146 MAT147 MAT148	Discipline Specific Elective 3	**(Choose one)** 1. Theory of Equations 2. Bio-Mathematics 3. Linear Programming	5	1	0	6
	Discipline Specific Elective 4	(Choose one)				
MAT149 MAT189		1. (a) Mathematical Modeling	4	0	0	4
		(b) Mathematical Modeling Lab	0	0	4	2
MAT150		2. Statics & Dynamics	5	1	0	6
MAT151		3. Differential Geometry	5	1	0	6
TOTAL			**20**	**4**	**0**	**24**

Theory – 2 Midterm Exams and Course Work* (40%) End Term Exam (60%)
Practical- 2 Midterm Exams and Course Work* (60%) End Term Exam (40%)
*Class work shall include: Quiz, Assignment, Seminars, Presentations, Attendance, Case study, Surprise class test, Lab record, Viva, Projects, and Observation Book.

LIST OF SKILL ENHANCEMENT COURSES

Course Code	Skill Enhancement Courses
I Semester (Any One)	
MAT183	Logic and Sets
MAT190	Computer Graphics
II Semester(Any One)	
MAT133	Graph Theory
BCS501	Operating System: Linux
II Semester(Compulsory)	
SEP 200	Extra-Curricular Activity (NSS/NCC/Scouting/ club activity)
II Semester(Compulsory)	
BCS 203	Computer Application lab

LIST OF GENERIC ELECTIVE COURSES

(TO BE OFFERED AS MINOR SUBJECTS)

I Semester	
PHY 109	Mechanics
PHY 110	Mechanics Lab
II Semester	
PHY 111	Electricity & Magnetism
PHY 112	Electricity & Magnetism Lab
III Semester	
PHY 113	Thermal Physics & Statistical Mechanics
PHY 114	Thermal Physics & Statistical Mechanics Lab
IV Semester	
PHY 115	Waves & optics
PHY 116	Waves & optics Lab

Course Code	Discipline Specific Elective Courses
III Semester(Any One)	
MAT140	Portfolio Optimization
MAT141	Number Theory
MAT142	Analytical Geometry
IV Semester(Any One)	
MAT143	Industrial Mathematics
MAT144	Boolean Algebra and Automata Theory
MAT145	Probability and Statistics
V Semester(Any One)	
MAT146	Theory of Equations
MAT147	Bio-Mathematics
MAT148	Linear Programming
VI Semester(Any One)	
MAT149	(a) Mathematical Modeling (b) Mathematical Modeling Lab
MAT150	Statics & Dynamics
MAT151	Differential Geometry

Semester I Syllabus

Course Code	University Course Category	Course Title
MAT121	Core Theory	Calculus
MAT122	Core Theory	Algebra
MAT185	Core Practical	Calculus Lab
CHY103	Ability Enhancement course	Environmental Science
MAT183 BCS604	Skill Enhancement Course 1	**(Choose one)** 1.Logic and Sets 2. Computer Graphics
PHY109	Generic Elective 1	Mechanics
PHY110		Mechanics Lab

MAT121
CALCULUS

B.Sc. (Mathematics) **Semester I**

L-T-P-C Structure 4-0-0-4 **Course Type: Core Theory**

Module 1: Hyperbolic functions, higher order derivatives, Leibniz rule and its applications to problems of type $e^{ax+b}\sin x$, $e^{ax+b}\cos x$, $(ax+b)^n\sin x$, $(ax+b)^n\cos x$, concavity and inflection points.

Module 2: Asymptotes, curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves, L 'Hospital's rule, applications in business, economics and life sciences.

Module 3: Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \sin nxdx$, $\int \cos nxdx$, $\int \tan nxdx$, $\int \sec nxdx$, $\int (\log x)^n dx$, $\int \sin^n x \sin^m xdx$ volumes by slicing, disks and washers methods, volumes by cylindrical shells, parametric equations, parameterizing a curve, arc length, arc length of parametric curves, area of surface of revolution.

Module 4: Techniques of sketching conics, reflection properties of conics, rotation of axes and second degree equations, classification into conics using the discriminant, polar equations of conics.

Module 5: Introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions, tangent and normal components of acceleration, Theorem of vectors

Reference Books:

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. M.J. Strauss, G.L. Bradley and K. J. Smith, *Calculus*, 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.
3. H. Anton, I. Bivens and S. Davis, *Calculus*, 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
4. R. Courant and F. John, *Introduction to Calculus and Analysis* (Volumes I & II), Springer-Verlag, New York, Inc., 1989.

MAT122
ALGEBRA

B.Sc. (Mathematics) **Semester I**

L-T-P-C Structure 5-1-0-6 **Course Type: Core Theory**

Module 1: Polar representation of complex numbers, nth roots of unity, De Moivre's theorem for rational indices and its applications. Equivalence relations, Functions, Composition of functions, Invertible functions.

Module 2: One to one correspondence and cardinality of a set, Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers.

Module 3: Principles of Mathematical Induction, statement of Fundamental Theorem of Arithmetic. Systems of linear equations, row reduction and echelon forms, vector equations.

Module 4: The matrix equation Ax=b, solution sets of linear systems, applications of linear systems, linear independence, Introduction to linear transformations, matrix of a linear transformation.

Module 5: Inverse of a matrix, characterizations of invertible matrices Subspaces of Rn, dimension of subspaces of Rn and rank of a matrix, Eigen values, Eigen Vectors and Characteristic Equation of a matrix.

Reference Books:

1. Titu Andreescu and Dorin Andrica, *Complex Numbers from A to Z*, Birkhauser, 2006.

2. Edgar G. Goodaire and Michael M. Parmenter, *Discrete Mathematics with Graph Theory*, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005**.**

3. David C. Lay, *Linear Algebra and its Applications*, 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.

MAT185
CALCULUS LAB

B.Sc. (Mathematics) **Semester I**

L-T-P-C Structure 0-0-4-2 **Course Type: Core Practical**

List of Practical (using any software):

(i) Plotting of graphs of function e^{ax+b}, log(ax + b), 1/(ax + b), sin(ax + b), cos(ax + b), |ax + b| and to illustrate the effect of a and b on the graph.

(ii) Plotting the graphs of polynomial of degree upto 5, the derivative graph, the second derivative graph and comparing them.

(iii) Sketching parametric curves (Eg. Trochoid, cycloid, epicycloids, hypocycloid).

(iv) Matrix operation (addition, multiplication, inverse, transpose).

Reference Books:

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. M.J. Strauss, G.L. Bradley and K. J. Smith, *Calculus*, 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.
3. H. Anton, I. Bivens and S. Davis, *Calculus*, 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
4. R. Courant and F. John, *Introduction to Calculus and Analysis* (Volumes I & II), Springer-Verlag, New York, Inc., 1989.

CHY103
ENVIRONMENTAL SCIENCE

B.Sc. (Mathematics) **Semester I**

L-T-P-C Structure 2-0-0-2 **Course Type: Ability Enhancement**

Module 1: Introduction and natural resources: Multidisciplinary nature and public awareness, renewable and non renewable resources and associated problems, forest, water , mineral, food , energy and land resources. Introduction to natural resources, conservation of natural resources and human role.

Module 2: Ecosystem: Ecological concepts, concept of ecosystems, types of ecosystems, ecosystem structure and functioning, energy flow, food chains and food webs, ecological pyramids

Module 3: Biodiversity and Conservation: Definition, genetic species and ecosystem diversity biogeographically , classification of Indian value of biodiversity at national and local levels, India as a mega-diversity nation , treats to biodiversity and endangered and endemic species of India, need for conservation of biodiversity.

Module 4: Environmental pollution: Definition , causes, effect and control of air pollution , water pollution, soil pollution, marine pollution, noise pollution, thermal pollution, electromagnetic pollution, nuclear hazards , human role in prevention of pollution, solid waste management, disaster management, floods , earthquake, cyclone, and landslide

Firework Safety:, Combustion of firework and pollution (noise, smoke, fireworks fallout and residue pollution), heavy metal toxicity due to fireworks and associated health effects.

Module 5: Social Issue and Environment: Unsuitable to suitable development , urban problem related to energy and water conservation, environment protection act, wild life protection act, forest conservation act, environmental issues, population explosion, and family welfare programme. Environmental and human health HIV, women and child welfare, role of information technology on environment and human health.

Corruption: definition and reasons, details of organizations/agencies working against corruption, role of individual against corruption and mode of action.

Ethics : Meaning , nature, determinants and objectives of ethics, ethics and its relation to values norms and morals, Indian ethos, Swami Vivekananda and ethics.

Reference Books :

1. Agrawal,K.C.: Fundamentals of Environmental Biology,2001, Bikaner (India): Nidhi Publishers
2. Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders Co. USA
3. Odum E.P.: Fundamentals of Ecology,1996, Dehradun: Natraj Publisher
4. Chapman,J.L. & Reiss, M.J.: Ecology: Principles and Applications, 1995, Cambridge University Press
5. Atmospheric pollution, by W Buch , Tata McGraw Hill(TMH)
6. Professional Ethics and Human Values, Govindarajan M, PHI Learning Private Limited , Delhi
7. Corruption and Reform in India By Jennifer Bussell , Cambridge University Press

MAT183

Logic and Sets

B.Sc. (Mathematics) **Semester I**

L-T-P-C Structure 2-0-0-2 **Course Type: Skill Enhancement**

Module 1: Introduction, propositions, truth table, negation, conjunction and disjunction, Implications, bi conditional propositions. Converse, contra positive and inverse propositions and precedence of logical operators, Propositional equivalence.

Module 2:, Logical equivalences. Predicates and quantifiers: Introduction, Quantifiers, Binding variables and Negations.

Module 3: Sets, subsets, Set operations and the laws of set theory and Venn diagrams. Examples of finite and infinite sets, Empty set, properties of empty set, Standard set operations.

Module 4: Finite sets and counting principle. Classes of sets, Power set of a set, nce and Symmetric difference of two sets, Set identities, Generalized union and intersections.

Module 5:. Relation: Product set, Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation, Partial ordering relations, binary relations.

Reference Books:

1. R.P. Grimaldi, *Discrete Mathematics and Combinatorial Mathematics*, Pearson education, 1998.
2. P.R. Halmos, *Naive Set Theory*, Springer, 1974.
3. E. Kamke, *Theory of Sets*, Dover Publishers, 1950.

MAT190

Computer Graphics

B.Sc. (Mathematics) **Semester I**

L-T-P-C Structure 2-0-0-2 **Course Type: Skill Enhancement**

Module 1: Development of computer Graphics: Raster Scan and Random Scan graphics storages.

Module 2: Displays processors and character generators, colour display techniques.

Module 3: Interactive input/output devices, Points, lines and curves: Scan conversion.

Module 4: Line-drawing algorithms, circle and ellipse generation, conic-section generation, polygon filling anti-aliasing.

Module 5: Two-dimensional viewing: Coordinate systems, linear transformations, line and polygon clipping algorithms.

Books Recommended

1. D. Hearn and M.P. Baker, *Computer Graphics,* 2nd Ed., Prentice–Hall of India, 2004.
2. J.D. Foley, A van Dam, S.K. Feiner and J.F. Hughes, *Computer Graphics: Principals and Practices,* 2nd Ed., Addison-Wesley, MA, 1990.
3. D.F. Rogers, *Procedural Elements in Computer Graphics,* 2nd Ed., McGraw Hill Book Company, 2001.
4. D.F. Rogers and A.J. Admas, *Mathematical Elements in Computer Graphics,* 2nd Ed., McGraw Hill Book Company, 1990.

MECHANICS

B.Sc. (Mathematics) **Semester I**

L-T-P-C Structure 4-0-0-4 **Course Type: General Elective 1 Theory**

Module 1: Vectors: Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter.

Ordinary Differential Equations: 1^{st} order homogeneous differential equations. 2^{nd} Order homogeneous differential equations with constant coefficients.

Module 2: Laws of Motion: Frames of reference. Newton's Laws of motion. Dynamics of a system of particles Centre of Mass.

Momentum and Energy: Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets.

Rotational Motion: Angular velocity and angular momentum. Torque. Conservation of angular momentum.

Module 3: Gravitation: Newton's Law of Gravitation .Motion of a particle in a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant). Kepler's Laws (statement only). Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS).

Module 4: Oscillations: Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped oscillations.

Elasticity: Hooke's law - Stress-strain diagram - Elastic moduli-Relation between elastic constants -Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants-Work done in stretching and work done in twisting a wire-Twisting couple on a cylinder - Determination of Rigidity modulus by static torsion - Torsional pendulum-Determination of Rigidity modulus and moment of inertia -q,η and by Searles method

Module 5: Special Theory of Relativity: Constancy of speed of light. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic addition of velocities.

Books Suggested:

1. UniversityPhysics. FWSears, MWZemansky and HDYoung13/e,1986.Addison- Wesley
2. Mechanics Berkeley Physics course,v.1:Charles Kittel, et.Al.2007, Tata McGraw- Hill.
3. Physics–Resnick, Halliday & Walker 9/e, 2010, Wiley.
4. Engineering Mechanics, Basudeb Bhattacharya, 2^{nd} edn., 2015,Oxford University Press.

MECHANICS LAB

B.Sc. (Mathematics) **Semester I**

L-T-P-C Structure 0-0-4-2 **Course Type: General Elective 1 Practical**

1. Measurements of length (ordiameter) using vernier caliper, screw gauge and travelling microscope.
2. To determine the Height of a Building using a Sextant.
3. To determine the Moment of Inertia of a Flywheel.
4. To determine the Young's Modulus of a Wire by Optical Lever Method.
5. To determine the Modulus of Rigidity of a Wireby Maxwell's needle.
6. To determine the Elastic Constants of a Wireby Searle's method.
7. To determine g by Bar Pendulum.
8. To determine g by Kater's Pendulum.
9. To determine **g** and velocity for a freely falling body using Digital Timing Technique
10. To study the Motion of a Spring and calculate(a) Spring Constant(b)Value of g

Books Suggested:

1. Advanced Practical Physics for students, B.L.FlintandH.T.Worsnop, 1971, Asia Publishing House.

2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.

3. Engineering Practical Physics, S.Panigrahi & B . Mallick, 2015, Cengage Learning India Pvt. Ltd.

4. A Text Book of Practical Physics, Indu Prakash and Ramakrishna,11th Edition 2011, Kitab Mahal,New Delhi.

MATHEMATICAL ANALYSIS

B.Sc. (Mathematics) **Semester II**

L-T-P-C Structure 5-1-0-6 **Course Type: Core Theory**

Module 1: Review of Algebraic and Order Properties of R, δ-neighborhood of a point in R, Idea of countable sets, uncountable sets and uncountability of R. Bounded above sets, Bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima.

Module 2: The Completeness Property of R, The Archimedean Property, Density of Rational (and Irrational) numbers in R, Intervals. Limit points of set, isolated points, Illustrations of Bolzano-Weierstrass theorem for sets.

Module 3: Sequences, Bounded sequence, Convergent sequence, Limit of a sequence. Limit Theorems, Monotone Sequences, Monotone Convergence Theorem. Subsequences, Divergence Criteria, Monotone Subsequence Theorem (statement only).

Module 4: Bolzano Weierstrass Theorem for Sequences. Cauchy sequence, Cauchy's Convergence Criterion. Infinite series, convergence and divergence of infinite series, Cauchy Criterion.

Module 5: Tests for convergence: Comparison test, Limit Comparison test, Ratio Test, Cauchy's nth root test, Integral test, Alternating series, Leibniz test, Absolute and Conditional convergence.

Reference Books:

1. R.G. Bartle and D. R. Sherbert, *Introduction to Real Analysis*, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.

2. Gerald G. Bilodeau , Paul R. Thie, G.E. Keough, *An Introduction to Analysis*, 2nd Ed., Jones & Bartlett, 2010.

3. Brian S. Thomson, Andrew. M. Bruckner and Judith B. Bruckner, *Elementary Real Analysis*,Prentice Hall, 2001.

4. S.K. Berberian, *A First Course in Real Analysis*, Springer Verlag, New York, 1994.

MAT125

DIFFERENTIAL EQUATIONS AND MODELING

B.Sc. (Mathematics) **Semester II**

L-T-P-C Structure 4-0-0-0 **Course Type: Core Theory**

Module 1: Differential equations and mathematical models. General, particular, explicit, implicit and singular solutions of a differential equation.

Module 2: Exact differential equations and integrating factors, separable equations and equations reducible to this form, linear equation and Bernoulli equations, special integrating factors and transformations.

Module 3: Introduction to compartmental model, exponential decay model, lake pollution model (case study of Lake Burley Griffin), drug assimilation into the blood (case of a single cold pill, case of a course of cold pills), exponential growth of population, limited growth of population, limited growth with harvesting.

Module 4: General solution of homogeneous equation of second order, principle of super position for homogeneous equation, Wronskian: its properties and applications, linear homogeneous and non-homogeneous equations of higher order with constant coefficients.

Module 5: Euler's equation, method of undetermined coefficients, method of variation of parameters. Equilibrium points, Interpretation of the phase plane, predatory-prey model and its analysis, epidemic model of influenza and its analysis, battle model and its analysis.

Reference Books:

1. Belinda Barnes and Glenn R. Fulford, *Mathematical Modeling with Case Studies, A Differential Equation Approach using Maple and Matlab,* 2nd Ed., Taylor and Francis group, London and New York, 2009.

2. C.H. Edwards and D.E. Penny, *Differential Equations and Boundary Value problems Computing and Modeling,* Pearson Education India, 2005.

3. S.L. Ross, *Differential Equations,* 3rd Ed., John Wiley and Sons, India, 2004.

4.Martha L Abell, James P Braselton, *Differential Equations with MATHEMATICA,* 3rd Ed., Elsevier Academic Press, 2004.

DIFFERENTIAL EQUATIONS LAB

B.Sc. (Mathematics) **Semester II**

L-T-P-C Structure 0-0-4-2 **Course Type: Core Practical**

List of Practicals (Any ten using any software):

1. Plotting of second order solution family of differential equation.
2. Plotting of third order solution family of differential equation.
3. Growth model (exponential case only).
4. Decay model (exponential case only).
5. Lake pollution model (with constant/seasonal flow and pollution concentration).
6. Case of single cold pill and a course of cold pills.
7. Limited growth of population (with and without harvesting).
8. Predatory-prey model (basic volterra model, with density dependence, effect of DDT, two prey one predator).
9. Epidemic model of influenza (basic epidemic model, contagious for life, disease with carriers).
10. Battle model (basic battle model, jungle warfare, long range weapons).
11. Plotting of recursive sequences.
12. Study the convergence of sequences through plotting.
13. Verify Bolzano-Weierstrass theorem through plotting of sequences and hence identify convergent subsequences from the plot.
14. Study the convergence/divergence of infinite series by plotting their sequences of partial sum.
15. Cauchy's root test by plotting nth roots.
16. Ratio test by plotting the ratio of nth and (n+1)th term.

Reference Books:

1. Belinda Barnes and Glenn R. Fulford, *Mathematical Modeling with Case Studies, A Differential Equation Approach using Maple and Matlab*, 2nd Ed., Taylor and Francis group, London and New York, 2009.

2. C.H. Edwards and D.E. Penny, *Differential Equations and Boundary Value problems Computing and Modeling*, Pearson Education India, 2005.

3. S.L. Ross, *Differential Equations,* 3rd Ed., John Wiley and Sons, India, 2004.

4.Martha L Abell, James P Braselton, *Differential Equations with MATHEMATICA,* 3rd Ed., Elsevier Academic Press, 2004.

ENG 106
PROFESSIONAL COMMUNICATION

B.Sc. (Mathematics) **Semester II**

L-T-P-C Structure 2-0-0-2 **Course Type: Ability Enhancement Course**

Module 1: Fundamentals of Communication:

- Introduction , Definition , Process , Importance, Different Forms and Purpose of Communication
- Barriers to Communication
- Organization and Interpersonal Communication

Module 2: Group Discussion

- Introduction to Group Discussion
- Types, Roles and Functions in Group Discussion
- Difference between GD and Debate
- Preparation Strategy
- Tips for a good GD

Module 3: Presentation:

- Fundamentals of Presentation
- Audience Analysis
- Organizing Material Effective Presentation
- Question –Answer Session

Module 4: Professional Writing :

- Official Correspondence- Drafting E-mails, Memorandum, Notice, agenda, Minutes, Circulars
- Business Correspondence-Business letter writing, sales letters, Enquiry letters and replies to enquiry(enquiry about a product, service or information, asking for a quotation, placing an order and replies to the same) letters of Claim and Adjustment.

Module 5: Technical Writing

- Report Writing- General and Technical report, Definition, Types, structure
- Technical proposals-Definitions, Types and Format

Reference Books:

1. Communication Skills, Pushp Lata, Sanjay Kumar, Oxford Higher Education/Oxford University Press , 2011.
2. Technical Communication, Principles and Practice, Meenakshi Raman & Sangita Sharma, Oxford University Press
3. Effective Technical Communication, M Ashraf Rizvi, Tata McGraw –Hill Eduction
4. Basic Communication Skills for Technology, Andre J Rutherford , Person Education Asia.

ENG 107

COMMUNICATION TECHNIQUE LAB

B.Sc. (Mathematics) **Semester II**

L-T-P-C Structure 2-0-0-2 **Course Type: Ability Enhancement Course**

- Phonetics Symbols and Transcriptions
- Methods of word formation
- Reading , Listening and speaking Skills
- Seminar Presentation
- Group Discussion
- Job Interview

Reference Books:

1. Advanced Manual for Communication Laboratories and Technical report Writing, D.Sindha Rani, Pearson (New Delhi)
2. A Course in Phonetics and Spoken English , J. Sethi & P.V.Dhamija, PHI Learning Pvt. Ltd.
3. English Language Laboratories: A Comprehensive manual, Nira Konar , PHI Learning Pvt.Ltd.
4. Oxford English Learning Package (with CDs: Headway Series)
5. Tata McGraw hills English Learning package (with CDs)
6. Oxford advanced Learners Dictionary by Oxford University Press (New Delhi)

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Graph Theory

B.Sc. (Mathematics) **Semester II**

L-T-P-C Structure 2-0-0-2 **Course Type: Skill Enhancement**

Module 1: Definition, examples and basic properties of graphs.

Module 2: Pseudo graphs, complete graphs, bi-partite graphs.

Module 3: Isomorphism of graphs, paths and circuits, Eulerian circuits, Hamiltonian cycles.

Module 4: The adjacency matrix, weighted graph, travelling salesman's problem.

Module 5: Shortest path, Dijkstra's algorithm, Floyd-Warshall algorithm.

Reference Books:

1. B.A. Davey and H.A. Priestley, *Introduction to Lattices and Order*, Cambridge university Press, Cambridge, 1990.
2. Edgar G. Goodaire and Michael M. Parmenter, *Discrete Mathematics with Graph theory*, 2nd Edition, Pearson Education (Singapore) P. Ltd., Indian Reprint 2003.
3. Rudolf Lidl and Gunter Pilz, Applied Abstract Algebra, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

MAT191

Operating System: Linux

B.Sc. (Mathematics) **Semester II**

L-T-P-C Structure 2-0-0-2 **Course Type: Skill Enhancement**

Module 1: Linux – The Operating System: Linux history, Linux features, Linux distributions, Linux's relationship to Unix, Overview of Linux architecture.

Module 2: Installation, Start up scripts, system processes (an overview), Linux Security, The Ext2 and Ext3 File systems: General Characteristics of, the Ext3 File system, file permissions.

Module 3: User Management: Types of users, the powers of Root, managing users (adding and deleting): using the command line and GUI tools.

Module 4: Resource Management in Linux: file and directory management, system calls for files Process Management, Signals.

Module 5: IPC: Pipes, FIFOs, System V IPC, Message Queues, system calls for processes, Memory Management, library and system calls for memory.

Reference Books:

1. Arnold Robbins, *Linux Programming by Examples The Fundamentals*, 2nd Ed., Pearson Education, 2008.
2. Cox K, *Red Hat Linux Administrator's Guide*, PHI, 2009.
3. R. Stevens, *UNIX Network Programming*, 3rd Ed., PHI, 2008.
4. Sumitabha Das, *Unix Concepts and Applications*, 4th Ed., TMH, 2009.
5. Ellen Siever, Stephen Figgins, Robert Love, Arnold Robbins, *Linux in a Nutshell*, 6th Ed., O'Reilly Media, 2009.
6. Neil Matthew, Richard Stones, Alan Cox, *Beginning Linux Programming*, 3rd Ed., 2004.

PHY 111
ELECTRICITY AND MAGNETISM

B.Sc. (Mathematics) **Semester II**

L-T-P-C Structure 4-0-0-4 **Course Type: General Elective Theory**

Module 1: Vector Analysis: Review of vector algebra (Scalar and Vector product), gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only).

Module 2: Electrostatics: Gauss's theorem of electrostatics. Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Displacement vector.

Module 3: Magnetism: Magnetostatics: Biot-Savart's law & its applications- straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law. Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-, para- and ferro-magnetic materials.

Module 4: Electromagnetic Induction: Faraday's laws of electromagnetic induction, Motional Emf, Lenz's law, Self and mutual inductance, L of single coil, M of two coils, Application of mutual inductance to transformer, Magnetic energy density.

Module 5: Maxwell`s equations and Electromagnetic wave propagation: Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, polarization.

Reference Books:

1. ElectricityandMagnetism,EdwardM.Purcell,1986,McGraw-HillEducation..
2. ElectricityandMagnetism,J.H.Fewkes&J.Yarwood.Vol.I,1991,OxfordUniv.Press.
3. ElectricityandMagnetism,DCTayal,1988,HimalayaPublishingHouse.
4. UniversityPhysics,RonaldLaneReese,2003,ThomsonBrooks/Cole. 5. D.J. Griffiths, Introduction to Electrodynamics, 3rd Edn, 1998,Benjamin Cummings

PHY 112
ELECTRICITY AND MAGNETISM LAB

B.Sc. (Mathematics) **Semester II**

L-T-P-C Structure 0-0-4-2 **Course Type: General Elective Practical**

List of Practicals:

1. To use a Multimeter for measuring
   (a) Resistances, (b)AC and DC Voltages, (c) DC Current, and
   (d) checking electrical fuses.
2. Ballistic Galvanometer:
   (i) Measurement of charge and current sensitivity
   (ii) Measurement of CDR
   (iii)Determine a high resistance by Leakage Method
   (iv)To determine Self Inductance of a Coil by Rayleigh's Method.
3. To compare capacitances using De'Sauty's bridge.
4. Measurement of field strength B and its variation in a Solenoid (Determine dB/dx).
5. To study the Characteristics of a Series RC Circuit.
6. To study the a series LCR circuit and determine its (a)Resonant Frequency,(b) Quality Factor
7. To study a parallel LCR circuit and determine its
   (a)Anti-resonant frequency and
   (b)Quality factor Q
8. To determine a Low Resistance by Carey Foster's Bridge.
9. To verify the The venin and Norton theorem
10. To verify the Superposition, and Maximum Power Transfer Theorem

Reference Books:

1. Advanced Practical Physics for students, B.L.Flint &H.T.Worsnop,1971,Asia Publishing House.
2. A Text Book of Practical Physics, Indu Prakash and Ramakrishna,11th Edition,2011, Kitab Mahal, NewDelhi.
3. Engineering Practical Physics, S.Panigrahi & B.Mallick, 2015,Cengage Learning India Pvt. Ltd.
4. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers

MAT127
THEORY OF REAL FUNCTIONS

B.Sc. (Mathematics) **Semester III**

L-T-P-C Structure 5-1-0-6 **Course Type: Core Theory**

Module 1: Limits of functions ($\varepsilon-\delta$ approach), sequential criterion for limits, divergence criteria. Limit theorems, one sided limits. Infinite limits and limits at infinity. Continuous functions, sequential criterion for continuity and discontinuity.

Module 2: Algebra of continuous functions. Continuous functions on an interval, intermediate value theorem, location of roots theorem, preservation of intervals theorem. Uniform continuity, non-uniform continuity criteria, uniform continuity theorem.

Module 3: Algebra of differentiable functions. Relative extrema, interior extremum theorem. Rolle's Theorem, Mean value theorem, intermediate value property of derivatives, Darboux's theorem.

Module 4: Applications of mean value theorem to inequalities and approximation of polynomials, Taylor's theorem to inequalities. Cauchy's mean value theorem. Taylor's theorem with Lagrange's form of remainder, Taylor's theorem with Cauchy's form of remainder.

Module 5: Application of Taylor's theorem to convex functions, relative extrema. Taylor's series and Maclaurin's series expansions of exponential and trigonometric functions, ln (1 + x), 1/ax+b and $(1+x)^n$.

Reference Books:

1. R. Bartle and D.R. Sherbert, *Introduction to Real Analysis*, John Wiley and Sons, 2003.
2. K.A. Ross, *Elementary Analysis: The Theory of Calculus*, Springer, 2004.
3. A. Mattuck, *Introduction to Analysis*, Prentice Hall, 1999.
4. S.R. Ghorpade and B.V. Limaye, *A Course in Calculus and Real Analysis*, Springer, 2006.

MAT128
GROUP THEORY I

B.Sc. (Mathematics) **Semester III**

L-T-P-C Structure 5-1-0-6 **Course Type: Core Theory**

Module 1: Symmetries of a square, dihedral groups, definition and examples of groups including permutation groups and quaternion groups (illustration through matrices), elementary properties of groups.

Module 2: Subgroups and examples of subgroups, centralizer, normalizer, center of a group, product of two subgroups. Properties of cyclic groups, classification of subgroups of cyclic groups.

Module 3: Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group, properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem.

Module 4: External direct product of a finite number of groups, normal subgroups, factor groups, Cauchy's theorem for finite abelian groups.

Module 5: Group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms, First, Second and Third isomorphism theorems.

Reference Books:

1. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002**.**
2. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.
3. Joseph A. Gallian, *Contemporary Abstract Algebra*, 4th Ed., Narosa Publishing House, New Delhi, 1999.
4. Joseph J. Rotman, *An Introduction to the Theory of Groups*, 4th Ed., Springer Verlag, 1995.
5. I.N. Herstein, *Topics in Algebra*, Wiley Eastern Limited, India, 1975.

MAT129
PDE AND SYSTEMS OF ODE

B.Sc. (Mathematics) **Semester III**

L-T-P-C Structure 4-0-0-4 **Course Type: Core Theory**

Module 1: Partial Differential Equations – Basic concepts and Definitions, Mathematical Problems. First-Order Equations: Classification, Construction and Geometrical Interpretation. Method of Characteristics for obtaining General Solution of Quasi Linear Equations. Canonical Forms of First-order Linear Equations.

Module 2: Method of Separation of Variables for solving first order partial differential equations. Derivation of Heat equation, Wave equation and Laplace equation. Classification of second order linear equations as hyperbolic, parabolic or elliptic. Reduction of second order Linear Equations to canonical forms.

Module 3: The Cauchy problem, the Cauchy-Kowaleewskaya theorem, Cauchy problem of an infinite string. Initial Boundary Value Problems, Semi-Infinite String with a fixed end, Semi-Infinite String with a Free end, Equations with non-homogeneous boundary conditions, Non-Homogeneous Wave Equation.

Module 4: Method of separation of variables, solving the Vibrating String Problem, Solving the Heat Conduction problem Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients.

Module 5: Basic Theory of linear systems in normal form, homogeneous linear systems with constant coefficients: Two Equations in two unknown functions, The method of successive approximations, the Euler method, the modified Euler method, The Runge-Kutta method.

Reference Books:

1. Tyn Myint-U and Lokenath Debnath, *Linear Partial Differential Equations for Scientists and Engineers*, 4th edition, Springer, Indian reprint, 2006.

2. S.L. Ross, *Differential equations*, 3rd Ed., John Wiley and Sons, India, 2004.

3. Martha L Abell, James P Braselton, *Differential equations with MATHEMATICA*, 3rd Ed. Elsevier Academic Press, 2004.

PDE AND SYSTEMS OF ODE LAB

B.Sc. (Mathematics) **Semester III**

L-T-P-C Structure 0-0-4-2 **Course Type: Core Practical**

List of Practical (using any software)

(i) Solution of Cauchy problem for first order PDE.

(ii) Finding the characteristics for the first order PDE.

(iii) Plot the integral surfaces of a given first order PDE with initial data.

(iv) Solution of wave equation

Reference Books:

1. Tyn Myint-U and Lokenath Debnath, *Linear Partial Differential Equations for Scientists and Engineers*, 4th edition, Springer, Indian reprint, 2006.

2. S.L. Ross, *Differential equations*, 3rd Ed., John Wiley and Sons, India, 2004.

3. Martha L Abell, James P Braselton, *Differential equations with MATHEMATICA*, 3rd Ed. Elsevier Academic Press, 2004.

PHY113
THERMAL PHYSICS AND STASTICAL MECHANICS

B.Sc. (Mathematics) **Semester III**

L-T-P-C Structure 4-0-0-4 **Course Type: Generic Elective Theory**

Module 1: Laws of Thermodynamics: Thermodynamic Description of system: Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: General Relation between CP & CV, Work Done during Isothermal and Adiabatic Processes, Compressibility & Expansion Coefficient.

Module 2: Reversible & irreversible processes, Second law & Entropy, Carnot's cycle & theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero. Thermodynamic Potentials: Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations & applications.

Module 3: Joule-Thompson Effect, Clausius- Clapeyron Equation, Expression for (CP – CV), CP/CV, TdS equations. Kinetic Theory of Gases: Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path (Zeroth Order), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case).

Module 4: Law of equipartition of energy (no derivation) and its applications to specific heat of gases; mono-atomic and diatomic gases.

Theory of Radiation: Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh- Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law.

Module 5: Statistical Mechanics: Phase space, Macrostate and Microstate, Entropy and Thermodynamic probability, Maxwell-Boltzmann law - distribution of velocity - Quantum statistics - Fermi-Dirac distribution law - electron gas - Bose-Einstein distribution law - photon gas - comparison of three statistics.

Reference Books:

1. Thermal Physics, S. Garg, R. Bansal and C. Ghosh, , Tata McGraw-Hill,1993.
2. A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, Indian Press,1969,.
3. Thermodynamics, Enrico Fermi, Courier Dover Publications,1956,.
4. Heat and Thermodynamics, M.W.Zemasky and R. Dittman, , McGraw Hill,1981

PHY114

THERMAL PHYSICS AND STASTICAL MECHANICS LAB

B.Sc. (Mathematics) **Semester III**

L-T-P-C Structure 0-0-4-2 **Course Type: General Elective Practical**

List of Practical:

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. Measurement of Planck's constant using black body radiation.
3. To determine Stefan's Constant.
4. To determine the coefficient of thermal conductivity of copper by Searle's Apparatus.
5. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
6. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
7. To determine the temperature co-efficient of resistance by Platinum resistance thermometer.
8. To study the variation of thermo emf across two junctions of a thermocouple with temperature.
9. To record and analyze the cooling temperature of an hot object as a function of time using a thermocouple and suitable data acquisition system
10. To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge

Reference Books:

1. Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, Asia Publishing House,1971.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted Heinemann Educational Publishers, 1985.
3. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, Kitab Mahal, New Delhi, 2011.
4. A Laboratory Manual of Physics for Undergraduate Classes, D.P. Khandelwal, Vani Publication,1985.

MAT130

NUMERICAL METHODS

B.Sc. (Mathematics) **Semester IV**

L-T-P-C Structure 4-0-0-4 **Course Type: Core Theory**

Module 1: Errors: Relative, Absolute, Round off, Truncation. Transcendental and Polynomial equations: Bisection method, Newton's method, Secant method, Regula Falsi Method, Iteration Method, Rate of convergence of these methods.

Module 2: System of linear algebraic equations, Factorization, Cholesky decomposition. Diagonal dominance, ill conditioned matrices, Gaussian Elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis.

Module 3: Difference operators (shift, forward, backward and central difference), Application of finite difference operators to solve initial and boundary value problems, Interpolation, Lagrange and Newton's methods, Error bounds, Gregory forward and backward difference interpolation. Stirling's and Bessel's formula for interpolation, Gauss forward formula, Gauss backward formula.

Module 4: Numerical Differentiation, Numerical Integration, Trapezoidal rule, Simpson's rule, Simpsons 3/8th rule, Boole's Rule, Composite Trapezoidal rule, Composite Simpson's rule, Weddle rule.

Module 5: Numerical integration of Ordinary Differential Equations of first order, Picard's method, Euler's method, Euler's modified method, Runge-Kutta methods of orders two and four.

Reference Books:

1. Brian Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.

2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 6th Ed., New age International Publisher, India, 2007.

3. C.F. Gerald and P.O. Wheatley, Applied Numerical Analysis, Pearson Education, India, 2008.

4. Uri M. Ascher and Chen Greif, A First Course in Numerical Methods, 7th Ed., PHI Learning Private Limited, 2013.

5. John H. Mathews and Kurtis D. Fink, Numerical Methods using MATLAB, 4th Ed., PHI Learning Private Limited, 2012.

MAT131

RIEMANN INTEGRATION AND SERIES OF FUNCTIONS

B.Sc. (Mathematics) **Semester IV**

L-T-P-C Structure 5-1-0-6 **Course Type: Core Theory**

Module 1: Riemann integration; inequalities of upper and lower sums; Riemann conditions of integrability.Riemann sum and definition of Riemann integral through Riemann sums; equivalence of two definition.

Module 2: Riemann integrability of monotone and continuous functions, Properties of the Riemann integral; definition and integrability of piecewise continuous and monotone functions.

Module 3: Intermediate Value theorem for Integrals; Fundamental theorems of Calculus.Improper integrals; Convergence of Beta and Gamma functions.
Pointwise and uniform convergence of sequence of functions.

Module 4: Theorems on continuity, derivability and integrability of the limit function of a sequence of functions. Series of functions;Theorems on the continuity and derivability of the sum function of a series of functions; Cauchy criterion for uniform convergence and Weierstrass M-Test.

Module 5: Limit superior and Limit inferior. Power series, radius of convergence, Cauchy Hadamard Theorem, Differentiation and integration of power series; Abel's Theorem; Weierstrass Approximation Theorem.

Reference Books:

1. K.A. Ross, Elementary Analysis, The Theory of Calculus, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
2. R.G. Bartle D.R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
3. Charles G. Denlinger, Elements of Real Analysis, Jones & Bartlett (Student Edition), 2011.

MAT132

RING THEORY AND LINEAR ALGEBRA I

B.Sc. (Mathematics) **Semester IV**

L-T-P-C Structure 5-1-0-6 **Course Type: Core Theory**

Module 1: Definition and examples of rings, properties of rings, subrings, integral domains and fields, characteristic of a ring.

Module 2: Ideal, ideal generated by a subset of a ring, factor rings, operations on ideals, prime and maximal ideals. Ring homomorphisms, properties of ring homomorphisms, Isomorphism theorems I, II and III,

Module 3: Vector spaces, subspaces, algebra of subspaces, field of quotients, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces.

Module 4: Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations.

Module 5: Isomorphisms, Isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix.

Reference Books:

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
3. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra, 4th Ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.
4. Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, New Delhi, 1999.
5. S. Lang, Introduction to Linear Algebra, 2nd Ed., Springer, 2005.
6. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007.
7. S. Kumaresan, Linear Algebra- A Geometric Approach, Prentice Hall of India,1999.
8. Kenneth Hoffman, Ray Alden Kunze, Linear Algebra, 2nd Ed., Prentice-Hall of India Pvt. Ltd., 1971.
9. D.A.R. Wallace, Groups, Rings and Fields, Springer Verlag London Ltd., 1998.

MAT188

NUMERICAL METHODS LAB

B.Sc. (Mathematics) **Semester IV**

L-T-P-C Structure 0-0-4-2 **Course Type: Core Practical**

List of Practical (Do any eight using any software):

(i) Calculate the sum 1/1 + 1/2 + 1/3 + 1/4 + ----------+ 1/ N.
(ii) To find the absolute value of an integer.
(iii) Enter 100 integers into an array and sort them in an ascending order.
(iv) Bisection Method.
(v) Newton Raphson Method.
(vi) Secant Method.
(vii) Regulai Falsi Method.
(viii) LU decomposition Method.
(ix) Gauss-Jacobi Method.
(x) SOR Method or Gauss-Siedel Method.
(xi) Lagrange Interpolation or Newton Interpolation.
(xii) Simpson's rule.

Reference Books:

1. Brian Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.

2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 6th Ed., New age International Publisher, India, 2007.

3. C.F. Gerald and P.O. Wheatley, Applied Numerical Analysis, Pearson Education, India, 2008.

4. Uri M. Ascher and Chen Greif, A First Course in Numerical Methods, 7th Ed., PHI Learning Private Limited, 2013.

5. John H. Mathews and Kurtis D. Fink, Numerical Methods using MATLAB, 4th Ed., PHI Learning Private Limited, 2012.

PHY115
WAVES AND OPTICS

B.Sc. (Mathematics) **Semester IV**

L-T-P-C Structure 4-0-0-4 **Course Type: Generic Elective Theory**

Module 1: Superposition of Two Collinear Harmonic oscillations: Linearity and Superposition Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats). **Superposition of Two Perpendicular Harmonic Oscillations**: Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses. **Waves Motion- General**: Transverse waves on a string. Travelling and standing waves on a string. Normal Modes of a string. Group velocity, Phase velocity. Plane waves. Spherical waves, Wave intensity.

Module 2: Fluids: Surface Tension: Synclastic and anticlastic surface - Excess of pressure - Application to spherical and cylindrical drops and bubbles - variation of surface tension with temperature - Jaegar's method. Viscosity: Viscosity - Rate flow of liquid in a capillary tube - Poiseuille's formula - Determination of coefficient of viscosity of a liquid - Variations of viscosity of a liquid with temperature lubrication. Physics of low pressure - production and measurement of low pressure - Rotary pump - Diffusion pump - Molecular pump - Knudsen absolute gauge - penning and pirani gauge – Detection of leakage.

Module 3: Sound: Simple harmonic motion - forced vibrations and resonance - Fourier's Theorem - Application to saw tooth wave and square wave - Intensity and loudness of sound - Decibels - Intensity levels - musical notes - musical scale. Acoustics of buildings: Reverberation and time of reverberation - Absorption coefficient - Sabine's formula - measurement of reverberation time - Acoustic aspects of halls and auditoria.

Module 4: Wave Optics: Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle. **Interference:** Interference: Division of amplitude and division of wavefront. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Film, Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings and its applications. Michelson's Interferometer: Idea of form of fringes (no theory needed) and its applications

Module 5: Diffraction: Fraunhofer diffraction: Single slit, multiple slits & Diffraction grating. Fresnel Diffraction: Half-period zones. Zone plate. Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis. **Polarization:** Transverse nature of light waves. Plane polarized light – production and analysis. Circular and elliptical polarization.

Reference Books:

1. Fundamentals of Optics, F A Jenkins and H E White, McGraw-Hill,1976.
2. Principles of Optics, B.K. Mathur, , Gopal Printing, 1995
3. Fundamentals of Optics, H.R. Gulati and D.R. Khanna, R. Chand Publication,1991

PHY116

WAVES AND OPTICS LAB

B.Sc. (Mathematics) **Semester IV**

L-T-P-C Structure 0-0-4-2 **Course Type: Generic Elective Practical**

List of Practical:

1. To investigate the motion of coupled oscillators
2. To determine the Frequency of an Electrically Maintained Tuning Fork by Melde's Experiment and to verify λ^2 – T Law.
3. To study Lissajous Figures
4. To determine the Refractive Index of the Material of a given Prism using Sodium Light.
5. To determine Dispersive Power of the Material of a given Prism using Mercury Light
6. To determine the value of Cauchy Constants of a material of a prism.
7. To determine the Resolving Power of a Prism.
8. To determine wavelength of sodium light using Fresnel Biprism.
9. To determine wavelength of sodium light using Newton's Rings.
10. To determine the Resolving Power of a Plane Diffraction Grating.

Reference Books:

1. Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi

BCS203

Computer Application Lab

L-T-P-C Structure 0-0-4-2 Course Type: Skill Enhancement Practical

Module I

Introduction to computer- characteristics of computers, The computer System, Parts of Computer): Computer H/W Setup, Configuration, networking, Mobile H/W device and, types, wireless Networking; Operating System- Introduction to operating system, An overview of various computer & mobile OS & Application (UNIX/LINUX, DOS, Window mobile iOS Like), Features of latest window operating system & its management & networking (Installation, backup, security, User control), Usage of payment gateways.

Module II

Introduction to essential tools- Introduction to facilities & commonly used features of:

a) **Word:** Working with word document, Inserting, filling and formatting a table, Mail Merge including linking with access database, creating macros- Sending E-mail from word Import/Export of filled converting word document to web document, PDF files hyperlinks; OLE security features in MS word – Protection of documents- Checking for viruses in macro referencing, creating bibliography, manage sources and citations, review documents.

b) **Power Point:** Preparing Presentations, Slides, Handouts, Speaker's Notes- Outlines- Media Clip – Graphs, Adding the transitions to the slide Show- Special effects in detail, - Setting Slip timings.

Module III

Using MS Excel for Data Analysis & Reporting Features:

- Using spread sheet for following purposes and making reports:
- Loan & Lease Statement
- Ratio Analysis Payroll Statements
- Capital Budgeting
- Depreciable representation of data
- Frequency distribution and its statistical parameters

Correlation and Regression

Module IV

RDBMS Concepts & Access- RDBMS Concepts, Terminology, Models- RDBMS, Data Modelling using ERD , DB Design using Normalization, Access Creating Databases & Tables- An Introduction; Event Handling & Report Generation : Using Queries through case study.

Module-V

CAAT Tools- Capabilities & Importing Data from accounting & other application System – An Introduction: Analytical reports, Duplicates/ Gaps. Sorting & charting: Stratification, Summarization Statistics 7 Aging-An Introduction Sampling Macros and Audit Trail.

Books Suggested:

1. Rajaraman, V. Introduction to information Technology,PHI.

2.Eliason, A.L, On-line business computer- Application science research Associates Chicago.

3.Curtis D. Frye, Step Microsoft Excel 2010, PHI.

MULTIVARIATE CALCULUS

B.Sc. (Mathematics) **Semester V**

L-T-P-C Structure 5-1-0-6 **Course Type: Core Theory**

Module 1: Functions of several variables, limit and continuity of functions of two variables Partial differentiation, total differentiability and differentiability, sufficient condition for differentiability.

Module 2: Chain rule for one and two independent parameters, directional derivatives, the gradient, maximal and normal property of the gradient, tangent planes, Extrema of functions of two variables, method of Lagrange multipliers, constrained optimization problems.

Module 3: Definition of vector field, divergence and curl Double integration over rectangular region, double integration over non-rectangular region, Double integrals in polar co-ordinates.

Module 4: Triple integrals, Triple integral over a parallelepiped and solid regions. Volume by triple integrals, cylindrical and spherical co-ordinates. Change of variables in double integrals and triple integrals.

Module 5: Line integrals, Applications of line integrals: Mass and Work. Fundamental theorem for line integrals, conservative vector fields,
independence of path. Green's theorem, surface integrals, integrals over parametrically defined surfaces. Stoke'stheorem, the Divergence theorem.

Reference Books:

1. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
2. M.J. Strauss, G.L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007.
3. E. Marsden, A.J. Tromba and A. Weinstein, Basic Multivariable Calculus, Springer (SIE), Indian reprint, 2005.
4. James Stewart, Multivariable Calculus, Concepts and Contexts, 2nd Ed., Brooks /Cole, Thomson Learning, USA, 2001.

MAT137
GROUP THEORY II

B.Sc. (Mathematics) **Semester V**

L-T-P-C Structure 5-1-0-6 **Course Type: Core Theory**

Module 1: Automorphism, inner automorphism, automorphism groups, automorphism groups of finite and infinite cyclic groups, applications of factor groups to automorphism groups.

Module 2: Characteristic subgroups, Commutator subgroup and its properties.
Properties of external direct products, the group of units modulo n as an external direct product, internal direct products.

Module 3: Fundamental Theorem of finite abelian groups. Group actions, stabilizers and kernels, permutation representation associated with a given group
action.

Module 4: Applications of group actions: Generalized Cayley's theorem, Index theorem. Groups acting on themselves by conjugation, class equation and consequences.

Module 5: Conjugacy in S_n, p-groups, Sylow's theorems and consequences, Cauchy's theorem, Simplicity of A_n for $n \geq 5$, non-simplicity tests, Groups of order 12. Computation in the symmetric groups. Free groups

Reference Books:

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
3. Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, 1999.
4. David S. Dummit and Richard M. Foote, Abstract Algebra, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2004.
5. J.R. Durbin, Modern Algebra, John Wiley & Sons, New York Inc., 2000.
6. D. A. R. Wallace, Groups, Rings and Fields, Springer Verlag London Ltd., 1998.

MAT 140
PORTFOLIO OPTIMIZATION

B.Sc. (Mathematics) **Semester V**

L-T-P-C Structure 5-1-0-6 **Course Type: Discipline Specific Elective 1**

Module 1: Financial markets. Investment objectives. Measures of return and risk. Types of risks. Risk free assets.

Module 2: Mutual funds. Portfolio of assets. Expected risk and return of portfolio. Diversification.

Module 3: Mean-variance portfolio optimization- the Markowitz model and the two-fund theorem, risk-free assets and one fund theorem, efficient frontier.

Module 4: Portfolios with short sales. Capital market theory.Capital assets pricing model- the capital market line, beta of an asset, beta of a portfolio.

Module 5: Security market line. Index tracking optimization models. Portfolio performance evaluation measures.

Reference Books:

1. F. K. Reilly, Keith C. Brown, Investment Analysis and Portfolio Management, 10th Ed.,South-Western Publishers, 2011.
2. H.M. Markowitz, Mean-Variance Analysis in Portfolio Choice and Capital Markets, Blackwell, New York, 1987.
3. M.J. Best, Portfolio Optimization, Chapman and Hall, CRC Press, 2010.
4. D.G. Luenberger, Investment Science, 2nd Ed., Oxford University Press, 2013.

MAT 141
NUMBER THEORY

B.Sc. (Mathematics) **Semester V**

L-T-P-C Structure 5-1-0-6 **Course Type: Discipline Specific Elective 1**

Module 1: Linear Diophantine equation, prime counting function, statement of prime number theorem, Goldbach conjecture, linear congruences, complete set of residues, Chinese Remainder theorem, Fermat's Little theorem, Wilson's theorem.

Module 2: Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Mobius Inversion formula, the greatest integer function.

Module 3: Euler's phi-function, Euler's theorem, reduced set of residues, some properties of Euler's phi-function. Order of an integer modulo n, primitive roots for primes, composite numbers having primitive roots,

Module 4: Euler's criterion, the Legendre symbol and its properties, quadratic reciprocity, quadratic congruences with composite moduli.

Module 5: Public key encryption, RSA encryption and decryption, the equation x2 + y2= z2, Fermat's Last theorem.

Reference Books:

1. David M. Burton, *Elementary Number Theory,* 6th Ed., Tata McGraw-Hill, Indian reprint, 2007.
2. Neville Robinns, *Beginning Number Theory,* 2nd Ed., Narosa Publishing House Pvt. Ltd.,Delhi, 2007.
3. Thomas Koshy, *Elementary Number Theory with Applications*, Elsevier Science & Technology Books

MAT 142
ANALYTICAL GEOMETRY

B.Sc. (Mathematics) **Semester V**

L-T-P-C Structure 5-1-0-6 **Course Type: Discipline Specific Elective 1**

Module 1: Polar Form of General Conics : Polar equations of a straight line, Joining two lines , Normal form, Line parallel and perpendicular to the initial line, General equation, Polar equations of a circle, Equation of chord, tangent and normal to the circle . Polar equations of a conic in the form $\frac{l}{r} = 1 + e\cos\theta$, Chord, Tangent and normal of a conic.

Module 2 The Sphere, Equations in different forms of sphere. Intersection of a sphere with straight line and a plane. Power of a point and radical plane. Tangent plane and condition of tangency. Equations of a circle. Intersection of two spheres , Intersection of a sphere and plane. Orthogonality of two spheres.

Module 3: Cones, Right circular cone, enveloping cone. Cylinder, Right circular cylinder and enveloping cylinder.

Module 4: Central Conicoids: Equation of tangent plane. Director sphere. Normal to the conicoids. Polar plane of a point. Enveloping cone of a coincoid. Enveloping cylinder of a coincoid.

Module 5: Paraboloids: Circular section, Plane sections of conicoids. Generating lines. Confocal conicoid. Reduction of second degree equations.

Reference Books:

1. Shantinarayan: *Analytical Solid Geometry*, S. Chand and Company Ltd, New Delhi, 1998.
2. David Burton, *Elementary Number Theory*, Tata McGraw Hill, Indian Edition.
3. H. Anton and C. Rorres, *Elementary Linear Algebra with Applications*, Seventh Ed Wiley, (1994).
4. P.K.Jain and Khalil Ahmad,*A Text Book of Analytical Geometry of Three Dimensions*, Wiley Estern Ltd. 1999.
5. K.B.Datta, *Matrix and Linear Algebra*, Prentice hall of India Pvt.Ltd, New Delhi 2000.

MAT 143
INDUSTRIAL MATHEMATICS

B.Sc. (Mathematics) **Semester V**

L-T-P-C Structure 5-1-0-6 **Course Type: Discipline Specific Elective 2**

Module 1: Medical Imaging and Inverse Problems. The content is based on Mathematics of X-ray and CT scan based on the knowledge of calculus, elementary differential equations, complex numbers and matrices.
Module 2: Introduction to Inverse problems: need of Inverse Problems, Illustration of Inverse problems through problems taught in Pre-Calculus, Calculus, Matrices and differential equations.
Module 3: Geological anomalies in Earth's interior from measurements at its surface (Inverse problems for Natural disaster) and Tomography. X-ray: Introduction, X-ray behavior and Beers Law (The fundament question of image construction) Lines in the place.
Module 4: Radon Transform: Definition and Examples, Linearity, Phantom (Shepp - Logan Phantom -Mathematical phantoms). Back Projection: Definition, properties and examples.
Module 5: CT Scan: Revision of properties of Fourier and inverse Fourier transforms and applications of their properties in image reconstruction. Algorithms of CT scan machine. Algebraic reconstruction techniques abbreviated as ART with application to CT scan.

Reference Books:

1. Timothy G. Feeman, *The Mathematics of Medical Imaging, A Beginners Guide*, Springer Under graduate Text in Mathematics and Technology, Springer, 2010.
2. C.W. Groetsch, *Inverse Problems*, Activities for Undergraduates, The Mathematical Association of America, 1999.
3. Andreas Kirsch, *An Introduction to the Mathematical Theory of Inverse Problems*, 2nd Ed., Springer, 2011.

MAT 144
Boolean Algebra and Automata Theory

B.Sc. (Mathematics) **Semester V**

L-T-P-C Structure 5-1-0-6 **Course Type: Discipline Specific Elective 2**

Module 1: Definition, examples and basic properties of ordered sets, maps between ordered sets, duality principle, lattices as ordered sets, lattices as algebraic structures, sublattices, products and homomorphisms.

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Module 2: Definition, examples and properties of modular and distributive lattices, Boolean algebras, Boolean polynomials, minimal forms of Boolean polynomials, Quinn-McCluskey method, Karnaugh diagrams, switching circuits and applications of switching circuits.

Module 3: Introduction: Alphabets, strings, and languages. Finite Automata and Regular Languages: deterministic and non-deterministic finite automata, regular expressions, regular languages and their relationship with finite automata, pumping lemma and closure properties of regular languages.

Module 4: Context Free Grammars and Pushdown Automata: Context free grammars (CFG), parse trees, ambiguities in grammars and languages, pushdown automaton (PDA) and the language accepted by PDA, deterministic PDA.

Module 5: Non- deterministic PDA, properties of context free languages; normal forms, pumping lemma, closure properties, decision properties.

Reference Books:

1. B A. Davey and H. A. Priestley, *Introduction to Lattices and Order*, Cambridge University Press, Cambridge, 1990.
2. Edgar G. Goodaire and Michael M. Parmenter, *Discrete Mathematics with Graph Theory*, (2nd Ed.), Pearson Education (Singapore) P.Ltd., Indian Reprint 2003.
3. Rudolf Lidl and Günter Pilz, *Applied Abstract Algebra*, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
4. J. E. Hopcroft, R. Motwani and J. D. Ullman, *Introduction to Automata Theory, Languages, and Computation*, 2nd Ed., Addison-Wesley, 2001.
5. H.R. Lewis, C.H. Papadimitriou, C. Papadimitriou, *Elements of the Theory of Computation*, 2nd Ed., Prentice-Hall, NJ, 1997.
6. J.A. Anderson, *Automata Theory with Modern Applications*, Cambridge University Press, 2006.
7. M. Morris Mano, *Digital Logic And Computer Design*, Prentice-Hall, 1979.

MAT 145
PROBABILITY AND STATISTICS

B.Sc. (Mathematics) **Semester V**

L-T-P-C Structure 5-1-0-6 **Course Type: Discipline Specific Elective 2**

Module 1: Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation, moments, moment generating function, characteristic function.

Module 2: Discrete distributions: uniform, binomial, Poisson, geometric, negative binomial, continuous distributions: uniform, normal, exponential. Joint cumulative distribution function and its properties, joint probability density functions.

Module 3: Marginal and conditional distributions, expectation of function of two random variables, conditional expectations, independent random variables, bivariate normal distribution.

Module 4: Correlation coefficient, joint moment generating function (jmgf) and calculation of covariance (from jmgf), linear regression for two variables.
Chebyshev's inequality, statement and interpretation of (weak) law of large numbers and strong law of large numbers.

Module 5: Central Limit theorem for independent and identically distributed random variables with finite variance, Markov Chains, Chapman-Kolmogorov equations, classification of states.

Reference Books:

1. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, Introduction to Mathematical Statistics, Pearson Education, Asia, 2007.
2. Irwin Miller and Marylees Miller, John E. Freund, Mathematical Statistics with Applications, 7th Ed., Pearson Education, Asia, 2006.
3. Sheldon Ross, Introduction to Probability Models, 9th Ed., Academic Press, Indian Reprint, 2007.
4. Alexander M. Mood, Franklin A. Graybill and Duane C. Boes, Introduction to the Theory of Statistics, 3rd Ed., Tata McGraw- Hill, Reprint 2007

MAT138
METRIC SPACES AND COMPLEX ANALYSIS

B.Sc. (Mathematics) **Semester VI**

L-T-P-C Structure 5-1-0-6 **Course Type: Core Theory**

Module1: Metric spaces: definition and examples, Sequences in metric spaces, Cauchy sequences, Complete Metric Spaces, Open and closed balls, neighbourhood, open set, interior of a set, Limit point of a set, closed set, diameter of a set, Cantor's theorem, Subspaces, dense sets, separable spaces.

Module 2: Continuous mappings, sequential criterion and other characterizations of continuity, Uniform continuity, Homeomorphism, Connectedness, connected subsets of R.

Module 3: Limits, Limits involving the point at infinity, continuity, Properties of complex numbers, regions in the complex plane, functions of complex variable, mappings, Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability.

Module 4: Analytic functions, examples of analytic functions, exponential function, Logarithmic function, trigonometric function, derivatives of functions, Complex definite integrals of functions, Contours, Contour integrals and its examples, upper bounds for module of contour integrals.

Module 5: Cauchy- Goursat theorem, Cauchy integral formula, Liouville's theorem and the fundamental theorem of algebra, Convergence of sequences and series, Singularities, Residues of Residues, Max modulus theorem, Taylor series and its examples, Laurent series and its examples, absolute and uniform convergence of power series.

Reference Books:

1. Satish Shirali and Harikishan L. Vasudeva, Metric Spaces, Springer Verlag, London, 2006.
2. S. Kumaresan, Topology of Metric Spaces, 2nd Ed., Narosa Publishing House, 2011.
3. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill, 2004.
4. James Ward Brown and Ruel V. Churchill, Complex Variables and Applications, 8th Ed., McGraw – Hill International Edition, 2009.
5. Joseph Bak and Donald J. Newman, Complex Analysis, 2nd Ed., Undergraduate Texts in Mathematics, Springer-Verlag New York, Inc., NewYork, 1997.

MAT139
RING THEORY AND LINEAR ALGEBRA II

B.Sc. (Mathematics) **Semester VI**

L-T-P-C Structure 5-1-0-6 **Course Type: Core Theory**

Module 1: Polynomial rings over commutative rings, division algorithm and consequences, principal ideal domains, factorization of polynomials, reducibility tests, irreducibility tests, Eisenstein criterion.

Module 2: unique factorization in Z[x]. Divisibility in integral domains, irreducibles, primes, unique factorization domains, Euclidean domains.

Module 3: Dual spaces, dual basis, double dual, transpose of a linear transformation and its matrix in the dual basis, annihilators, Eigen spaces of a linear operator, diagonalizability.

Module 4: invariant subspaces and Cayley-Hamilton theorem, the minimal polynomial for a linear operator. Inner product spaces and norms, Gram-Schmidt orthogonalisation process, orthogonal complements.

Module 5: Bessel's inequality, the adjoint of a linear operator, Least Squares Approximation, minimal solutions to systems of linear equations, Normal and self-adjoint operators, Orthogonal projections and Spectral theorem.

Reference Books:

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.

2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.

3. Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, 1999.

4. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra, 4th Ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.

5. S. Lang, Introduction to Linear Algebra, 2nd Ed., Springer, 2005.

6. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007.

5. S. Kumaresan, Linear Algebra- A Geometric Approach, Prentice Hall of India, 1999.

6. Kenneth Hoffman, Ray Alden Kunze, Linear Algebra, 2nd Ed., Prentice-Hall of India Pvt. Ltd., 1971.

7. S.H. Friedberg, A.L. Insel and L.E. Spence, Linear Algebra, Prentice Hall of India Pvt. Ltd.,2004.

MAT 146
THEORY OF EQUATIONS

B.Sc. (Mathematics) **Semester VI**

L-T-P-C Structure 5-1-0-6 **Course Type: Discipline Specific Elective 3**

Module 1: General properties of polynomials, Graphical representation of a polynomial, maximum and minimum values of a polynomials, General properties of equations, Descartes's rule of signs positive and negative rule, Relation between the roots and the coefficients of equations.
Module 2: Symmetric functions, Applications of symmetric function of the roots, Transformation of equations. Solutions of reciprocal and binomial equations.
Module 3: Algebraic solutions of the cubic and biquadratic. Properties of the derived functions, Symmetric functions of the roots.
Module 4: Newton's theorem on the sums of powers of roots, homogeneous products, limits of the roots of equations, Separation of the roots of equations.
Module 5: Strums theorem, Applications of Strum's theorem, Conditions for reality of the roots of an equation and biquadratic. Solution of numerical equations.

Reference Books:

1. W.S. Burnside and A.W. Panton, *The Theory of Equations*, Dublin University Press, 1954.
2. C. C. MacDuffee, *Theory of Equations*, John Wiley & Sons Inc., 1954.

MAT147
BIO-MATHEMATICS

B.Sc. (Mathematics) **Semester VI**

L-T-P-C Structure 5-1-0-6 **Course Type: Discipline Specific Elective 3**

Module 1: Mathematical Biology and the modeling process: an overview. Continuous models: Malthus model, logistic growth, Allee effect, Gompertz growth, Michaelis-Menten Kinetics, Holling type growth.

Module 2: Bacterial growth in a Chemostat, Harvesting a single natural population, Prey predator systems and Lotka Volterra equations, Populations in competitions, Epidemic Models (SI, SIR, SIRS, SIC), Activator-Inhibitor system.

Module 3: Insect Outbreak Model: Spruce Budworm, Numerical solution of the models and its graphical representation. Qualitative analysis of continuous models: Steady state solutions, stability and linearization, multiple species communities and Routh-Hurwitz Criteria.

Module 4: Phase plane methods and qualitative solutions, bifurcations and limit cycles with examples in the context of biological scenario. Spatial Models: One species model with diffusion, Two species model with diffusion, Conditions for diffusive instability, Spreading colonies of microorganisms.

Module 5: Blood flow in circulatory system, Travelling wave solutions, Spread of genes in a population. Discrete Models: Overview of difference equations, steady state solution and linear stability analysis.

Reference Books:

1. L.E. Keshet, Mathematical Models in Biology, SIAM, 1988.
2. J. D. Murray, Mathematical Biology, Springer, 1993.
3. Y.C. Fung, Biomechanics, Springer-Verlag, 1990.
4. F. Brauer, P.V.D. Driessche and J. Wu, Mathematical Epidemiology, Springer, 2008.
5. M. Kot, Elements of Mathematical Ecology, Cambridge University Press, 2001

MAT 148
LINEAR PROGRAMMING

B.Sc. (Mathematics) **Semester VI**

L-T-P-C Structure 5-1-0-6 **Course Type: Discipline Specific Elective 3**

Module 1: Introduction to linear programming problem, Statement and Formulation of Linear programming problem, Graphical solution, Convex sets, Hyperphlane and related theorems,

Module 2: Standard and matrix forms of linear programming problem, Basic feasible solution. Slack variables, Surplus variables and Artificial variables, Theory of simplex method, optimality and unboundedness.

Module 3: The simplex algorithm, simplex method in tableau format, introduction to artificial variables, two-phase method, Big-M method and their comparison.

Module 4: Resolution of degeneracy, Duality, formulation of the dual problem, primal-dual relationships, economic interpretation of the dual,

Module 5: Assignment problem and its mathematical formulation, Hungarian method for solving assignment problem. Transportation problem and its mathematical formulation, northwest-corner method least cost method and Vogel approximation method for determination of starting basic solution, algorithm for solving transportation problem.

Reference Books:

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, *Linear Programming and Network Flows,* 2nd Ed., John Wiley and Sons, India, 2004.
2. F.S. Hillier and G.J. Lieberman, *Introduction to Operations Research,* 9th Ed., Tata McGraw Hill, Singapore, 2009.
3. Hamdy A. Taha, *Operations Research, An Introduction*, 8th Ed., Prentice-Hall India, 2006.
4. G. Hadley, *Linear Programming*, Narosa Publishing House, New Delhi, 2002.

MAT 149
MATHEMATICAL MODELING

B.Sc. (Mathematics) **Semester VI**

L-T-P-C Structure 4-0-0-4 **Course Type: Discipline Specific Elective 4**

Module 1: Power series solution of a differential equation about an ordinary point, solution about a regular singular point, Bessel's equation and Legendre's equation, Laplace transform and inverse transform, application to initial value problem up to second order.

Module 2: Basic concepts. Real world problems, (Physics, Chemistry, Biology, Economics, and others) Approximation of the problem, Steps involved in modeling. Mathematical models: Linear growth and decay model, Logistic model, model of Mass-spring-dashpot (present in shock absorbed, mechanical engineering problems), Chemical reaction, Drug absorption from blood stream.

Module 3: Monte Carlo Simulation Modeling: simulating deterministic behavior (area under a curve, volume under a surface), Generating Random Numbers: middle square method, linear congruence.

Module 4: Queuing Models: harbor system, morning rush hour, Overview of optimization modeling, Linear Programming Model: geometric solution algebraic solution, simplex method, sensitivity analysis.

Reference Books:

1. Tyn Myint-U and Lokenath Debnath, Linear Partial Differential Equation for Scientists and Engineers, Springer, Indian reprint, 2006.

2. Frank R. Giordano, Maurice D. Weir and William P. Fox, A First Course in Mathematical Modeling, Thomson Learning, London and New York, 2003.

3. J. N. Kapur: Mathematical Moodelling, Wiley Eastern Ltd., 1998.

4. M. K. Jain, S. R. K.Iyengar and R.K.Jain : Numerical methods for scientific and engineering computation, Wiley Eastern Ltd. 1993, Third Edition.

5. C.F.Gerald, and P.O. Wheatley : Applied Numerical Methods, Low- priced edition, Pearson Education Asia 2002, Sixth Edition.

6. D.V. Griffiths and I.M. Smith, Numerical Methods for Engineers, Blackwell Scientific Publications (1991).

MAT189

MATHEMATICAL MODELING LAB

B.Sc. (Mathematics) **Semester VI**

L-T-P-C Structure 0-0-4-2 **Course Type: Discipline Specific Elective Lab 4**

List of Practical (Do any five using any software):

(i) Plotting of Legendre polynomial for n = 1 to 5 in the interval [0,1]. Verifying graphically that all the roots of Pn (x) lie in the interval [0,1].
(ii) Automatic computation of coefficients in the series solution near ordinary points.
(iii) Plotting of the Bessel's function of first kind of order 0 to 3.
(iv) Automating the Frobenius Series Method.
(v) Random number generation and then use it for one of the following (a) Simulate area under a curve (b) Simulate volume under a surface.
(vi) Programming of either one of the queuing model (a) Single server queue (e.g. Harbor system) (b) Multiple server queue (e.g. Rush hour).
(vii) Programming of the Simplex method for 2/3 variables.

Reference Books:

1. Tyn Myint-U and Lokenath Debnath, *Linear Partial Differential Equation for Scientists and Engineers*, Springer, Indian reprint, 2006.
2. Frank R. Giordano, Maurice D. Weir and William P. Fox, *A First Course in Mathematical Modeling*, Thomson Learning, London and New York, 2003.

MAT150
STATICS & DYNAMICS

B.Sc. (Mathematics) **Semester VI**

L-T-P-C Structure 5-1-0-6 **Course Type: Discipline Specific Elective 4**

MODULE I: Basic definitions: Basic definitions, Resultant of forces, parallelogram law of forces, triangular law of forces, Lami's theorem, Polygon law of forces, Resultant of parallel forces.Coplanar forces, conditions of equilibrium of coplanar forces in three dimensions.

MODULE II: Common catenary and virtual work: Common catenary and virtual work, Equilibrium of particle, Equilibrium of system of particles, Work, energy and power, Forces in three dimensions.

MODULE III: Velocity and acceleration: Velocity and acceleration-along radial and transverse directions, along tangential and normal directions. Simple Harmonic motion, Hooke's law, motion along horizontal and vertical elastic strings.

MODULE IV: Motion in resisting medium: Motion in resisting medium- Resistance varies as velocity and square of velocity. Work and Energy. Motion on a smooth curve in a vertical plane. Motion inside and outside of a smooth vertical circle. Projectile motion and projectile in an inclined plane.

MODULE V: Planetary motion and Moment of inertia: Central orbits-p-r equations, Apses, Time in an orbit, Kepler's Law of planetary motion. Moment of inertia-M.I. of rods, Circular rings, Circular disks, Solid and Hollow spheres, Rectangular lamina, Ellipse and Triangle. Theorem of Parallel axis. Product of inertia.

References Books

1. S.L. Loney, An elementary Treaties on the Dynamics of a particle and of rigid bodies", A.I. T. S. Publications, 2003.
2. S.L. Loney, An elementary Treaties on Statics, A.I.T. S. Publishers and distributors, Delhi, 2003.
3. Synge and Griffth, Principles of Mechanics.
4. Chorlton, A Text Book of Dynamics.
5. Gate Wood, A Text Book of Dynamics.
6. Ghosh & Chakraborty, Advanced Analytical Dynamics.
7. Ganguly & Saha, Dynamics.
8. Dutta & Jana, Dynamics.

MAT151
DIFFERENTIAL GEOMETRY

B.Sc. (Mathematics) **Semester VI**

L-T-P-C Structure 5-1-0-6 **Course Type: Discipline Specific Elective 4**

Module 1: Theory of Space Curves: Space curves, Planer curves, Curvature, torsion and Serret-Frenet formulae. Osculating circles, Osculating circles and spheres. Existence of space curves, Evolutes and involutes of curves.

Module 2: Theory of Surfaces: Parametric curves on surfaces, Direction coefficients, First and second Fundamental forms, Principal and Gaussian curvatures, Lines of curvature, Euler's theorem, Rodrigue's formula, Conjugate and Asymptotic lines.

Module 3: Developables: Developable associated with space curves and curveson surfaces, Minimal surfaces, Geodesics: Canonical geodesic equations. Nature of geodesics on a surface of revolution.Clairaut's theorem. Normal property of geodesics.
Module 4: Torsion of a geodesic. Geodesic curvature.Gauss-Bonnet theorem. Surfaces of constant curvature. Conformal mapping. Geodesic mapping. Tissot's theorem.Tensors: Summation convention and indicial notation, Coordinate transformation and Jacobian.

Module 5: Contra-variant and Covariant vectors, Tensors of different type, Algebra of tensors and contraction, Metric tensor and 3-index Christoffel symbols, Parallel propagation of vectors, Covariant and intrinsic derivatives, Curvature tensor and its properties, Curl, Divergence and Laplacian operators in tensor form, Physical components.

Reference Books:

1. T.J. Willmore, *An Introduction to Differential Geometry*, Dover Publications, 2012.
2. B. O'Neill, *Elementary Differential Geometry*, 2nd Ed., Academic Press, 2006.
3. C.E. Weatherburn, *Differential Geometry of Three Dimensions*, Cambridge University Press 2003.
4. D.J. Struik, *Lectures on Classical Differential Geometry*, Dover Publications, 1988.
5. S. Lang, *Fundamentals of Differential Geometry*, Springer, 1999.
6. B. Spain, *Tensor Calculus: A Concise Course*, Dover Publications, 2003.