VIDYASAGAR UNIVERSITY

Curriculum for 3-Year BSc (General)
in

Mathematics

Under Choice Based Credit System (CBCS)
[w.e.f 2018-2019]

VIDYASAGAR UNIVERSITY

B Sc (General) in Mathematics

[Choice Based Credit System]

Year	Semester	Course Type	Course Code	Course Title	Credit	L-T-P	Marks		
1	I	SEMESTER-I					CA	ESE	TOTAL
		Core-1 (DSC-1A)		Differential Calculus	6	5-1-0	15	60	75
		Core-2 (DSC-2A)		Other Discipline/TBD	6	4-0-4/ 5-1-0	15	60	75
		Core-3 (DSC-3A)		Other Discipline/TBD	6	4-0-4/ 5-1-0	15	60	75
		AECC-1 (Elective)		English/MIL	2	1-1-0	10	40	50
				Semester - I : Total	**20**				**275**
	II	SEMESTER-II							
		Core-4 (DSC-1B)		Differential Equations	6	5-1-0	15	60	75
		Core-5 (DSC-2B)		Other Discipline/TBD	6	4-0-4/ 5-1-0	15	60	75
		Core-6 (DSC-3B)		Other Discipline/TBD	6	4-0-4/ 5-1-0	15	60	75
		AECC-2 (Elective)		Environmental Studies	4		20	80	100
				Semester - 2 : Total	**22**				**325**

Year	Semester	Course Type	Course Code	Course Title	Credit	L-T-P	Marks		
2	III	SEMESTER-III					CA	ESE	TOTAL
		Core-7 (DSC-1C)		Real Analysis	6	5-1-0	15	60	75
		Core-8 (DSC-2C)		Other Discipline/TBD	6	4-0-4/ 5-1-0	15	60	75
		Core-9 (DSC-3C)		Other Discipline/TBD	6	4-0-4/ 5-1-0	15	60	75
		SEC-1		TBD	2	1-1-0	10	40	50
				Semester - 3 : Total	**20**				**275**
	IV	SEMESTER-IV							
		Core-10 (DSC-1D)		Algebra	6	5-1-0	15	60	75
		Core-11 (DSC-2D)		Other Discipline/TBD	6	4-0-4/ 5-1-0	15	60	75
		Core-12 (DSC-3D)		Other Discipline/TBD	6	4-0-4/ 5-1-0	15	60	75
		SEC-2		TBD	2	1-1-0	10	40	50
				Semester - 4 : Total	**20**				**275**

Year	Semester	Course Type	Course Code	Course Title	Credit	L-T-P	Marks		
3	**V**	**SEMESTER-V**					**CA**	**ESE**	**TOTAL**
		DSE-1A		Discipline-1(Mathematics)	6	5-1-0	15	60	75
		DSE-2A		Other Discipline/TBD	6	4-0-4/ 5-1-0	15	60	75
		DSE-3A		Other Discipline/TBD	6	4-0-4/ 5-1-0	15	60	75
		SEC-3		TBD	2	1-1-0	10	40	50
				Semester - 5 : Total	**20**				**275**
	VI	**SEMESTER-VI**							
		DSE-1B		Discipline-1(Mathematics)	6	5-1-0	15	60	75
		DSE-2B		Other Discipline/TBD	6	4-0-4/ 5-1-0	15	60	75
		DSE-3B		Other Discipline/TBD	6	4-0-4/ 5-1-0	15	60	75
		SEC-4		TBD	2	1-1-0	10	40	50
				Semester - 6 : Total	**20**				**275**
	Total in all semester:				**122**				**1700**

CC = Core Course , **AECC** = Ability Enhancement Compulsory Course , **GE** = Generic Elective , **SEC** = Skill Enhancement Course , **DSE** = Discipline Specific Elective , **CA**= Continuous Assessment , **ESE**= End Semester Examination , **TBD**=To be decided , **CT** = Core Theory, **CP**=Core Practical , **L** = Lecture, **T** = Tutorial ,**P** = Practical , **MI**L = Modern Indian Language , **ENV**S = Environmental Studies ,

List of Core and Elective Courses

Core Courses (CC)

DSC-1A: Differential Calculus
DSC-1B: Differential Equations
DSC-1C: Real Analysis
DSC-1D: Algebra

Discipline Specific Electives (DSE)

DSE-1: Complex Analysis
Or
DSE-1: Matrices
Or
DSE-1: Linear Algebra
Or
DSE-1: Vector Calculus and Analytical Geometry

DSE-2: Mechanics
Or
DSE-2: Linear Programming
Or
DSE-2: Numerical Methods
Or
DSE-2: Integer Programming and Theory of Games

Skill Enhancement Course (SEC)

SEC-1: Theory of Equation
Or
SEC-1: Logic and Sets
Or
SEC-1: Boolean Algebra

SEC-2: Graph Theory
Or
SEC-2: Integral Calculus
Or
SEC-2: Mathematical Finance

SEC-2: Number Theory
Or
SEC-3: Bio-Mathematics
Or
SEC-3: Mathematical Modeling

SEC-4: Probability and Statistics
Or
SEC-4: Understanding Probability and Statistics through practical
Or
SEC-4: Forecasting
Or
SEC-4: Portfolio Optimization

Core Courses (CC)

DSC-1A(CC-1): Differential Calculus **Credit : 06**

DSC-1AT(CC-1): Differential Calculus

Course Contents:

Limit and Continuity (ε and δ definition), Types of discontinuities, Differentiability of functions, Successive differentiation, Leibnitz's theorem, Partial differentiation, Euler's theorem on homogeneous functions. Tangents and normals, Curvature, Asymptotes, Singular points, Tracing of curves. Parametric representation of curves and tracing of parametric curves, Polar coordinates and tracing of curves in polar coordinates. Rolle's theorem, Mean Value theorems, Lagrange and cauchy theorems. Taylor's theorem with Lagrange's and Cauchy's forms of remainder, Power series and its convergences. Taylor's series, Maclaurin's series of sin x, cos x, ex, log(l+x), (l+x)m, Maxima and Minima, Indeterminate forms.

Suggested Readings:

- H. Anton, I. Birens and S. Davis, *Calculus*, John Wiley and Sons, Inc., 2002.
- G.B. Thomas and R.L. Finney, *Calculus*, Pearson Education, 2007.

DSC-1B(CC-2): Differential Equations **Credit : 06**

DSC1BT(CC-2) : Differential Equations

Course Contents:

First order exact differential equations. Integrating factors, rules to find an integrating factor. First order higher degree equations solvable for x, y, p. Methods for solving higher-order differential equations. Basic theory of linear differential equations, Wronskian, and its properties. Solving a differential equation by reducing its order. Linear homogenous equations with constant coefficients, Linear non-homogenous equations, The method of variation of parameters, The Cauchy-Euler equation, Simultaneous differential equations, Total differential equations. Order and degree of partial differential equations, Concept of linear and non-linear partial differential equations, Formation of first order partial differential equations, Linear partial differential equation of first order, Lagrange's method, Charpit's method. Classification of second order partial differential equations into elliptic, parabolic and hyperbolic through illustrations only.

Suggested Readings:

- Shepley L. Ross, *Differential Equations*, 3rd Ed., John Wiley and Sons, 1984.
- Sneddon, *Elements of Partial Differential Equations*, McGraw-Hill, International Edition, 1967.

DSC-1C(CC-3): Real Analysis **Credit : 06**

DSC1CT(CC-3): Real Analysis

Course Contents:

Finite and infinite sets, examples of countable and uncountable sets. Real line, bounded sets, suprema and infima, completeness property of R, Archimedean property of R, intervals. Concept of cluster points and statement of Bolzano-Weierstrass theorem.Real Sequence, Bounded sequence, Cauchy convergence criterion for sequences. Cauchy's theorem on limits, order preservation and squeeze theorem, monotone sequences and their convergence (monotone convergence theorem without proof). Infinite series. Cauchy convergence criterion for series, positive term series, geometric series, comparison test, convergence of p-series, Root test, Ratio test, alternating series, Leibnitz's test (Tests of Convergence without proof). Definition and examples of absolute and conditional Convergence Series. Sequences and series of functions, Pointwise and uniform convergence. μ-test, M-test, Statements of the results about uniform convergence and integrability and differentiability of functions, Power series and radius of convergence.

Suggested Readings:

- T.M. Apostol, *Calculus* (Vol. I), John Wiley and Sons (Asia) P. Ltd., 2002.
- R.G. Bartle and D. R Sherbert, *Introduction to Real Analysis*, John Wiley and Sons (Asia) P. Ltd., 2000.
- E. Fischer, *Intermediate Real Analysis*, Springer Verlag, 1983.
- K.A. Ross,(2003). *Elementary Analysis - The Theory of Calculus Series*- Undergraduate Texts in Mathematics, Springer Verlag.
- S.K.Mapa Introduction to real analysis, Sarat Book House.

DSC-1D (CC-4): Algebra **Credits 06**

DSC1DT(CC-4): Algebra

Course Contents:

Definition and examples of groups, examples of abelian and non-abelian groups, the group Zn of integers under addition modulo n and the group U(n) of units under multiplication modulo n. Cyclic groups from number systems, complex roots of unity, circle group, the general linear group GLn (R), groups of symmetries of (i) an isosceles triangle, (ii) an equilateral triangle, (iii) a rectangle, and (iv) a square, the permutation group Sym (n), Group of quaternions. Subgroups, cyclic subgroups, the concept of a subgroup generated by a subset and the commutator subgroup of group, examples of subgroups including the center of a group. Cosets, Index of subgroup, Lagrange's theorem, order of an element, Normal subgroups: their definition, examples, and characterizations, Quotient groups.Definition and examples of rings, examples of commutative and non-commutative rings: rings from number systems, Zn the ring of integers modulo n, ring of real quaternions, rings of matrices, polynomial rings, and rings of continuous functions. Subrings and ideals, Integral domains and fields, examples of fields: Zp, Q, R, and C. Field of rational functions.

Suggested Readings:

- John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002**.**
- M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.
- Joseph A Gallian, *Contemporary Abstract Algebra*, Narosa, 1999.
- George E Andrews, *Number Theory*, Hindustan Publishing Corporation, 1984.
- S.K.Mapa. Higher Algebra : Abstract and Linear, Sarat Book House, Calcutta.

Discipline Specific Electives (DSE)

DSE-1 : Complex Analysis **Credit : 06**

DSE1T : Complex Analysis

Course Contents:

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. Analytic functions, examples of analytic functions, exponential function, Logarithmic function, trigonometric function, derivatives of functions, definite integrals of functions. Contours, Contour integrals and its examples, upper bounds for moduli of contour integrals. Cauchy - Goursat theorem, Cauchy integral formula. Liouville's theorem and the fundamental theorem of algebra. Convergence of sequences and series, Taylor series and its examples. Laurent series and its examples, absolute and uniform convergence of power series. Singular points of all kind, residue, Cauchy residue theorem and example.

Suggested Readings:

- James Ward Brown and Ruel V. Churchill, *Complex Variables and Applications*, 8th Ed., McGraw – Hill International Edition, 2009.
- Joseph Bak and Donald J. Newman, *Complex analysis*, 2nd Ed., Undergraduate Texts in Mathematics, Springer-Verlag New York, Inc., New York, 1997.

Or

DSE - 1: Matrices **Credit : 06**

DSE1T: Matrices

Course Contents:

R, R2, R3 as vector spaces over R. Standard basis for each of them. Concept of Linear Independence and examples of different bases. Subspaces of R2, R3. Translation, Dilation, Rotation, Reflection in a point, line and plane. Matrix form of basic geometric transformations. Interpretation of eigen values and eigenvectors for such transformations and eigen spaces as invariant subspaces. Matrices in diagonal form. Reduction to diagonal form upto matrices of order 3. Computation of matrix inverses using elementary row operations. Rank of matrix. Solutions of a system of linear equations using matrices.

Illustrative examples of above concepts from Geometry, Physics, Chemistry, Combinatorics and Statistics.

Suggested Readings:

- A.I. Kostrikin, *Introduction to Algebra*, Springer Verlag, 1984.
- S. H. Friedberg, A. L. Insel and L.E. Spence, *Linear Algebra*, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
- Richard Bronson, Theory and Problems of Matrix Operations, Tata McGraw Hill, 1989.
- M. Pal (2013). Higher Algebra, PHI Learning Pvt. Ltd.

Or

DSE-1 : Linear Algebra **Credit : 06**

DSE1T: Linear Algebra

Course Contents:

Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces. Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations. Isomorphisms, Isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix.

Suggested Readings:

- Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, *Linear Algebra,* 4th Ed., Prentice- Hall of India Pvt. Ltd., New Delhi, 2004.
- David C. Lay, *Linear Algebra and its Applications,* 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
- S. Lang, *Introduction to Linear Algebra*, 2nd Ed., Springer, 2005.
- Gilbert Strang, *Linear Algebra and its Applications*, Thomson, 2007.
- M.Pal. Higher Algebra. PHI Pvt. Ltd. 2013.

Or

DSE - 1: Vector Calculus and Analytical Geometry **Credit : 06**

DSE1T: Vector Calculus and Analytical Geometry

Course Contents:

Algebra of vectors, Differentiation and partial differentiation of a vector function. Derivative of sum, dot product and cross product of two vectors. Gradient, divergence and curl. Techniques for sketching parabola, ellipse and hyperbola. Reflection properties of parabola, ellipse and hyperbola. Classification of quadratic equations representing lines, parabola, ellipse and hyperbola. Spheres, Cylindrical surfaces. Illustrations of graphing standard quadric surfaces like cone, ellipsoid.

Suggested Readings:

- G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
- H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) P. Ltd. 2002.
- P.C. Matthew's, *Vector Calculus*, Springer Verlag London Limited, 1998.
- S.L. Loney, *The Elements of Coordinate Geometry*, McMillan and Company, London.
- R.Khan. Analytical Geometry and Vector Algebra, New Central Book Agency.
- R.J.T. Bill, *Elementary Treatise on Coordinate Geometry of Three Dimensions*, McMillan India Ltd., 1994.

DSE-2 : Mechanics **Credit : 6**

DSE2T: Mechanics

Course Contents:

Conditions of equilibrium of a particle and of coplanar forces acting on a rigid Body, Laws of friction, Problems of equilibrium under forces including friction, Centre of gravity, Work and potential energy. Velocity and acceleration of a particle along a curve: radial and transverse components (plane curve), tangential and normal components (space curve), Newton's Laws of motion, Simple harmonic motion, Simple Pendulum, Projectile Motion.

Suggested Readings:

- A.S. Ramsay, *Statics*, CBS Publishers and Distributors (Indian Reprint), 1998.
- A.P. Roberts, *Statics and Dynamics with Background in Mathematics*, Cambridge University Press, 2003.
- S.L.Loney. An elementary treaties on the dynamics of a particle and rigid body, New Age International Pvt. Ltd.

Or

DSE-2: Linear Programming **Credit: 06**

DSE2T: Linear Programming

Course Contents:

Linear Programming: Definition and formation Problems, Graphical Approach for solving some Linear Programming problems. Convex Sets, Supporting and Separating Hyperplanes. Theory of simplex method, optimality and unboundedness, the simplex algorithm, simplex method in tableau format, introduction to artificial variables, two-phase method, Big-M method and their comparison. Duality, formulation of the dual problem, primal- dual relationships, economic interpretation of the dual.

Suggested Readings:

- Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, *Linear programming and Network Flows,* 2nd Ed., John Wiley and Sons, India, 2004.
- F.S. Hillier and G.J. Lieberman, *Introduction to Operations Research,* 8th Ed., Tata McGrawHill, Singapore, 2004.
- Hamdy A. Taha, *Operations Research, An Introduction,* 8th Ed., Prentice-Hall India, 2006.

Or

DSE-2 : Numerical Methods **Credit : 06**

DSE2T: Numerical Methods

Course Contents:

Algorithms, Convergence, Bisection method, False position method, fixed point iteration method, Newton's method, Secant method, LU decomposition, Gauss-Jacobi, Gauss-Siedel and SOR iterative methods. Lagrange and Newton interpolation: linear and higher order, finite difference operators. Numerical differentiation: forward difference, backward difference and central Difference. Integration: trapezoidal rule, Simpson's rule.
Solving ordinary differential equations : Euler's method. Runge – Kutta method of second and fourth order, Prediction – correlation methods.

Suggested Readings:

- B. Bradie, *A Friendly Introduction to Numerical Analysis*, Pearson Education, India, 2007.
- M.K. Jain, S.R.K. Iyengar and R.K. Jain, *Numerical Methods for Scientific and Engineering Computation*, 5th Ed., New age International Publisher, India, 2007.
- M. Pal. Numerical Analysis for Scientists and Engineers: Theory and C Programming, Narosa, 2007.

Or

DSE-2: Integer Programming and Theory of Games **Credit : 06**

DSE2T: Integer Programming and Theory of Games

Course Contents:

Integer Linear Programming. Modeling using pure and mixed integer programming, Branch and Bound Technique, Gomory's Cutting Plane Algorithm. Game theory: formulation of two person zero sum games, solving two person zero sum games, games with mixed strategies, graphical solution procedure, linear programming solution of games. Methods of dominance.

Suggested Readings:

- Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, *Linear Programming and Network Flows,* 2nd Ed., John Wiley and Sons, India, 2004.

- F. S. Hillier and G. J. Lieberman, *Introduction to Operations Research*, 9th Ed., Tata McGraw Hill, Singapore, 2009.
- Hamdy A. Taha, *Operations Research, An Introduction*, 8th Ed., Prentice-Hall India, 2006.

Skill Enhancement Course (SEC)

SEC-1: Theory of Equations **Credit: 02**

SEC1T: Theory of Equations

Course Contents:

General properties of polynomials, Graphical representation of polynomials, maximum and minimum values of a polynomial, General properties of equations, Descarte's rule of signs positive and negative rule, Relation between the roots and the coefficients of equations. Symmetric functions, Applications of symmetric function of the roots, Transformation of equations. Solutions of reciprocal and binomial equations. Algebraic solutions of the cubic and biquadratic equations. Properties of the derived functions.

Suggested Readings:

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

Or

SEC-1: Logic and Sets **Credit: 02**

SEC1T: Logic and Sets

Course Contents:

Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, single words and inverse propositions and precedence of logical operators. Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, Quantifiers, Binding variables and Negations. Sets, subsets, Set operations, the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. Empty set, properties of empty set. Cartesian product. Partition of sets. Power set of a set. Difference and Symmetric difference of two sets. Set identities, Generalized union and intersections. Relation: Product set, Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation.

Suggested Readings:

- R.P. Grimaldi, *Discrete Mathematics and Combinatorial Mathematics*, Pearson Education, 1998.

- P.R. Halmos, *Naive Set Theory*, Springer, 1974.
- E. Kamke, *Theory of Sets*, Dover Publishers, 1950.

Or

SEC-1: Boolean algebra Credit: 02

SEC1T: Boolean algebra

Course Contents:

Definition, examples and basic properties of partially ordered sets, nasse – diagram, maps between ordered sets, duality principle, maximal and minimal elements, lattices as ordered sets, complete lattices, lattices as algebraic structures, sub lattices, products and homo morphisms. 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.

Suggested Readings:

- B A. Davey and H. A. Priestley, *Introduction to Lattices and Order*, Cambridge University Press, Cambridge, 1990.
- Rudolf Lidl and Günter Pilz, *Applied Abstract Algebra*, 2nd Ed., Undergraduate Texts inMathematics, Springer (SIE), Indian reprint, 2004.

SEC-2: Graph Theory Credit: 02

SEC2T: Graph Theory

Course Contents:

Definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bi-partite graphs, isomorphism of graphs, paths and circuits, connected graphs, Eulerian circuits, Hamiltonian cycles, the adjacency matrix, weighted graph, travelling salesman's problem, shortest path, Dijkstra's algorithm, Floyd-Warshall algorithm.

Suggested Readings:

- Edgar G. Goodaire and Michael M. Parmenter, *Discrete Mathematics with Graph Theory*2nd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2003.
- Narsingh Deo, Graph Theory with applications to Engineering and computer Science, PHI.
- D.B.West. Introduction to graph theory, PHI,2001.

Or

SEC -2: Integral Calculus Credit: 02

SEC2T: Integral Calculus

Course Contents:

Integration by Partial fractions, integration of rational and irrational functions. Properties of definite integrals. Reduction formulae for integrals of rational, trigonometric, exponential and logarithmic functions and of their combinations. Evaluation of areas and lengths of curves in the plane, valuation of volumes and surfaces of solids of revolution. Double and Triple integrals.

Suggested Readings:

- G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
- H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) P. Ltd. 2002.

Or

SEC-2 : Mathematical Finance **Credit : 02**

SEC2T : Mathematical Finance

Course Contents:

Basic principles: Comparison, arbitrage and risk aversion, Interest (simple and compound, discrete and continuous), time value of money, inflation, net present value, internal rate of return (calculation by bisection and Newton-Raphson methods), comparison of NPV and IRR. Bonds, bond prices and yields. floating-rate bonds, immunization. Asset return, short selling, portfolio return, (brief introduction to expectation, variance, covariance and correlation), random returns, portfolio mean return and variance, diversification, portfolio diagram, feasible set, Markowitz model (review of Lagrange multipliers for 1 and 2 constraints).

Suggested Readings:

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

SEC-3: Number Theory **Credit :02**

SEC3T: Number Theory

Course Contents:

Division algorithm, Lame's theorem, linear Diophantine equation, fundamental theorem of arithmetic, prime counting function, statement of prime number theorem. Goldbach conjecture, binary and decimal representation of integers, linear congruences, complete set of residues. Number theoretic functions, sum and number of divisors, totally multiplicative

functions, definition and properties of the Dirichlet product, the Möbius inversion formula, the greatest integer function, Euler's phi-function.

Suggested Readings:

- David M. Burton, *Elementary Number Theory*, 6th Ed., Tata McGraw-Hill Edition, Indian reprint, 2007.
- Richard E. Klima, Neil Sigmon, Ernest Stitzinger, *Applications of Abstract Algebra with Maple*, CRC Press, Boca Raton, 2000.
- Neville Robinns, *Beginning Number Theory*, 2nd Ed., Narosa Publishing House Pvt. Limited, Delhi, 2007.

Or

SEC-3: Bio-Mathematics **Credit: 02**

SEC3T: Bio-Mathematics

Course Contents:

Mathematical Biology and the modeling process: an overview. Continuous models: Malthus model, logistic growth, Allee effect, Gompertz growth, Michaelis-Menten Kinetics, Holling type growth, 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, 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. Spatial Models: One species model with diffusion. Discrete Models: Overview of difference equations, steady state solution and linear stability analysis, Introduction to Discrete Models, Linear Models, Growth models, Decay models. Case Studies: Optimal Exploitation models, Models in Genetics.

Suggested Readings:

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

Or

SEC-3: Mathematical Modeling **Credits 02**

SEC3T: Mathematical Modeling

Course Contents:

Applications of differential equations: the vibrations of a mass on a spring, mixture problem, free damped motion, forced motion, resonance phenomena, electric circuit

problem, mechanics of simultaneous differential equations. Applications to Traffic Flow. Vibrating string, vibrating membrane, conduction of heat in solids, gravitational potential, conservation laws.

Suggested Readings:

- Shepley L. Ross, *Differential Equations*, 3rd Ed., John Wiley and Sons, 1984.
- I. Sneddon, *Elements of Partial Differential Equations*, McGraw-Hill, International Edition,1967.16

SEC-4: Probability and Statistics **Credit : 02**

SEC4T: Probability and Statistics

Course Contents:

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, discrete distributions: uniform, binomial, Poisson, continuous distributions: uniform, normal, exponential. Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions, expectation of function of two random variables, conditional expectations, independent random variables.

Suggested Readings:

- Robert V. Hogg, Joseph W. McKean and Allen T. Craig, *Introduction to Mathematical Statistics*, Pearson Education, Asia, 2007.
- Irwin Miller and Marylees Miller, John E. Freund, *Mathematical Statistics with Application*,7th Ed., Pearson Education, Asia, 2006.
- Sheldon Ross, *Introduction to Probability Model*, 9th Ed., Academic Press, Indian Reprint,2007.

Or

SEC-4: Understanding Probability and Statistics through Practical **Credit : 02**

SEC4T: Understanding Probability and Statistics through Practical

Course Contents:

Practical/ Lab work to be performed on a computer using Excel.

Practicals should broadly cover the following areas:

a) Fitting of Binomial, Poisson, Negative Binomial, Normal Distributions.
b) Applications of Chi-square, t and F Distributions.
c) Calculation of correlation coefficient, Rank Correlation, etc.
d) Fitting of polynomials and regression curves.
e) Methods of estimation (MLE and method of Moments)

f) Selecting a simple random sample using random number tables.

Suggested Readings:

- Robert V. Hogg, Joseph W. McKean and Allen T. Craig, *Introduction to Mathematical Statistics*, Pearson Education, Asia, 2007.
- Irwin Miller and Marylees Miller, John E. Freunds, *Mathematical Statistics with Applications*, 7th Ed., Pearson Education, Asia, 2006.
- Sheldon Ross, *Introduction to Probability Models*, 9th Ed., Academic Press, Indian Reprint, 2007.

Or

SEC-4: Forecasting **Credits 02**

SEC4T: Forecasting

Course Contents:

Introduction to forecasting, Types of forecast, Basic forecasting tools. Time Series and its Components. Linear and Nonlinear Trend, seasonal Variations and Irregular Variations and their Measurements. Moving Averages. Single and Double exponential smoothing.

Suggested Readings:

- John E. Hanke, Dean Wichern and Arthur G. Reitch, *Business Forecasting*, 7th Ed., Pearson, 2008.
- J. Holton, Wilson and Barry Keating, *Business Forecasting Wforecast*, 6th Ed., Tata McGraw Hill, 2009.
- S.C. Gupta and V.K. Kapoor, *Fundamentals of Applied Statistics*, Sultan Chand and Sons, 2009.
- G. Hadley, T.M. Whitin, *Analysis of Inventory Systems*, D.B. Taraporevala and Sons, Published by arrangement with Prentice Hall Inc., 1979.

Or

SEC-4: Portfolio Optimization **Credit: 02**

SEC4T: Portfolio Optimization

Course Contents:

Financial markets. Investment objectives. Measures of return and risk. Types of risks. Portfolio of assets. Expected risk and return of portfolio. Diversification. Mean-variance portfolio optimization- the Markowitz model and the two-fund theorem, risk-free assets and one fund theorem, efficient frontier. Portfolio performance evaluation measures.

Suggested Readings:

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