National Institute of Technology Agartala
Department of Mathematics
BTMT in Computational Mathematics

Course Structure of Dual Degree course

On

BTMT in Computational Mathematics

Semester – 1st		22 – Credits				
	Engineering Mathematics-I	**100**	**2**	**1**	**0**	**3**
	Engineering Physics – I	**100**	**3**	**0**	**0**	**3**
	Engineering Chemistry – I	**100**	**3**	**0**	**0**	**3**
	Basic Electrical Engineering (Gr.I) / Basic Electronics (Gr.II)	**100**	**3**	**0**	**0**	**3**
	Engineering Mechanics-I (Gr.I) / Disaster Management (Gr.II)	**100**	**3/2**	**1/0**	**0/0**	**4/2**
	Communication in English (Gr.I) / Introduction to Programming (Theory) (Gr.II)	**100**	**3**	**0**	**0**	**3**
	Chemistry Laboratory (Gr.I) / Engineering Physics Lab (Gr.II)	**50**	**0**	**0**	**2**	**1**
	Workshop Practice (Gr.I) / Engineering Graphics (Gr.II)	**50**	**0/1**	**0/0**	**2/2**	**1/2**
	Basic Electrical Laboratory (Gr.I) / Basic Electronics Laboratory (Gr.II)	**50**	**0**	**0**	**2**	**1**
	Computer Programming Laboratory (Gr. II)	**50**	**0**	**0**	**2**	**0/1**
	NSS / NCC	**-**	**0**	**0**	**3**	**0**

Semester – 2nd		21 – Credits				
	Engineering Mathematics – II	**100**	**2**	**1**	**0**	**3**
	Engineering Physics – II	**100**	**3**	**0**	**0**	**3**
	Engineering Chemistry – II	**50**	**2**	**0**	**0**	**2**
	Basic Electronics(Gr.I) / Basic Electrical Engineering (Gr.II)	**100**	**3**	**0**	**0**	**3**
	Disaster Management (Gr.I) / Engineering Mechanics-I (Gr.II)	**50**	**2/3**	**0/1**	**0/0**	**2/4**
	Introduction to Programming (Theory) (Gr.I) / Communication in English (Gr.II)	**100**	**3**	**0**	**0**	**3**
	Engineering Physics Lab (Gr.I) / Chemistry Lab (Gr.II)	**50**	**0**	**0**	**2**	**1**
	Engineering Graphics(Gr.I) / Workshop Practice (Gr.II)	**50**	**1/0**	**0/0**	**2/2**	**2/1**
	Computer Programming Laboratory (Gr. I)	**50**	**0**	**0**	**2**	**1**
	Basic Electronics Laboratory (Gr.I) / Basic Electrical Laboratory (Gr.II)	**50**	**0**	**0**	**2**	**1/0**
	NSS / NCC	**-**	**0**	**0**	**3**	**0**

Semester – 3rd		22– Credits				
	Probability and Statistics	**100**	**3**	**1**	**0**	**4**
	Mathematical Analysis	**100**	**3**	**1**	**0**	**4**
	Differential Equation	**100**	**3**	**1**	**0**	**4**
	Discrete Mathematics and Fuzzy set theory	**100**	**3**	**1**	**0**	**4**
	Data Structure and Algorithm (Theory)	**100**	**3**	**1**	**0**	**4**
	Data Structure and Algorithm (Practical)	**50**	**0**	**0**	**2**	**2**
Semester – 4th		23 – Credits				
	Algebra	**100**	**3**	**1**	**0**	**4**
	Numerical Analysis	**100**	**3**	**1**	**0**	**4**
	LPP and Game Theory	**100**	**3**	**1**	**0**	**4**
	Computer Organization	**100**	**3**	**1**	**0**	**4**
	Object Oriented Programming (C++ and Python) (Theory)	**100**	**3**	**1**	**0**	**4**
	Object Oriented Programming (C++ and Python) (Practical)	**50**	**0**	**0**	**2**	**3**
Semester – 5th		19 – Credits				
	Soft Computing	**100**	**3**	**1**	**0**	**4**
	Integral Transform	**100**	**3**	**1**	**0**	**4**
	Financial Mathematics	**100**	**3**	**1**	**0**	**4**
	Statistical Inference	**100**	**3**	**1**	**0**	**4**
	Scientific Computing (Practical)	**100**	**0**	**0**	**3**	**3**
	(Student Activity – 1) **Industrial Training-1 / Internship-1 (during summer vacation minimum 15days)**					
Semester – 6th		22 – Credits				
	Graph Theory	**100**	**3**	**1**	**0**	**4**
	Number Theory and Cryptography	**100**	**3**	**1**	**0**	**4**
	Design and Analysis of Algorithms	**100**	**3**	**1**	**0**	**4**
	Machine Learning and Data Mining	**100**	**3**	**1**	**0**	**4**
	Data Base Management System (Theory)	**100**	**3**	**1**	**0**	**4**
	Data Base Management System (Practical)	**50**	**0**	**0**	**2**	**2**
Semester – 7th		16– Credits				
	Randomized Algorithm	**100**	**3**	**1**	**0**	**4**
	Image Processing	**100**	**3**	**1**	**0**	**4**

	Optimization Techniques	**100**	**3**	**1**	**0**	**4**
	Stochastic Processes	**100**	**3**	**1**	**0**	**4**
	(Student Activity – 2) **Industrial Training-2 / Internship-2 (during summer vacation minimum 15days)**					
Semester – 8th		25 – Credits				
	Formal Language and Automata Theory	**100**	**3**	**1**	**0**	**4**
	Artificial Intelligence	**100**	**3**	**1**	**0**	**4**
	Deep Learning	**100**	**3**	**1**	**0**	**4**
	Elective – I	**100**	**3**	**1**	**0**	**4**
	Engineering Economics and Accountancy					
	Computer Networks and Security (Theory)					
	Non stationary data analysis					
	Operations Research-I					
	Mathematical Modeling and Simulation-I					
	Compiler Design					
	Dissertation – I	**100**	**0**	**3**	**0**	**3**
	Grand Viva-I	**100**	**0**	**0**	**3**	**3**
	Seminar Presentation-I	**100**	**0**	**0**	**3**	**3**
Semester – 9th		18 – Credits				
	Complexity Theory and Approximation Algorithm	**100**	**3**	**1**	**0**	**4**
	Social Media Data Analysis (Theory)	**100**	**3**	**1**	**0**	**4**
	Big Data Analytics (Practical)	**50**	**0**	**0**	**2**	**2**
	Elective – II	**100**	**3**	**1**	**0**	**4**
	Data Communication					
	Human Computer Interaction					
	Operations Research-II					
	Mathematical Modeling and Simulation-II					
	Elective –III	**100**	**3**	**1**	**0**	**4**
	Operating system					
	Decision Theory and Computational Statistics					
	Stochastic Calculus					
	Mobile Computing					

Semester – 10th		17– Credits				
Option – 1						
	Dissertation – II	**200**	**0**	**10**	**0**	**10**
	Grand Viva-II	**100**	**0**	**0**	**4**	**4**
	Seminar Presentation-II	**100**	**0**	**0**	**3**	**3**
Option – 2						
	Industrial Project	**200**	**0**	**0**	**10**	**10**
	Project Seminar	**100**	**0**	**0**	**3**	**3**
	Grand Viva-II	**100**	**0**	**0**	**4**	**4**

1st Semester = 22 – Credits
2nd Semester = 21 – Credits
3rd Semester = 22 – Credits
4th Semester = 23 – Credits
5th Semester = 19 – Credits
6th Semester = 22 – Credits
7th Semester = 16 – Credits
8th Semester = 25 – Credits
9th Semester = 18 – Credits
10th Semester = 17 – Credits

Total = 205 – Credits

BT -170 Credits

MT - 35 Credits

NATIONAL INSTITUTE OF TECHNOLOGY AGARTALA

DEPARTMENT OF MATHEMATICS

SYLLABUS

FOR

BTMT

IN

COMPUTATIONAL MATHEMATICS

BTMT
COMPUTATIONAL MATHEMATICS
1st SEMESTER

Engineering Mathematics - I

1. Infinite series: Convergence of Sequence, Bounded Sequence, Monotonic Sequence, Convergent, Divergent and Oscillatory Series, Geometric Series, Positive term series, p-series, Comparison Test, D'Alembert's Ratio tests, Raabe's Test, Gauss's Test, Cauchy's Integral Test, Cauchy's Root test, Logarithmic Test.

2. Calculus of function of one variable: Limit and continuity of functions, Uniform continuity and differentiability, successive differentiation, Leibnitz's theorem, Rolle's theorem, Mean Value theorems and Taylor's theorem, expansion of functions into Taylor's and Maclaurin's series, Indeterminate forms, Curvature, Asymptotes, Concavity, Convexity and point of inflexion.

3. Function of Several Variables: Limit, Continuity, Partial Derivatives, Chain Rule, Differentiation of Implicit functions, Exact Differentials, Euler's theorem on homogeneous function and its converse, Tangent planes and Normal planes, Maxima, Minima and Saddle points, Simple problems in extrema of functions with constraints, Method of Lagrangian Multipliers.

4. Ordinary Differential Equation: First order ordinary differential equation, Linear equations and Bernoulli's equation, Ordinary linear differential equation of nth order, Solution of homogeneous and non-homogeneous equations, Operator method, method of undetermined coefficients and variation of parameters, Solution of simple simultaneous ordinary differential equation. Series solution of differential equation.

5. Laplace Transform: Transforms of elementary functions, Inverse transforms, properties of laplace transform, Convolutions, Transforms of periodic functions, unit step functions, shifting theorems, Solution of ODE's using transforms.

Text/Reference Books:-

a) *M. D. Raisinghania. Ordinary and Partial Differential Equation, S. Chand, 19th Edition, 2017.*
b) *S. C. Malik and S. Arora, Mathematical Analysis, New Age International Publisher, 5th Edition, 2017.*
c) *H. K. Das, Advanced Engineering Mathematics, S. Chand, 1st Edition, 1988.*
d) *B. V. Ramana, Higher Engineering Mathematics, Tata McGraw Hill Education (India) Private Limitd, 20th Edition, 2013.*
e) *E. Kreyszig, Advanced Engineering Mathematics, Wiley, 10th Edition, 2015.*

Engineering Physics - I

1. Mathematical Preliminary: Vector Differentiation, Scalar and Vector Fields, Directional Derivatives, Vector Differential Operator, Gradient, Divergence, Curl, Line, Surface and Volume integrals and their applications, Green's theorem.

2. Electromagnetics: Gauss's Theorem of Electrostatics, Ampere's law, Magneto statics and laws of Electromagnetic Induction, Self and Mutual induction, Concept of Displacement Current, Difference

between Conduction Current and Displacement Current, Eddy Current, Maxwell's Equations, Propagation of Electromagnetic Waves in Free Space, Solution of propagation of Plane Electromagnetic Wave in free space and medium, Eddy Current, Concept of Field Energy (Poynting Vector)

3. Oscillations and Waves: Plane progressive wave, Energy of waves, Reverberation, Sabine's law(derivation), Damped Vibration:-differential equation and solution, critical damping, logarithmic decrement, analogy with electrical circuit, Forced damped Vibration, Amplitude and Velocity Resonance, sharpness of resonance and quality factor, applications of oscillatory motions.

4. Interference: Coherence (temporal and spatial), Fresnel's Bi-prism, Conditions for interference, Techniques of obtaining interference: Interference of Light due to division of wave front, Interference of Light due to division of amplitude; Newton's Ring, colour of thin film.

5. Diffraction: Types of Diffraction; Fresnel and Fraunhofer, Difference between Interference and Diffraction, Zone plate; positive and Negative Zone plates, action of zone plate as a convex lens, Fraunhofer Diffraction at a Single Slit and Double slit, Plane transmission diffraction grating spectra, Comparison between Prism and Grating Spectra, Resolving Power and limit of resolution, Rayleigh's criterion, Resolving Power of Microscope, Telescope and prism.

6. Polarization: Polarization, types of polarized light, polarizer and analyzer, Effect of polarizer on natural light, Effect of analyser on plane polarized light-Malus Law, Nicol's Prism; Polaroid, Anisotropic crystal; Birefringence, calcite crystal; Huygens' explanation of double refraction; Huygens' construction of wave fronts; experimental determination of principal refractive indices; phase difference between o – ray and e – ray; superposition of waves linearly polarized at right angles; Conditions for obtaining linearly polarized light, circularly polarized light and elliptically polarized light, retarders or wave plates; Babinet Compensator.

Reference Books

1. D. J. Griffith, Introduction to Electrodynamics, PHI Pubs.
2. G. B. Arfken and H. J. Weber, Mathematical Methods for Physicists, Elsevier Academic Press. 3. H. J. Pain, The Physics of Vibrations and Waves, John Wiley and Sons Ltd.
4. A. Ghatak, Optics, Tata Mc Graw Hill.
5. Optics, E. Hecht, Pearson.
6. F. A. Jenkins and H. E. White, Fundamentals of Optics, Tata Mc Graw Hill.

Engineering Chemistry - I

a) Chemical Bonding: - Ionic and Covalent bonds; Valence Bond Theory (V.B.T) of covalency-atomic orbital and their overlap, hybridization of orbitals definition types and associated geometries, VSEPR theory, shapes of simple molecules like-H2O, CO2, NH3, CH4,C2H6, C2H2 BF3, PCl5, SF6 in the light of the hybridization state of the central atom and VSEPR effects; Molecular Orbital Theory (M.O.T)- concept of molecular orbital, molecular orbital energy level diagrams of homonuclear diatomic molecules-He2,O2, N2 and molecular ions, determination of bond order, bond length and magnetic properties from M.O diagrams; Noncovalent interactions- van der Waals and hydrogen bonding and their effect over physical properties of different substances, metallic bonds-Electron sea model.

b) Fuels: - Definition and classification of fuels; Characteristics of a good fuel, comparison between solid, liquid and gaseous fuel; Calorific value of fuels- definition, units, higher and lower calorific value, determination of the calorific value of a solid fuel by bomb calorimeter; Solid fuel- coal, origin, types, proximate and ultimate analysis of coal; Liquid fuel- petroleum, origin, refining of crude, cracking, synthetic petrol, Fischer-Tropsch and Bergius method for the synthesis of gasoline, knocking

c) Water: Introduction; Hardness of Water- cause, types, units, disadvantages of using hard water for domestic and industrial purposes (e.g., scale and sludge formation in boilers, causticembitterment, boiler corrosion etc.), softening of hard water (lime-soda, permutit and ion exchange processes); Chemical analysis of Waterestimation of free chlorine, total alkalinity, hardness and dissolved oxygen, numerical based on determination of hardness.

d) Pollution and its control:- Pollution- introduction, air pollutants, particulates, smog, photochemical smog, acid rain, green house effects, depletion of ozone layer, analysis of gaseous effluents-oxides of nitrogen, oxides of sulphur and H2S, control of air pollution- particulate emission, gaseous pollutants, water pollution- arsenic pollution and its remedies. Chemical analysis of effluent liquid streams, BOD, COD.

e) Electrochemistry: - Arrhenius theory of electrolytic dissociation, classification of electrolytes; degree of dissociation of acids, dissociation constant of weak acids, Debye-Huckel theory, concept of pH and pOH, buffer solutions, solubility product, common ion effect, conductance of solutionsspecific, molar and equivalent conductance, variation of molar conductance with dilution for strong and weak electrolytes; Migration of ions- Kohlrausch's law of independent migration of ions, Ostwald's dilution law; transport number, Nernst equation for single electrode, electrochemical cells.

f) Polymer Chemistry: - Introduction, types of polymerization, classification of polymers based on chain characteristics, source, method of synthesis and molecular forces involved, mechanism of polymerization reaction: cationic, anionic and catalytic polymerization; glass transition and crystalline melting point temperatures, Factors influencing glass transition and crystalline melting point temperatures. Preparation, properties and uses of the Polyethylene, PVC, Polystyrene, PAN, Teflon, Nylon- 6:6, polyester ; Rubber- monomer, structure, compounding of rubber, vulcanization, synthetic rubbers- Buna-S, Buna-N, neoprene, butyl rubber and polyurethanes

Reference books:

1. Jain and Jain, Engineering Chemistry; 15th Edition,
2. Engineering Chemistry; Wiley - India.
3. S. S Dara, S chand Publisher, A Text Book of Engineering Practical Chemistry .
4. Sashi Chawla, A text book of Engineering Chemistry;
5. S. S Dara, S chand Publisher, A Text Book of Engineering Chemistry;
6. A. K Dey, Environmental Chemistry, John Wiley.

Basic Electrical Engineering

Basic circuit analysis methods:

Kirchhoff"s laws, mesh and nodal analysis. Network Theorems: Superposition theorem, Thevenin-Norton theorem, maximum powertransfer theorem, star-delta transformation.

AC circuit analysis:

AC fundamentals, phasor diagrams, Power in ac circuits, Series AC circuit and parallel AC circuit, Resonance, Network analysis methods, Poly-phase circuit.

Basics of Electrical Machines:

Basic principle of generator and motor, emf induced in a coil, concept of rotating magnetic field, introduction to transformer.

Reference Books:

1. Vincent Del Toro, „Electrical Engineering Fundamentals", Phi Learning, 2nd Edition, 2014.

2. D. P. Kothari and I. J. Nagrath, „Basic Electrical Engineering", McGraw Higher Ed., 3rd Edition, 2009.

3. K.V.V. Murthy and M.S.Kamath, „Basic Circuit Analysis", 1st Edition (reprinted with corrections) Jaico publishing, 1998.

4. W.H. Hayt and J.E. Kemmerley, „Engineering Circuit Analysis", Int. St. Ed.(4th) McGraw Hill, 1986.

5. S.K.Bhattacharya, 'Electrical Machines', Tata McGraw Hill Publishing company Ltd., second Edition, 2007

6. I. J. Nagrath and D. P. Kothari, 'Electric Machines', Tata McGraw Hill, 1985

Engineering Mechanics -I

Force Systems and Equilibrium

Force moment and couple, principle of transmissibility, Varignon's theorem. Resultant of force system- concurrent and nonconcurrent coplanar forces, free body diagram, equilibrium equations and their uses in solving elementary engineering problems.

Plane trusses

Analysis of plane trusses and plane frames (Analytical and graphical methods). Method of joints, methods of sections, graphical method.

Friction

Coulumb's laws of fraction, belt fraction problems involving fraction related to practical application.

Moment of Inertia and plane figure:-

Moment of Inertia of a plane figure with respect to an axis in its plane, Moment of Inertia with respect to an axis perpendicular to the plane of the figure. Parallel axis theorem, perpendicular axis theorem. Polar moment of inertia

Moment of inertia of material bodies:

Mass moment of inertia in case of disc cone cylinder sphere slender rod

Centre of gravity of rigid body

Centre of gravity of right circular cone, cylinder,hemisphere and composite rigid body.

Virtual work :

Work of a force principle of virtual work and itsapplication, Constriction of force polygon, Raydiagram, Funicular polygon, Maxwelldiagrams. Mass moment of inertia in case of disc, cone,cylinder, sphere slender rod.

Text/Reference Books:

1. Timoshenko and Young, Engineering Mechanics.

2. R.S. Khurmi , A text Book of Engineering Mechanics.

3. R.K. Bansal , A text Book of Engineering Mechanics.

Communication in English

Pronunciation, Vocabulary Extension, basic aspects of language skills, modes of writing, comprehension, composition, word-order, structure of words etc. The fundamentals of Grammar, textual pieces for literary appreciation, non-traditional materials, newspaper articles, advertisements, notice writing, Soft Skills Development etc.
The following textual pieces from "English for All" by Nilanjana Gupta, published by Mac Millan:

Text/Reference Books: -

1. Shakespeare's Sister by Virginia Woolf

2. Scientific Research for Amateurs by J.B.S. Haldane

3. When I Have Seen by William Shakespeare

4. Lines Written in Early Spring by William Wordsworth

5. On His Blindness by John Milton

6. Prospice by Robert Browning

7. After Twenty Years by O' Henry

8. The Adventures of the Blue Carbuncle by Arthur Conan Doyle

Chemistry Laboratory

List of experiments:

1. Determinations of hardness of water.
2. Determinations of percentage purity of lime stone sample.
3. Determinations of dissolved oxygen in water.
4. Determinations of sodium carbonate and sodium bicarbonate in a mixture.
5. Determinations of iron content in a sample.
6. Determinations of chloride content of water.
7. Determinations of proximate analysis of coal.
8. Determinations of flash point of anoil by penskymartein's closed cup flash point Apparatus.
9. Determinations of viscosity of oil by redwood viscometer.
10. Determination of Dissociation constant of weak acids by conductometric Titration.
11. Determinations of carbon residue of oil by Conrad son's apparatus.
12. Determination of pH of an electrolyte by potentiometer Titration.

Workshop Practice

1. Fitting Shop

i) Introduction of hand Tools.

ii) Job No. 01:- Making of Square bar from round bar of mild steel by metal wearing process.

iii) Job No.02:- Making of V-Groove on Mild Steel Flat by metal cutting process.

2. Carpentry Shop

i) Introduction of Hand Tools.

ii) Job No.01:- Making of wooden End half lap joint.

iii) Job No.02:- Making of wooden T-Joint.

3. Smithy Shop

i) Introduction of Hand Tools

ii) Job No.01:- To make square bar from round bar of Mild Steel by heatingand hammering.

iii) Job No.02:- To make Hexagonal bar from round bar of Mild Steel by heating and hammering

Basic Electrical Laboratory

List of Experiments:

1) Study of different Electrical sources.

2) Verification of Thevenin‟s theorem.

3) Verification of Norton‟s theorem.

4) Verification of Maximum power transfer theorem.

5) Verification of Superposition theorem.

6) Extension of meter range.

7) Study of characteristics of Fluorescent lamp and Incandescent lamp.

8) Characteristics of R-L circuit, R-C circuit, R-L-C series circuit with AC source.

9) Determination of insulation resistance by using Megger.

10) Study of different transformer connections.

11) Transformer testing
12) Starting of induction motor

BTMT
COMPUTATIONAL MATHEMATICS
2nd SEMESTER

Engineering Mathematics - II

1. Matrices: Algebra of matrices, Vector spaces, linear dependence of vectors, basis, Linear Transformations, Rank and inverse of a matrix, Solution of algebraic equations, consistency conditions, Hermitian, skew- Hermitian and Unitary matrices, by-linear form, eigen value and eigen vectors. Cayley-Hamilton theorem.

2. Complex numbers: Exponential complex numbers and logarithm of a complex number, circular, hyperbolic and inverse circular functions of complex numbers.

3. Function of a Complex Variable: Limit, continuity and differentiation, Analytic function, Cauchy- Riemann equations, Conjugate functions, Application to two dimensional problems, Taylor's and Laurent's expansions, Branch points, zeros, poles, residues, Cauchy's Integral theorem, simple problems on Contour Integration.

4. Integral Calculus: Improper Integrals, Beta and Gamma function. Double and Triple Integrals, Jacobians and transformation of co-ordinates.

5. Vectors: Scalar and vector triple product, space curves, Seret - Frenet formula, velocity and acceleration simple problems, moment of force, work done, angular velocity, relative velocitysimple applications. Vector function of one variable, vector differentiation and integration, gradient, divergence and curl ---Applications. Stoke's theorem, Green's theorem, Gauss divergence theorem - simple applications to areas, Volumes and center of Pressure.

Text/Reference Books:

1. Malik and Arora, Mathematical Analysis:

2. H.K.Dass., Advanced Engineering Mathematics

3. B.V.Ramana. Higher Engg. Mathematics

4. E. Kreyszig , Advanced Engineering Mathematics.

5. G.B.Thomas and R.L.Finney, Calculus and Analytic Geometry:

6. M.L.Khanna , Vector Calculas

Engineering Physics - II

1. Introduction to Quantum Mechanics: Blackbody Radiation, Planck's Radiation Formula, de Broglie's hypothesis, Davisson Germer Experiment, Stern-Gerlach Experiment, Heisenberg's uncertainty principle and its application, Wave packets, Phase velocity and group velocity, probability current density, Operators, Hermitian operators, expectation 1values, Interpretation of wave function, Postulates of quantum mechanics, Orthogonal and orthonormal functions, Schrödinger equation in one dimensional problems, Particle in a box, Eigen values and Eigen function, stationary states, Tunneling problems, Bound States.

2. Relativity: Reference Frames, Michelson - Morley Experiment and its consequences, Lorentz Transformation, Postulates of Relativity, Relativistic Mass and Mass-Energy Equivalence, Time Dilation, Length Contraction, Relativistic Kinematics, Principle of Simultaneity, Twin Paradox.

3. Concepts of Solids: Statistical distributions, M-B, B-E and F-D statistics and their simple applications, Planck's radiation law, Degenerate Fermi Gas. Crystallographic planes, reciprocal lattice and miller indices, Inter-planer spacing (cubic system only), Bragg's diffraction, Laue's equation of X-ray diffraction, Crystal structure analysis, Lattice Vibration, Electrons in a crystalline solid, free electron theory, electronic conduction in solids, Band theory of solids, Kronig - Penny model.

4. Introduction to Laser and Optical Fibre: Spontaneous and stimulated emission, Einstein's A-B coefficients, Meta - Stable states, population inversion, basic principle of laser (three and four level), optical cavity and resonator, Ruby and He-Ne laser, holography. Propagation of light in fibre, step and graded index fibre, numerical aperture, attenuation in optical fibre, introduction of optical window, application of laser and optical fibre.

Reference Books:

1. A. K. Ghatak and S. Lokanathan, Quantum Mechanics, Macmillan India Ltd.

2. R. Eisberg and Resnick, Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, Wiley India Pvt. Ltd.

3. Robert Resnick, Introduction to Special Relativity, John Wiley and Sons.

4. F. Reif, Statistical Mechanics, Mc Graw Hill.

5. B.K. Agarwal, Elements of Statistical Mechanics

6. Kittel, Introduction solid State Physics, Willy Eastern Limited

7. K. Thyagrajan, A. Ghatak, Lasers, Fundamentals and Applications, Springer Pub.

8. D. J. Griffiths, Introduction to Quantum Mechanics, Pearson

9. M. Ali Omar, Elementary Solid State Physics: Principles and Applications, Pearson Pub.

Engineering Chemistry –II

(a) Cement: - Introduction, classification; Portland Cement definition, raw materials, manufacture, ideal composition and physical requirement according to I.S code, chemical constitution of the

finished product, setting and hardening, heat of hydration; Special Cements- high-alumina, white portland, water-proof cements etc.

(b) Refractories: - Definition, objective of using, classification based on chemical nature; Properties- refractoriness, strength, dimensional stability, chemical inertness, thermal expansion, thermal conductivity, porosity, spalling, electrical conductivity etc. and interrelations between them; selection of good refractory; Common Refractory Bricks- silica, fireclay, high alumina, magnesite and zirconia bricks, properties and uses.

(c) Corrosion: - Introduction, definition, classification; Dry Corrosion factors effecting dry corrosion, mechanism, types, oxidation corrosion, Pilling-Bedworth rule, corrosion by other gases, hydrogen related corrosion, liquid metal corrosion; Wet Corrosion- types, chemical corrosion, factors affecting chemical corrosion, mechanism of wet corrosion- electrochemical mechanism, evolution of H2 and absorption of O2 types; Differential aeration theory, passivity, pitting, waterline and stress corrosion; Corrosion Control purification, alloying, application of protective coatings, cathodic protection etc.

(d) Lubricants: - Introduction; Mechanism- thick-film, thin-film and extreme pressure lubrication; Classification of Lubricantslubricating oils, greases and solid lubricants, their properties, use and additives required (e.g., anti-oxidants, corrosion preventers etc.); Properties of Lubricating Oils- viscosity, flash and fire-point, cloud and pour point, oiliness, carbon residue, aniline point etc.; Cutting fluids.

(e) Thermochemistry: - Different types of energy and other definitions; Endothermic/ Exothermic Reactions and Energy Diagrams; thermochemistry stoichiometry, enthalpy, standard enthalpy of formation and reaction, Hess's Law, heat of solution, heat of neutralization.

Text/Reference Books:

1. Jain and Jain, Engineering Chemistry; 15th Edition.

2. Engineering Chemistry; Wiley - India.

3. S.S Dara, S chand Publisher, A Text Book of Engineering Practical Chemistry.

4. Sashi Chawla, A text book of Engineering Chemistry

5. S.S Dara, S Chand Publisher, A Text Book of Engineering Chemistry.

6. A.K Dey, Environmental Chemistry, John Wiley.

7. Ashim K Das, Environmental chemistry with Green chemistry, Books and Allied Pvt. Ltd.

8. Vanloon Duffy, Environmental Chemistry, 2/E, Oxford University Press.

9. O. G. Palanna, Engineering Chemistry, Tata Mc-Graw Hill Education Private Ltd. New Delhi.

Basic Electronics

Elementary Physics of Semiconductor Material

PN Junction Diode- Operation Characteristics and Modelling, Zener Diode- Operation and Application; Diode Rectifiers, Filters, Clipper, Clamper. BJT Operation and Characteristic, NPN and PNP transistor, BJT biasing, Different circuit configurations with Circuit Models. Introduction to JFET Operation, Main Carriers in BJT and FET and Characteristics.

Operational Amplifiers

Inverting and Non inverting Configuration and its Common Applications IC-555 Timer Circuit-Astable, Monostable and Bistable Operations. Cathode Ray Oscilloscope. Elementary Construction, Connections for Viewing Signals, Measuring Voltage, Frequency and Time Period. Elementary Physics of Opto-electronic Devices like LED, LCD Devices, Photo-Diode, PhotoTransistor, LDR, 7-segment Display, Opto isolators.

Text/Reference Books: -

1. Vladimir V.Mitin, Viatcheslav A. Kochelap, Michael A. Stroscio, Introduction to Nanoelectronics - Science, Nanotechnology,Engineering and Application, Cambridge University Press.

2. D. De and K. P. Ghatak , Basic Electronics, Pearson Education.

3. R.F. Pierret, Semiconductor Device Fundamentals, Pearson Education.

4. Robert F Pierret and Gerold W.Neudeck , Modular Services on Solid State Device, Addison Wesley Publishing Company

5. K. Sedra and Smith, Microelectronic Circuits , Oxford

6. D. Carlo and Lin , Linear Circuit Analysis, Oxford University Press

Disaster Management

Elements of Engineering Seismology:- Earthquake occurrence in the world, causes of Earthquake, Plate tectonics, Earthquake mechanism, seismic zoning map of India and its use. Earthquake phenomenon:- Focus, Epicenter, seismic waves, magnitude, intensity scale its corelation assessment and Do's and Don's for protection of life and property during disaster. Landslides:- Geo-technical aspects of landslides and control of Landslide Hazard. Flood:- Flood control as a measure of Disaster Management and Mitigation Cyclone and Fire:- Cyclone Disaster Mitigation and ensuring wind and fire hazard safety during disaster.

Text/Reference Books:

1. A.K.Mukhopadhay, Crisis and Disaster Management Turbulence and Aftermath, New Age International Publishers.

2. H.N.Srivastava, S.N. Bhattacharya. G.D.Gupta, Earthquake Geography and Management, New Age International Publishers.

3. Thomas D. Schneid, Larry Collins, Disaster Management and Preparedness, Lewis Publishers, 2001.

4. C. V. R. Murty, IITK-BMTPC Earthquake Tips: Learning Seismic Design and Construction, National Information Centre of Earthquake Engineering.

Introduction to Programming(Theory)

BASIC OF COMPUTERS:

Computer fundamentals: Bits and Bytes , CPU, Memory, Input and output devices, I/O devices, operating system, Application software's , Number system- Decimal, Binary, Octal, Hexadecimal.Need for high level languages, Program design using flow charts

C LANGUAGE PRELIMINARIES:

C character set, Identifier and keywords, data types, declaration, expression, statements and symbolic constants.

Pre-processor commands: #include, #define, #ifdef

Input-Output: getchar, putchar, scanf, printf, gets,puts.

Operators and expressions: Arithmetic, unary,assignment, logical, conditional, and bit wise operators.

Control statements: if else, for, while, do-while, switch, break, continue, nested loops.

Storage types: Automatic, external, register andstatic variables.

Functions : Definiting and accessing , Passing arguments, Function prototypes, Recursion, Libraryfunctions, Static functions.

Arrays: Definiting and processing, Passing arrays to a function, Multi-dimension arrays.

Pointers: Basic concepts, malloc, pointer and arrays, simple single linked list example.

Text/Reference Books:

1. Introduction to Computer Science- ITL Education Solutions Limited , Pearson Education

2. Paul Deitel , C How to Program -5th Edition, PHI.

3. Dennis Ritchie and Brian Kernighan, The C Programming Language, PHI.

4. Behrouz A. Forouzan, Richard F. Gilberg, Computer Science: A Structured Programming Approach Using C , Course Technology

5. Gottfried, Byron S, Programming with C , TMH

Engineering Physics Lab

List of Experiments

1. To study the linear motion under virtually frictionless conditions using Linear Air Track.

2. Determination of the Co-efficient of viscosity of a liquid from its rate of flow through a capillary tube.

3. Construction of one ohm coil.

4. Determination of the frequency of a tuning fork by Melde's apparatus.

5. Determination of acceleration due to gravity (g) by a Kater's pendulum. 6. Measurementof unknown wavelength of a laser with a diffraction grating

Engineering Graphics

Drawing instruments and their uses, lines, lettering and dimensioning, scales, plains and diagonal scale, curves used in engineering practice, ellipse, parabola, hyperbola, cycloid, involutes orthographic projection, planes of projection, four quadrant, first angle projection, reference line, convention employed. Projection of points and lines, true length, true inclinations with reference plane, traces of a line, end view, and illustrative problems. Projection of planes, traces, end view planes perpendicular to one inclined to other reference planes. Projections of solid such as prism, pyramid, cone, cylinder, cube etc.

Text/Reference Books:

1. N.D. Bhatt , Elementary Engineering Drawing (Plane and solid geometry).

2. R.B Gupta , A text Book of Engineering Drawing.

3. K.Venugopal , A text Book of Engineering Drawing.

4. N.D. Bhatt, Machine Drawing.

5. R. K. Dhawan , A text Book of Machine Drawing (In first angle projection)

Computer Programming Laboratory

Programming simple problems exercising different features of C.

Basic Electronics Laboratory

Selected experiments based on Basic Electronics.

1) Study of characteristics of transistor indifferent modes i.e. common a emitter, common base and common collector configuration.

2) Experiments on class-A, class-B and AB of transistor power amplifiers.

3) Experiment on uncontrolled Diode-Bridge rectifier.

4) Determination of hybrid parameters of a transistor.

5) Characteristics of JFET, MOSFET.

6) Study of characteristics of Mono-stable, Bistable and a-stable multi vibrators using bipolar transistors.

7) Experiment on Schmitt Trigger Circuit.

8) Study of LED, photo-Diodes, Photo-Transistors, Light Development Resistors and OptoIsolators.

Text/Reference Books: -

1. Vladimir V.Mitin, Viatcheslav A. Kochelap, Michael A. Stroscio, Introduction to Nanoelectronics - Science, Nanotechnology,Engineering and Application, Cambridge University Press.

2. D. De and K. P. Ghatak , Basic Electronics, Pearson Education.

3. R.F. Pierret, Semiconductor Device Fundamentals, Pearson Education.

4. Robert F Pierret and Gerold W.Neudeck , Modular Services on Solid State Device, Addison Wesley Publishing Company

5. K. Sedra and Smith, Microelectronic Circuits , Oxford

6. D. Carlo and Lin , Linear Circuit Analysis, Oxford University Press

BTMT
COMPUTATIONAL MATHEMATICS
3rd SEMESTER

BTMT 3rd Semester
[Compulsory]

Probability and Statistics

Probability

Introduction

Random experiment, σ-field, sample space, probability as a set function, probability axioms, probability space, finite sample spaces, conditional probability, Baye's theorem, independence, random variables (discrete and continuous), cumulative distribution function, probability mass function, probability density function, mathematical expectation, moments, moment generating function, characteristic function, function of two random variables.

Discrete Distribution

Uniform, binomial, Poisson, geometric, negative binomial, hyper geometric distribution.

Continuous Distribution

Uniform, normal, exponential, gamma distribution.

Joint Distribution Function

Joint cumulative distribution function and its properties, joint probability density function, marginal and conditional distribution, expectation of function of two random variables, moments, covariance, correlation coefficient, independent random variables, joint moment generating function (JMGF) and calculation of covariance from JMGF, characteristic function, conditional expectation, linear regression for two variables, regression curves, bivariate normal distribution.

Statistics

Introduction

Markov and Chebyshev's inequality, convergence in probability, statement and interpretation of weak law of large numbers and central limit theorem for independent and identically distributed random variables with finite variance.

Sampling and Sampling Distribution

Population and sample, random sample, distribution of the sample, simple random sampling with and without replacement, sample characteristics.

Sampling Distribution

Statistic, sample moments, sample variance, sampling from the normal distribution, Chi-square, Student's t distribution and F-distribution.

Estimation of Parameters

Point estimation and interval estimation, mean-squared error, properties of good estimators: unbiasedness, consistency, sufficiency, Minimum Variance Unbiased Estimator (MVUE) (only definition).

Method of Maximum Likelihood

Likelihood function, ML estimators for discrete and continuous models.

Bivariate Frequency Distribution

Bivariate data, scatter diagram, correlation, linear regression, principle of least squares and fitting of polynomials and exponential curves.

Reference Books

a) *W. Feller, An Introduction to Probability Theory and Its Application, Wiley, 3rd Edition, 1970.*

b) *R. V. Hogg, J. W. McKean and Allen T. Craig, Introduction to Mathematical Statistics, Pearson Education, Asia, 2000.*

c) *R. L. Berger and G. Casella, Statistical Inference, Duxbury Thomson Learning, 2nd Edition, 2002.*

d) *Meyer and Meyer, Introductory Probability and Statistical Applications, Oxford and IBH Publishing, 2nd Edition, 2017.*

e) *N.G. Das, Statistical Methods, Combined Edition (vol. I and II), Mc. Graw Hill Education, 1st Edition, 2017.*

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BTMT 3rd Semester
[Compulsory]

Mathematical Analysis

Point Set Topology

Limit points of a set and isolated point of a set, closed sets, dense sets, countable and uncountable sets, neighbourhood of a point, interior point, open set, union, intersection of open sets and closed sets, Bolzano-Weierstrass theorem, series and sequence, Abel's test, Dirichlet's test, Mertens' theorem, Abel's theorem, limit of a function.

Metrics and Norms

Metric spaces, normed vector spaces, convergence in metric spaces, continuous functions, completeness,

Baire Category theorem, contraction mapping theorem, connectedness, intermediate value theorem, compactness, Heine-Borel theorem.

Integration

Function of bounded variation, Riemann-Stieltjes integral and relation with Riemann integral, Darboux-Stieltjes integral, mean value theorems.

Sequence and Series of Functions

Sequence and series of functions, uniform convergence, power series, Fourier series, Dirichlet's Kernel, Riemann-Lebesgue theorem, pointwise convergence of Fourier series of functions of bounded variation, Weierstrass approximation theorem, equicontinuity, Arzela-Ascoli theorem.

Reference Books

a) *K. R. Stromberg, Introduction to Classical Real Analysis, Wadsworth International, Springer, 1981.*

b) *J. M. Howie, A First Course in Real Analysis, Springer, 2001.*

c) *H. L. Royden, Real Analysis, Macmillan USA, 3rd Edition, 1988.*

d) *R. G. Bartle and D. R. Sherbert, Introduction to Real Analysis, Wiley, 4th Edition, 2011.*

e) *S. C. Malik, Principles of Real Analysis, New Age International Publishers, 1st Edition, 2017.*

f) *S. K. Mapa, Introduction to Real Analysis, Sarat Book Distributor, 8th Edition, 2019.*

g) *Shanti Narayan and M. D. Raisinghania, Elements of Real Analysis, S. Chand, 1965.*

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BTMT 3rd Semester
[Compulsory]

Differential Equation

Ordinary Differential Equation (ODE)

Introduction

Introduction, formation of ODE, significance of ODE, geometrical and physical consideration, solution of ODE in separable form.

First Order ODE

Exact and non-exact differential equations, simultaneous equations, first order linear equations, Bernoulli's equation, first order higher degree equations solvable for x, y and p, Clairaut's form and singular solutions.

Second Order ODE

Linear differential equations with constant coefficients, homogeneous and non-homogeneous linear ordinary differential equations of higher order, complementary function, method of undetermined coefficients, series solution.

Partial Differential Equation (PDE)

Introduction

Origin of PDE, order, degree, linear, non-linear, surfaces and curves, classification of first order PDE, quasi-linear equations, derivation of PDE.

Linear PDE

Solutions of PDE of order one: Lagrange's solution (type 1, type 2, type 3 and type 4), separation of variables.

Non-linear PDE

Complete integral, particular integral, singular integral, general integral, solution of non-linear PDE: Charpit's method.

Reference Books

a) *W. E. Boyce and R. C. Di Prima, Elementary Differential Equations and Boundary Value Problems, Wiley India, 9th Edition, 2009.*

b) *E. A. Coddington, An Introduction to Ordinary Differential Equations, PHI Learning, 1999.*

c) *M. Braun, Differential Equations and Their Applications, Springer-Verlag, 3rd Edition, 1983.*

d) *T. Amarnath, An Elementary Course in Partial Differential Equations, Alpha Science International Ltd, 2nd Edition, 2003.*

e) *P. Hartman, Ordinary Differential Equations, John Wiley and sons, New York, 1964.*

f) *M. Hirsch, S. Smale and R. Deveney, Differential Equations, Dynamical Systems and Introduction to Chaos, Academic Press, 2nd Edition, 2004.*

g) *I. N. Sneddon, Elements of Partial Differential Equations, Dover, 2006.*

h) *S. L. Ross, Differential Equations, Wiley India, 3rd Edition, 1984.*

i) *R. Haberman, Elementary Applied Partial Differential Equations with Fourier Series and Boundary Value Problem, Prentice Hall, 4th Edition, 1998.*

j) *L. C. Evans, Partial Differential Equations, American Mathematical Society, Rhode Island, 1998.*

k) *F. John, Partial Differential Equations, Narosa Publishing House, New Delhi, 1979.*

l) *M. D. Raisinghania, Ordinary and Partial Differential Equation, S. Chand, 2017.*

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BTMT 3rd Semester
[Compulsory]

Discrete Mathematics and Fuzzy Set Theory

Set Theory

Sets and classes, relations and functions, recursive definitions, posets, lattice, Zorn's lemma, cardinal and ordinal numbers.

Logic

Propositional and predicate calculus, well-formed formulae, tautology, equivalence, normal forms, theory of inference.

Combinatorics

Permutation and combination, partition, Pigeonhole principle, Inclusion-Exclusion principle, generating functions, recurrence relations.

Fuzzy Sets

Fuzzy sets, support of fuzzy set, α-level sets, strong and weak α-cut, fuzzy point, convex fuzzy sets, basic set theoretic operations on fuzzy sets, cartesian products, algebraic products, bounded sum and difference, probabilistic sum of fuzzy sets, t-norms and t-conorms, quasi-coincidence of two fuzzy subsets and fuzzy points, fuzzy numbers, triangular and trapezoidal fuzzy numbers.

Reference Books

a) *C. L. Liu, Elements of Discrete Mathematics, Tata McGraw-Hill, 2nd Edition, 2000.*
b) *G. Bojadzieve and M. Bojadzieve, Fuzzy Sets, Fuzzy Logic Applications, World Scientific, Illustrated Edition, 1996.*
c) *G. J. Klir, U. S. Clair and B. Yuan, Fuzzy Set Theory: Foundation and Application, Prentice Hall, 1997.*
d) *H. J. Zimmermann, Fuzzy Set Theory and Its Applications, Kluwer Academic, 3rd Edition, 1992.*
e) *J. L. Hein, Discrete Structures, Logic and Computability, Jones and Bartlett, 3rd Edition, 2010.*
f) *J. P. Tremblay and R. Manohar, Discrete Mathematical Structures with Applications to Computer Science, McGraw Hill Education, 1st Edition, 2017.*
g) *K. H. Rosen, Discrete Mathematics and Its Applications, Tata McGraw-Hill, 6th Edition, 2007.*
h) *L. H. Tsoukalas and R. E. Uhrig, Fuzzy and Neural Approaches in Engineering, John Wiley and Sons, 1997.*
i) *N. Deo, Graph Theory, Prentice Hall of India, 1974.*
j) *V. K. Balakrishnan, Introductory Discrete Mathematics, Dover Publication, 2010.*

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BTMT 3rd Semester
[Compulsory]

Data Structure and Algorithm (Theory)

Basic concepts

Mathematical background, complexity analysis. Arrays: one dimensional, multi-dimensional, sparse matrix, elementary operations, asymptotic notations- o, O, θ, Θ, ω, Ω and their properties.

Preliminaries

Growth of functions, recurrence relation, generating functions, solution of difference equations, Master's theorem (without proof), sorting and order statistics: bubble sort, merge sort, heap sort, quick sort, sorting in linear time, median and order statistics.

Linear Data Structure

Stacks: representation, elementary operations and applications such as infix to postfix, postfix evaluation, parenthesis matching. Queues: simple queue, circular queue, dequeue, elementary operations and applications. Linked lists: linear, circular and doubly linked lists, elementary operations and applications such as polynomial manipulation.

Non-Linear Data Structure

Trees: binary tree representation, tree traversal, complete binary tree, heap, binary search tree, height balanced trees like AVL tree and tries, red-black tree, other operations and applications of trees. Graphs: representation, adjacency list, graph traversal, path matrix, connected components, DAG, topological sort, spanning tree, radix sort. Searching: linear and binary search. Hashing: hash tables, hash functions, open addressing.

File Structures

Introduction, data file types, file organization, file access methods.

Reference Books

a) *Alfred V. Aho, Jeffrey D. Ullman, John E. Hopcroft, Data Structures and Algorithms, Addison Wesley, 1983.*
b) *M. A. Weiss, Data Structures and Algorithm Analysis in CTT, Addison-Wiesley, 3rd Edition, 2013.*
c) *A. M. Tenenbaum, Y. Langsam, and M. J. Augenstein, Data Structures Using C, PHI, New Delhi, 2009.*
d) *S. K. Srivastava, Data Structures Through C in Depth, BPB Publications, 2004.*
e) *T. H. Cormen, C. E. Leiserson, R.. L. Rivest and C. Stein, Introduction to Algorithms, 3rd Edition, PHI, 2009.*
f) *D. Samanta, Classical Data Structure, PHI Pvt. Ltd., 2011.*

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BTMT 3rd Semester
[Compulsory]

Data Structure and Algorithm (Practical)

1. Write a C-program for a tree DFS in matrix form.
2. Write a C-program for implementation of linked list.
3. Write a C-program for implementation of linked queue.
4. Write a C-program to display a single linked list.
5. Write a C-program to display a record in ascending and descending order using linked list.
6. Write a C-program to add and display records (name and enrolment no.) in a double linked list.
7. Write a C-program to display a record using linked list.
8. Write a C-program to display all the operations in a stack.
9. Write a C-program to insert, delete, peek and display elements in a queue.
10. Write a C-program to display the adjacency matrix of a graph.
11. Write a C-program to display the n^{th} term of Fibonacci series by iteration and recursion.
12. Write a C-program Tower of Hanoi.
13. Write a C-program to insert and delete node in a tree.
14. Write a C-program to construct an AVL tree.
15. Write a C-program to implement the depth-first search algorithm.
16. Write a C-program to read and display a 2D matrix of integers, its transpose.
17. Write a C-program to multiply two matrices.

Reference Books

a) *T.H. Cormen, C.E. Leiserson, R.L. Rivest and C. Stein, Introduction to Algorithms, PHI, New Delhi, 3rd Edition, 2009.*

b) *D. Samanta, Classical Data Structure, PHI Pvt. Ltd., 2011.*

c) *Alfred V. Aho, Jeffrey D. Ullman, John E. Hopcroft, Data Structures and Algorithms, Addison Wesley, 1983.*

d) *M.A. Weiss, Data Structures and Algorithm Analysis in CTT, Addison-Wesley, 3rd Edition, 2013.*

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BTMT
COMPUTATIONAL MATHEMATICS
4th SEMESTER

BTMT 4th Semester
[Compulsory]

Algebra

Abstract Algebra

Groups, permutation group, symmetric group, subgroups, coset, normal subgroup, centralizers, normalizers, stabilizers, kernels, cyclic groups, subgroups generated by a subset of a group, quotient groups, Lagrange's theorem, homomorphisms, isomorphism theorems, composition series, epimorphism, endomorphism, automorphisms, rings, ring homomorphisms, Boolean ring, ideal, quotient ring, ring embeddings, integral domain, properties, fields with examples, characteristic of a field, properties of field.

Linear Algebra

Vector spaces, bases and dimensions, change of bases and change of coordinates, sums and direct sums, spanning sets and independence, the dimension of a vector space, existence of eigen values, eigen vectors, eigen space, generalized eigenvectors, the complexification of a real vector space, quotient space, linear transformations, the kernel and image of a linear transformation, the rank and nullity theorem, change of bases for linear transformations, solvability of system of linear equations.

Reference Books

a) *S. Axler, Linear Algebra Done Right, Springer International Student Edition, 2nd Edition, 1997.*
b) *K. Hoffman and R. Kunze, Linear Algebra, Prentice Hall Int. Inc., Englewood Cliffs, 2nd Edition, 1971.*
c) *S. Lang, Algebra, Addison-Wesley, 3rd Edition, 1999.*
d) *J. A. Gallian, Contemporary Abstract Algebra, Narosa, 4th Edition, 1999.*
e) *M. Artin, Algebra, Prentice Hall inc., 1994.*
f) *I. N. Herstein, Topics in Algebra, John-Wiley, 1995.*
g) *M. T. Nair and A. Singh, Linear Algebra, Springer, 2018.*
h) *D. S. Dummit and R. M. Foote, Abstract Algebra, John-Wiley, 2nd Edition, 1999.*

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BTMT 4th Semester
[Compulsory]

Numerical Analysis

Error Analysis

Definition and sources of errors, propagation of errors, backward error analysis, sensitivity and conditioning, stability and accuracy, floating-point arithmetic and round-off error.

Algebraic and Transcendental Equation

Nonlinear equations, bisection method, secant method, Newton's method and its variants, fixed point iterations, convergence analysis, Newton's method for non-linear systems.

Interpolation

Finite differences, polynomial interpolation, Hermite interpolation, spline interpolation, b-splines, numerical differentiation.

Numerical Integration

Trapezoidal and Simpson's rules, Newton-Cotes formula, Gaussian quadrature, Richardson extrapolation.

Ordinary Differential Equation

Taylor series method, Picard's iterative method, Euler and modified Euler methods, Runge-Kutta methods, multistep methods, predictor-corrector methods, accuracy and stability, finite element method, finite difference method.

Reference Books

a) *James L. Buchanan and Peter R. Turner, Numerical Methods and Analysis, McGraw-Hill, 1992.*

b) *John H. Mathews, Numerical Methods for Mathematics, Science and Engineering, Prentice-Hall, 2nd edition, 1992.*

c) *Kendall E. Atkinson, An Introduction to Numerical Analysis, John Wiley and Sons, 1989.*

d) *M. K. Jain, S. R. K. Iyengar, R. K. Jain, Numerical Methods for Scientific and Engineering Competition, Wiley Eastern, 1985.*

e) *S. S. Sastry, Introductory Methods of Numerical Analysis, PHI, 5th Edition, 2012.*

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BTMT 4th Semester
[Compulsory]

LPP and Game Theory

Linear Programming

Lines and hyperplanes, convex sets, convex hull and their properties. formulation of a linear programming problem, theorems dealing with vertices of feasible regions and optimality, graphical solution, simplex method (including Big-M method and two phase method), infeasible and unbounded LPPs, alternate optima, dual problem and duality theorems, dual simplex method and its application in post optimality analysis, revised simplex method, sensitivity analysis, parametric programming.

Transportation Problem

Introduction, existence of solution, degeneracy, MODI method (including the theory), assignment problem, Hungarian method for solving assignment problems, travelling salesman problem.

Introduction to Game Theory

Introduction, minimax (maximin), criterion and optimal strategy, solution of games with saddle points, rectangular games without saddle points – 2×2 games – dominance principle – $m \times 2$ and $2 \times n$ games –graphical method.

Reference Books

a) *K. Swarup, Operations Research, Sultan Chand and Co., 2014.*

b) *S. D. Sharma ,Operations Research, Kedarnath, Ramnath and Co., 2002.*

c) *J. K. Sharma, Operation Research, MacMilan, 2006.*

d) *Hiller and Libermann, Introduction to Operation Research, TMH, 2017.*

e) *Wayne L.Winston, Operation Research, Thomson BrooCole, 2003.*

f) *H. A. Taha, An Introduction to Operations Research, PHI, 2010.*

g) *J. G. Chakravorty and P. R. Ghosh, Linear Programming and Game theory, Moulik Library, 2012.*

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BTMT 4th Semester
[Compulsory]

Computer Organization

Digital Logic

Boolean algebra, logic gates.

Computing and Computer

Evolution of computer: mechanical era, electronic computers, integrated circuits, processor architecture, system architecture.

Design Methodology

System design: system representation, design process, gate level, register level: register level components, programmable logic devices, register level design, the processor level: processor level components, processor level design.

Processor Basic

Computer organization, fundamentals, additional features, data representation: basic formats, fixed point numbers, floating numbers, instruction sets: instruction formats, instruction types, programming considerations.

Control Design

Instruction sequencing and instruction interpretation, hardwired control: design methods, multiplier control unit, CPU control unit, micro programmed control: micro instructions and their encoding.

Memory

C.P.U memory interaction, memory array organization and technology, memory hierarchies, main memory allocation, segment, pages and files, high speed memories, interleaved memories, caches and associative memories, cache coherence: sequential and weak consistency, snoopy bus protocol and directory based.

Input-Output Organization

Addressing I/O devices, data transfer synchronization, interrupt handling I/O channels, computer peripherals and interfacing, direct memory access, examples of I/O buses: PCI, SCSI, USB.

Basics of Pipelining

Instruction and data pipelining, speedup, definitions of pipeline hazards: structural, data, control and simple techniques for handling them.

Text Books

a) *M.M. Mano, Computer System Architecture, P.H.I, 3rd Edition, 2012.*
b) *J. P Hayes, Computer Architecture and Organisation, McGraw-Hill, 3rd Edition, 2017.*
c) *Carl Hamacher, Computer Organization,. McGraw-Hill, 5th Edition, 2011.*
d) *Stallings, Computer Organization and Architecture, Pearson Education India, 10th Edition 2016.*
e) *A. P. Malvino, Digital Computer Electronics, McGraw-Hill, 3rd Edition, 1992.*

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BTMT 4th Semester
[Compulsory]

Object Oriented Programming (C++ and Python) (Theory)

Introduction to Object Oriented Programming

Evolution of programming methodologies, introduction to OOP and its basic features, differences from procedural languages, data encapsulation, overloading binary operators, overloading binary operators using friends, inheritance and polymorphism**.**

Introduction to C++

Basic components of a C++, program and program structure, compiling and executing C++ Program.

Tokens, Expressions and Control Structures

Tokens, keywords, identifiers and constants, basic data types, user-defined and derived, data types, type compatibility, reference, variables, scope resolution operator, type casting, implicit conversion, operator precedence, control structures, structure and function.

Classes and Objects Initialization

Class specification, class objects, accessing class members, data hiding, pointers within a class, passing objects as arguments, friend functions and friend classes, constant parameters and member functions, structures and classes, static members, constructors, destructor, constructor overloading, order of construction and destruction, constructors with default arguments, dynamic initialization through constructors, constructors with dynamic operations, constant objects and constructor, static data members with constructors and destructors, nested classes.

Operator Overloading and Type Conversion

Defining operator overloading, overloading unary operators, manipulation of strings using operators, rules for overloading operators, type conversions.

Inheritance and Polymorphism

Deriving derived classes, single, multilevel, multiple, hierarchical, hybrid inheritance, constructors and destructors in derived classes, constructors invocation and data members, initialization, virtual base classes, abstract classes, delegation, pointers to derived classes, virtual functions, implementation of run-time polymorphism, pure virtual functions.

Fundamental Concepts of Python

Introduction to Python, history, unique features of Python, literals, variables and identifiers, operators, expressions and data types.

Control Structures

Selection control, iterative control.

Lists

List structures, lists (sequences), iterating over lists.

Functions

Program routines, calling value-returning functions, calling non value-returning functions, parameter passing, variable scope, dictionaries and sets, recursion, Python built in function, Python user defined functions, Python packages functions, defining and calling function, the anonymous functions, loops and statement in Python, yield and generators, Python modules and packages.

Text Files

Using text files, string passing, Python exceptions handling, handling an exception try, except, else, try-finally clause, argument of an exception, Python standard exceptions, raising an exceptions, user-defined exceptions.

Python Regular Expressions

Regular expressions, the match function, the search function, matching vs searching, search and replace, extended regular expressions.

Reference Books

a) *K. R. Venugopal, Rajkumar, T. Ravishankar, Mastering C++, TMH, 2006.*
b) *Lip man and Lajole, C++ Primer, Addison Wesley, 5th Edition, 2012.*
c) *Bjarne Stroustrup, The C++ Programming Language, Addition-Wesley, 4th Edition, 2013.*
d) *Robert Leffore, Object Oriented Programming in C++, Galgotia Publications Pvt Ltd, 1999.*
e) *Balaguruswamy, Object Oriented Programming with C++, TMH, 7th Edition, 2017.*
f) *Timthy Budd, An Introduction to Object Oriented Programming with C++, Addition-Wesley, 3rd Edition, 1991.*
g) *Kip R. Irvine, C++ and Object-Oriented Programming, Prentice Hall, 1st Edition 1996.*
h) *Kenneth A. Lambert, The Fundamentals of Python: First Programs, Course Technology Inc, 2nd Edition , 2017.*
i) *Eric Matthes, Python Crash Course: A Hands-On Project-Based Introduction to Programming, No Starch Press, 2nd Edition, 2019.*
j) *Paul Barry, Head-First Python: A Brain-Friendly Guide, Shroff/O'Reilly, 2nd Edition, 2016.*
k) *Zed Shaw, Learn Python the Hard Way, Addison-Wesley, 1st Edition, 2017.*
l) *Charles Dierbach, Introduction to Computer Science using Python a Computational Problem Solving Focus, John-Wiley and Sons, 2013.*

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BTMT 4th Semester
[Compulsory]

Object Oriented Programming (C++ and Python) (Practical)

Programming in C++

Accessing class members, data hiding, friend functions and friend classes, member functions, structures and classes, constructors, destructor, constructor overloading, dynamic initialization through constructors, operator overloading, overloading unary operators, overloading binary operators, manipulation of strings using operators, rules for overloading operators, type conversions, single, multilevel, multiple, hierarchical, hybrid inheritance, constructors invocation and data members, virtual base classes, abstract classes, delegation, pointers to derived classes, virtual functions, implementation of run-time polymorphism, pure virtual functions.

Programming in Python

Literals, variables and identifiers, operators, expressions and data types, selection control, iterative control, list structures, lists (sequences), iterating over lists, program routines, calling value-returning functions, calling non value-returning functions, parameter passing, variable scope, dictionaries and sets, recursion, yield and generators, using text files, string passing, exception handling.

Reference Book

a) *K. R. Venugopal, Rajkumar, T. Ravishankar, Mastering C++, TMH, 2006.*
b) *Lip man and Lajole, C++ Primer, Addison Wesley, 5th Edition, 2012.*
c) *Bjarne Stroustrup, The C++ Programming Language, Addition-Wesley, 4th Edition, 2013.*
d) *Robert Leffore, Object Oriented Programming in C++, Galgotia Publications Pvt Ltd, 1999.*
e) *Balaguruswamy, Object Oriented Programming with C++, TMH, 7th Edition, 2017.*
f) *Timthy Budd, An Introduction to Object Oriented Programming with C++, Addition-Wesley, 3rd Edition, 1991.*
g) *Kip R. Irvine, C++ and Object-Oriented Programming, Prentice Hall, 1st Edition 1996.*
h) *Kenneth A. Lambert, The Fundamentals of Python: First Programs, Course Technology Inc, 2nd Edition, 2017.*
i) *Eric Matthes, Python Crash Course: A Hands-On Project-Based Introduction to Programming, No Starch Press, 2nd Edition, 2019.*
j) *Paul Barry, Head-First Python: A Brain-Friendly Guide, Shroff/O'Reilly, 2nd Edition, 2016.*
k) *Zed Shaw, Learn Python the Hard Way, Addison-Wesley, 1st Edition , 2017.*
l) *Charles Dierbach, Introduction to Computer Science using Python a Computational Problem Solving Focus, John-Wiley and Sons, 2013.*

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BTMT
COMPUTATIONAL MATHEMATICS
5th SEMESTER

BTMT 5th Semester
[Compulsory]

Soft Computing

Artificial Neural Networks

Neural networks: overview of biological neuro-system, mathematical models of neurons, ANN architecture, learning rules, learning paradigms: supervised, unsupervised and reinforcement learning. ANN training algorithms: perceptions, training rules, delta, multilayer perception model, back propagation algorithm, competitive learning networks, Kohonen self organizing networks, Hebbian learning, Hopfield networks, associative memories, applications of artificial neural networks.

Fuzzy Logic

Introduction to fuzzy logic, linguistic variables, linguistic modifiers, propositions of fuzzy logic, measures of fuzziness, fuzzy inference rules and fuzzy reasoning, fuzzification and defuzzification, Mamdani- Sugeno inference rule, approximate reasoning.

Population Based Optimization Algorithms

Genetic algorithms, evolution strategies, evolutionary programming, genetic programming, differential evolution, selection, crossover, mutation, schema analysis, analysis of selection, Markov and other stochastic models, simulated annealing, particle swarm optimization.

Reference books

a) *J. S. R Jang, C.T. Sun and Mizutani E. Neuro, Fuzzy and Soft Computing, Pearson Education India, 1st Edition, 2015.*

b) *S. Haykin, Neural Networks and Learning Machines, Pearson Education Ltd., 3rd Edition, 2008.*

c) *Melani Mitchel, An Introduction to Genetic Algorithm, MIT Press, 1996.*

d) *David Goldberg, Genetic Algorithm in Search, Optimization and Machine Learning, Addison Wesley, 13th Edition, 1989.*

e) *Klir and Yuan, Fuzzy Sets and Fuzzy Logic, Pearson, 1st Edition, 1995.*

f) *A. Das Bhattacharjee, Artificial Intelligence and Soft Computing for Beginners, Shroff/X-Team, 3rd Edition, 2018.*

g) *H. J. Zimmermann, Fuzzy Set Theory and Its Applications, Allied Publisher's Limited, Springer, 2nd Edition, 1991.*

h) *George Klir, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Pearson, 1995.*

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BTMT 5th Semester
[Compulsory]

Integral Transform

Integral Transform

Basic concepts and definitions, integral transform operator, kernel of the transformation.

Fourier Transform

Definition and properties of Fourier transform, Fourier sine and cosine transform, convolution theorem for Fourier transform, Parseval's identity, finite Fourier sine and cosine transform, inversion.

Laplace Transform

Laplace transform and its applications.

Hankel Transform

Definition and properties of Hankel transform with examples, inversion formula, basic concept of Bessel's equation and Bessel's function, recurrence relations of Bessel's function, operational properties of Hankel transform, Parseval's theorem, Hankel transform of derivatives, applications.

Mellin Transform

Definition of Mellin transform and examples, Mellin transform of some special functions, Mellin transform of derivatives and integrals, Parseval's theorem, convolution theorem, applications.

Z-Transform

Definition and properties of Z-transform, inverse Z-transform (using partial fraction and residues), convolution theorem, formation of difference equations, solution of difference equations using Z - transform.

Reference Books

a) *I. N. Sneddon, The Uses of Integral Transforms, McGraw-Hill Inc., US, 1972.*
b) *C. J. Tranter, Integral Transforms in Mathematical Physics, Methuen and Co., 1959.*
c) *I. N. Sneddon, Fourier Transform, McGraw-Hill Book Company, 1951.*
d) *W.V. Lovitt, Linear Integral Equations, Dover Publications Inc., Reissue Edition, 2005.*
e) *F.G. Tricomi, Integral Equations, Dover Publications, 1985.*
f) *L.C. Andrews and B. K. Shivamoggi, Integral Transforms for Engineers, Prentice Hall India Learning Private Limited, 2003.*
g) *Dr. G. S. Sandhu, Integral Transforms and Their Applications, First World Publications, 2015.*

h) *L. Debnath and D. Bhatta, Integral Transforms and Their Applications, Chapman and Hall/CRC, 2nd Edition, 2006.*

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BTMT 5th Semester
[Compulsory]

Financial Mathematics

Introduction

Some basic definitions and terminology.

Basic Theory of Option Pricing

Single and multi-period binomial pricing models, Cox-Ross Rubinstein (CRR) model, Black-Scholes formula for option pricing as a limit of CRR model.

Stochastic Calculus

Brownian and geometric Brownian motion, theory of martingales, stochastic calculus, stochastic differential equations, Ito's formula to solve SDE's, applications of stochastic calculus in option pricing.

Mean-Variance Portfolio Theory

Markowitz model of portfolio optimization and Capital Asset Pricing Model (CAPM), limitations of Markowitz model and new measures of risk.

Interest Rates and Interest Rate Derivatives

Binomial lattice model, vasicek, hull and white models for bond pricing.

Reference Books

a) *Thomas Mikosch, Elementary Stochastic Calculus with Finance in view, World Scientific, 1998.*
b) *Suresh Chandra, S. Dharmaraja, Aparna Mehra, R. Khemchandani, Financial Mathematics: An Introduction, Narosa Publishing House, Illustrated Edition ,2013.*
c) *S. E. Shreve, Stochastic Calculus for Finance, Vol. I and Vol. II, Springer, 1st Edition, 2004 .*
d) *Sean Dineen, Probability Theory in Finance: A Mathematical Guide to the Black-Scholes Formula, American Mathematical Society, New Edition, 2006.*
e) *D. G. Luenberger, Investment Science, Oxford University Press, 2nd Edition, 2013.*
f) *M. Capińsky and T. Zastawniak, Mathematics for Finance: An Introduction to*

Financial Engineering, Springer, 2nd Edition, 2011.

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BTMT 5th Semester
[Compulsory]

Statistical Inference

Parametric models, parameters, random sample and its likelihood function, statistic and its sampling distributions, problems of inference, overview of Bernoulli, binomial, Poisson, negative binomial, normal, exponential, gamma, Weibull, Pareto etc., concept of sufficiency, minimal sufficiency, Neyman factorization criterion, Fisher information, maximum likelihood estimators, method of moment estimators, percentile estimators, least squares estimators, minimum mean squares estimators, uniformly minimum variance unbiased estimators, Cramer-Rao lower bound, Rao-Blackwell theorem, different examples, expectation maximization, statistical hypotheses-simple and composite, statistical tests, critical regions, type-I and type-II errors, size and power of a test, Neyman Pearson lemma and its different applications, most powerful test, uniformly most powerful test, unbiased test and uniformly most unbiased test, likelihood ratio test, interval estimation, confidence intervals, construction of confidence intervals, shortest expected length, confidence interval, most accurate one sided confidence interval and its relation to uniformly most powerful test.

References Books

a) *R. L. Berger and G. Casella, Statistical Inference, Cengage, 1st Edition, 2006.*
b) *E. L. Lehmann, G. Casella, Theory of Point Estimation Springer, 2nd Edition, 1998, (Corr. 4th printing 2003 Edition, 2003).*
c) *T. S. Ferguson, Statistical Decision Theory, Academic Press, 2014.*
d) *E. L. Lehmann, Testing of Statistical Hypotheses, Wiley–Blackwell, 1966.*
e) *P. J. Bickel and K. A. Doksum, Mathematical Statistics, Chapman and Hall/CRC, 2nd Edition, 2015.*
f) *J. O. Berger, Statistical Decision Theory, Springer; 2nd Edition, 1985. (Corr. 3rd printing 1993 Edition, 1993).*

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BTMT 5th Semester
[Compulsory]

Scientific Computing (Practical)

Starting with MATLAB

MATLAB windows, arithmetic operations, elementary built-in-functions, element by element operations, scalar variables, complex number, floating point arithmetic.

Array and Array Operations

Simple array, array addressing or indexing, array construction, array orientation, scalar array Mathematics, array manipulation, array sorting, sub array searching, array size, array and memory utilization, multidimensional array construction and its manipulation, numeric data type: integer data type, floating point data types.

Script M file

Creating and saving script file, input to a script file, running a script file.

Function and Function File

Creating a function file, structure of a function file, comparison between script and function file.

Cell Array and Structure

Cell array creation and its manipulation, retrieving cell array content, comma separated list, cell functions, cell array of strings, structure creation, structure manipulation, structure functions, character string: string construction, string evaluation, string functions, cell array of strings.

Relational and Logical Operators

Relational and logical functions, operator precedence. Control flow: for loops, while loops, if else end construction, switch case construction, nested loop, break and continue command.

Application to Numerical Analysis

Iterative method, bisection method, Newton Raphson method, Regula Falsi method, Graffe's root squaring method, power method, L.U. decomposition method, Romberg method, Muller method, Adams Moulton method, Newton's interpolation (forward and backward), Lagrange's interpolation, divided difference method, numerical differentiation (1^{st} and 2^{nd} Order), numerical integration, least square method, Gauss elimination method, Gauss Seidal method, Jacobi iteration method, Runge Kutta method, Euler method, Milne's method, Adams Bashforth method.

Reference Books

a) *A. Gilat, MATLAB: An Introduction with Applications, John Wiley and Sons, 6th Edition, 2016.*

b) *L.V . Fausett, Applied Numerical Analysis Using MATLAB, Pearson Education, 2nd Edition, 2016.*

c) *S. C. Chapra and R. P. Canale, Numerical Methods for Engineers, McGraw Hill, 6th Edition, 2005.*

d) *R. Pratab, Getting Started with Matlab: A Quick Introduction for Scientists and Engineers, OUP USA, 7th Edition, 2016.*

e) *S. C. Chapra, Applied Numerical Methods with Matlab for Engineers and Scientists, Tata McGraw Hill, 2008.*

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BTMT
COMPUTATIONAL MATHEMATICS
6th SEMESTER

BTMT 6th Semester
[Compulsory]

Graph Theory

Introduction to Graphs

The concept of a graph, paths in graphs, graph models, graph terminology and special types of graphs, bipartite graphs, complete graphs, external graphs, intersection graphs, operations on graph, graph isomorphism.

Blocks

Cutpoints, bridges and blocks, block graphs and cutpoint graphs.

Trees

Introduction to trees and characterizations, applications of trees, spanning trees, minimum spanning trees, trees in computer science, centres and centroids, block cutpoint trees, independent cycles and cocycles, matroids.

Connectivity

Connectivity and line-connectivity, graphical version of Menger's theorem, traversability : Eulerian graphs, Hamiltonian graphs.

Coverings and Matching

Coverings and independence, critical points and lines, matching, maximum matching problem, minimum covering problems.

Representing Graphs

Adjacency matrix, incidence matrix, cycle matrix.

Planarity

Plane and planar graphs, outerplanar graphs, Kuratowski's theorem, other characterizations of planar graphs.

Colorability

Vertex coloring, chromatic number, edge coloring, five color theorem, four color conjecture, unique colorable graphs.

Directed Graphs

Basic definitions, types of connectedness, covers and bases, distance concepts and matrices, connectivity, acyclic digraphs, cycles and traversability, orientations and tournaments.

Network Flows

Max flow - min cut theorem, Menger's theorem, Ford-Fulkerson algorithm.

Reference Books

a) *F. Harary, Graph Theory, Narosa Publishing House, 7th Edition, 2001.*

b) *Douglas B. West, Introduction to Graph Theory, Prentice-Hall of India Pvt. Ltd., 2nd Edition, 1999.*

c) *Narsingh Deo, Graph Theory with Applications to Engineering and Computer Science, Prentice-Hall of India Pvt. Ltd., New Edition, 1979.*

d) *K.R. Parthasarathi, Basic Graph Theory, Tata McGraw-Hill Publ. Co. Ltd., 1994.*

e) *Bondy and Murty, Graph Theory with Applications, Elsevier Science Ltd, 1976.*

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BTMT 6th Semester
[Compulsory]

Number Theory and Cryptography

Number Theory

Basis Representation

Principles of Mathematical induction, the basis representation theorem, the fundamental theorem of arithmetic, Euclid's division lemma, divisibility, the linear Diophantine equation.

Combinatorial and Computational Number Theory

Fermat's little theorem, Wilson's theorem, generating functions, the use of computers in number theory, fundamentals of congruences, basic properties of congruences, residue systems, riffling.

Solving Congruences

Linear congruences, the theorems of Fermat and Wilson revisited, the Chinese remainder theorem, polynomial congruences.

Arithmatic Functions

Combinatorial study of $\emptyset(n)$, formulae for d(n) and $\emptyset(n)$, multiplicative arithmetic functions, the Mobius inversion formula, primitive roots, properties of reduced residue systems, primitive root modulo p.

Cryptography

Introduction

Basic objects of cryptography, secret-key and public-key cryptography, one-way and trapdoor one-way functions, cryptanalysis attack models, classical cryptography.

Block and Stream Ciphers

Modes of operation, DES and its variants, RCS, IDEA, SAFER, FEAL, BlowFish, AES, linear and differential cryptanalysis, stream ciphers based on linear feedback shift registers, SEAL, unconditional security.

Message Digest

Properties of hash function, MD2, MD5 and SHA-1, keyed hash function, attack on hash function.

Public Key Parameters

Modular arithmetic, GCD, primality testing, modular square root, finite fields.

Intractable Problems

Integer factorization problem, RSA problem, modular square root problem, discrete logarithm problem, Diffie-Hellman problem, known algorithm for solving the intractable problems.

Public Key Encryption

RSA, Rabin and EIGamalscemes, side channel attacks. Key exchange: Diffie-Hellman and MQV algorithms.

Reference Books

a) *Douglas R. Stinson, Cryptography, Theory and Practice, CRC Press, 2nd Edition, 2002.*
b) *Alfred J. Menezes, Paul C. Van Oorschot and Scott A. Vanstone, Handbook of Applied Cryptography, CRC Press, 2001.*
c) *Johannes. A. Buchmann, Introduction to Cryptography, Springer, 1st Edition, 2001.*
d) *Steven D. Galbraith, Mathematics of Public Key Cryptography, Cambridge University Press, 2012.*
e) *Jonathan Katz, Yehuda Lindell, Introduction to Modern Cryptography, Chapman and Hall/CRC, 1st Edition, 2007.*

f) *Jay R Goldman, The Queen of Mathematics: A Historically Motivated Guide to Number Theory, A K Peters Ltd., 1st Edition, 1997.*
g) *Saban Alaca, Kenneth S Williams, Introduction to Algebraic Number Theory, Cambridge University Press, 1st Edition, 2004.*
h) *Richard A Mollin, Advanced Number Theory with Applications, CRC Press, A Chapman and Hall Book,1st Edition , 2017.*
i) *Kenneth. H. Rosen, Elementary Number Theory and Its Applications, Pearson, 6th Edition, 2011.*
j) *Kenneth Ireland and Michael Rosen, A Classical Introduction to Modern Number Theory, Springer-Verlag, 5th Edition, 1998.*

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BTMT 6th Semester
[Compulsory]

Design and Analysis of Algorithms

Introduction

Definition, asymptotic notations and complexity analysis (best, worst, and average case), notions of optimality, amortize analysis.

Algorithm Design Techniques

Greedy, divide and conquer, dynamic programming with examples, fractional knapsack and 0-1 knapsack problems, integer, matrix and polynomial multiplication, convex hull, closest pairs, string matching, FFT, extended Euclid's algorithm.

Graphs and Graph Algorithms

Definition, representations of graphs, depth first search, breadth first search, Kruskal's and Prim's algorithm for minimum spanning tree, Dijkstra's single source shortest path algorithm, Floyd-Warshall all-pairs shortest path algorithm.

Computational Complexity

Introduction to NP completeness, the classes P and NP, polynomial reduction, NP hard and NP complete problems, introduction to branch-and-bound, backtracking and approximation algorithms.

Reference Books

a) *Thomas. H. Corman, Charles E. Leiserson, Ronald L. Rivest and C. Stein, Introduction to Algorithms, PHI Learning Pvt. Ltd., 3rd Edition, 2010.*
b) *G. Brassard and P. Bratley, Fundamentals of Algorithms, Prentice Hall India Learning Private Limited, 2nd Edition, 1996.*
c) *Alfred V. Aho, Jhon E. Hopcroft and J. D. Ullman, The Design and Analysis of Computer Algorithms, Addison -Wesley Publishing Company, 1974.*
d) *E. Horowitz, S. Sahni and S. Rajsekaran, Fundamentals of Computer Algorithms, Golgotia Publications (P) Ltd , 2nd Edition , 2008.*

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BTMT 6th Semester
[Compulsory]

Machine Learning and Data Mining

Machine Learning

Introduction

Introduction to machine learning. Supervised learning: regression and classification, linear regression, logistic regression. Classification algorithms: minimum distance classifier, nearest neighbour, Baye's classifier, neural classifier. Support vector machine, decision trees, random forest.

Evaluation Measures

Precision, recall, F-measure, ROC curve.

Unsupervised Learning

K-means clustering, DBSCAN, hierarchical clustering, graph based clustering.

Learnability

Reinforcement learning, statistical relational learning.

Dimensionality Reduction

Sequential forward and backward search, singular value decomposition, principal component analysis.

Data Mining

Basic concepts on data mining and knowledge discovery in data bases, relation to statistics, databases, steps in data mining process, architecture of a typical data mining systems, classification of data mining systems, overview of data mining techniques, data preprocessing, data cleaning, data integration, data transformation and data reduction, data generalization and summarization based characterization, a statistical perspective on data mining, association rules in large databases, web mining, spatial mining, temporal mining.

Reference books:

a) *T.M. Mitchell, Machine Learning, Mc Graw Hill, 1st Edition,2017.*
b) *Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, Illustrated Edition, 2012.*
c) *Dolf Zantinge and Pieter Adriaans, Data Mining, Addison-Wesley, 1st Edition, 1996.*

d) *M.H. Dunham, Data Mining Introductory and Advanced Topics, Pearson Education, 1st Edition, 2006.*
e) *Jiawei Han and Micheline Kamber, Data Mining: Concepts and Techniques, Morgan Kaufmann, 3rd Edition , 2011.*
f) *Charu C Agarwal, Data Mining- The Text Book, Springer, 2015.*

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BTMT 6th Semester
[Compulsory]

Database Management System (Theory)

An Overview of Database

Database, database system, DBMS components, data independence, data abstraction, DDL, DML, data dictionary, data integration, database access method, advantages of using a DBMS.

Database System Architecture

Data models, schemas and instances, DBMS architecture, data independence, database languages and interfaces, database system environment, classification of database management systems.

Data Model Using E-R Model and Object Model

High-level conceptual, data models, entity types, entity sets, attributes and keys, relationships, relationship types, roles and structural constraints, weak entity types, refining the ER design, ER diagrams, naming conventions and design issues, subclasses, super classes, inheritance.

File Organization

Secondary storage devices, parallelizing disk access using RAID technology, buffering of blocks, placing file records on disk, operations on files, files of unordered records (heap files), files of ordered records (sorted files), hashing techniques, other primary file organizations, types of single-level ordered index, multilevel indexes, dynamic multilevel indexes using B-Trees and B+ Trees, indexes on multiple keys, other types of indexes.

Relational Model

Relational model concepts, relational constraints and relational database schemas, update operations and dealing with constraint violations, basic relational algebra operations, additional relational operations, relational calculus, tuple calculus, domain calculus.

Relational Database Standard

Data definition, constraints, schema changes in SQL, basic queries in SQL, insert, delete and update statements in SQL, views (virtual tables) in SQL, specifying general constraints as assertion, additional features of SQL.

Normalization for Relational Database

Functional dependencies, normal forms based on primary keys: 1NF, 2NF, 3NF, Boyce-Codd normal form, normalization through synthesis, normalization using join dependency.

Database Design and Tuning

Database design process, physical database design in relational databases, database tuning in relational systems.

Database Recovery and Security

Transactions, recovery concepts, transaction recovery, system recovery, media recovery, recovery technique, recovery in multi database systems, database security issues, access control for multilevel security, data encryption.

Advanced Topics

Object-oriented and object relational databases, logical databases, web databases, distributed databases, data warehousing and data mining, no SQL.

Reference Books

a) *Ramez Elmasri and Shamkant B. Navathe, Fundamentals of Database Systems, Pearson Education, 7th Edition , 2017.*

b) *Henry F. Korth, Database System Concepts, McGraw-Hill Publication, 6th Edition, 2013.*

c) *Raghu Ramakrishnan, Johannes Gehrke, Data Base Management System, McGraw Hill Education, 3rd Edition, 2014.*

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BTMT 6th Semester
[Compulsory]

Database Management System (Practical)

SQL query programming, designing databases and accessing them for reasonably large applications.

Reference Books

a) *R. Elmasri and S. Navathe, Fundamentals of Database Systems, Pearson, 6th Edition, 2010.*

b) *Abraham Silberschatz, Henry Korth, and S. Sudarshan, Database System Concepts, McGraw-Hill, 6th Edition, 2013.*

c) *Raghu Ramakrishnan, Database Management Systems, WCB/McGraw-Hill, 3rd Edition, 2014.*

d) *Bipin Desai, An Introduction to Database Systems, Galgotia Publications PVT LTD, 2012.*

e) *Serge Abiteboul, Richard Hull and Victor Vianu, Foundations of Databases., Pearson, Facsimile Edition , 1994.*

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BTMT
COMPUTATIONAL MATHEMATICS
7th SEMESTER

BTMT 7th Semester
[Compulsory]

Randomized Algorithms

Introduction: what randomized algorithms are, motivation for the design and use of randomized algorithms, types of randomized algorithms (Las Vegas and Monte Carlo), polynomial identity testing.

Events and probability, axioms of probability, the union bound, inclusion-exclusion principle, the balls and bins problem, conditional events, Bayes Law, Karger's randomized min-cut algorithm.

Discrete random variables (Bernoulli, Binomial, Geometric), expectation, linearity of expectation, coupon collector's problem, analysis of randomized quick sort, conditional expectation.

Markov's inequality, variance and Chebyshev's inequality, randomized selection.

Chernoff-Hoeffding (CH) Bounds: derivation and different versions, load balancing, randomized quicksort, packet routing in networks, skip lists.

The probabilistic method, the expectation argument, max-cut, maxSAT, the sample and modify method, independent sets, second moment method, threshold behavior in random graphs. Derandomization: method of conditional expectations.

Lovasz local lemma, derivation and the two versions, edge disjoint paths, satisfiability.

Algorithmic versions of the Lovasz local lemma: Beck's algorithm, the algorithm of Moser and Tardos. Distributed Maximal Independent Set (MIS) algorithms and the use of Beck's algorithm in this context.

Randomized rounding to solve problems in combinatorial optimization, maxSAT, max-cut, set cover. Randomized rounding of semi definite programs, introduction to semi definite programs, the Goemans-Williamson algorithm for finding large cuts.

Markov Chains, applications to 2-SAT and 3-SAT, random walks on graphs, electrical networks, cover time, hitting time, s-t connectivity algorithm.

Reference Books:

a) *Rajeev Motwani, Prabhakar Raghavan, Randomized Algorithms, Cambridge University Press, 1st Edition, 2004.*

b) *David Williamson, David Shmoys, The Design of Approximation Algorithms, Cambridge University Press, Illustrated Edition, 2011.*

c) *Devdatt Dubhashi, Alessandro Panconesi, Concentration Of Measure For The Analysis Of Randomized Algorithms, Cambridge University Press, New Edition, 2009.*

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BTMT 7th Semester
[Compulsory]

Image Processing

Introduction

Image definition and its representation, neighborhood. Orthogonal transformations like DFT, DCT, wavelet.

Enhancement and Restoration

Contrast enhancement, smoothing and sharpening, filtering and restoration.

Segmentation

Pixel classification, global/local gray level thresholding, region growing, split/merge techniques, edge detection operators, Hough transform. Image feature/primitive extraction, component labeling, medial axis transform, skeletonization/thinning, shape properties, textural features-moments, gray level co-occurrence matrix, structural features. Fourier descriptor, polygonal approximation.

Compression

Coding, quantization, spatial and transform domain based compression. Color image processing: color model, enhancement, and segmentation.

Mathematical Morphology

Basic concepts, erosion, dilation, opening, closing. Advanced applications like biomedical image processing, digital watermarking, etc.

Reference Books:

a) *R. C. Gonzalez and R. E. Woods, Digital Image Processing, Pearson, 4th Edition, 2018.*
b) *B. Chanda and D. Dutta Majumder, Digital Image Processing and Analysis, Prentice Hall of India, 2nd Edition, 2011.*
c) *Azriel Rosenfel and Avinash C. Kak , Digital Picture Processing, Vol. 1 and 2, Academic Press, 2nd Edition, 1982.*
d) *T. Y. Young and K. S. Fu, Handbook of Pattern Recognition and Image Processing, Vols. 1and 2, Academic Press, New York, 1986.*
e) *A. Jain, Fundamentals of Digital Image Processing, Prentice Hall of India, 1989.*
f) *K. R. Castleman, Digital Image Processing, Pearson, 4th Edition, 1995.*

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BTMT 7th Semester
[Compulsory]

Optimization Techniques

Mathematical Foundations and Basic Definitions

Concepts from linear algebra, geometry and multivariable calculus.

Revised Simplex Method (with and without artificial variables) Parametric and Post Optimal Analysis

Overview of Simplex method, change in the objective function, change in the requirement vector, addition of a variable, addition of a constraint, parametric analysis of cost and requirement vector.

Search Method

Fibonacci and Goldsen section method.

Gradient Method

Method of conjugate directions for quadratic function, steepest descent and Devidon-Fletcher-Powell method.

Constrained Optimization

Method of feasible direction, cutting hyperplane method.

Non-linear Optimization

Unconstrained and constrained optimization of several variables, Lagranges multipliers, Khun-Tucker theory. Numerical methods for optimization.

Quadratic Optimization

Quadratic programming method due to Beale, Wolf and Vandepanne duality in quadratic programming. Self -duality.

Integer Programming

Gomory's cutting plane algorithm, Gomory's mixed integer problem algorithm. Branch and bound algorithm.

Numerical Optimization Techniques

Line search methods, gradient methods, Newton's method, conjugate direction methods, quasi-Newton methods, projected gradient methods, penalty methods.

Software

Introduction to software for optimization techniques (LINGO/LINDO).

Reference Books

a) *E.K.P. Chong and S.H. Zak, An Introduction to Optimization, 2nd Edition, Wiley, 2010.*
b) *R. Fletcher, Practical Methods of Optimization, John Wiley, 2nd Edition, 2009.*
c) *D. G. Luenberger and Y. Ye, Linear and Nonlinear Programming, Springer India, 3rd Edition, 2010.*
d) *M. S. Bazarra, J.J. Jarvis, and H.D. Sherali, Linear Programming and Network Flows, Wiley India, 3rd Edition, 2008.*
e) *U. Faigle, W. Kern, and G. Still, Algorithmic Principles of Mathematical Programming, Kluwe, 2002.*
f) *N. S. Kambo, Mathematical Programming Techniques, East West Press, 1997.*
g) *D.P. Bertsekas, Nonlinear Programming, Athena Scientific, 2nd Edition, 1999.*
h) *M. S. Bazarra, H.D. Sherali, and C. M. Shetty, Nonlinear Programming: Theory and Algorithms, Wiley, 3rd Edition, 2006.*

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BTMT 7th Semester
[Compulsory]

Stochastic Processes

Stochastic Processes

Definition and examples of stochastic processes, classifications of stochastic processes, Markov chains: definition and examples, transition probability matrices, classification of states of a Markov chain, determination of higher order transition probabilities, stability of a Markov chain, graph theoretic approach, Markov chains with denumerable number of states, reducible Markov chains, Markov Chains with continuous state spaces, non-homogeneous Markov Chains, Martingales, Markov chains in continuous time: general pure birth and death processes, birth and death processes with absorbing states, Renewal processes: renewal processes in continuous time, renewal equation, renewal theorems, residual and excess lifetime, renewal reward processes, regenerative renewal processes, regenerative inventory systems, generalization of the classical renewal theory, stochastic processes in queuing and reliability: general concepts of queuing systems, steady state and transient behavior, birth and death process in queuing theory, network of Markovian queuing systems, reliability, introduction to Brownian motion: Wiener processes, differential equations for a Wiener process, Kolmogorov's equations, the first passage time distribution for a Wiener process, recent developments.

Reference Books :

a) *J. Medhi, Stochastic Processes, New Age Publishers, 2nd Edition, Reprint 2007.*
b) *S.Karlin and H. M. Taylor, A First Course in Stochastic Processes, Academic Press, 1975.*

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BTMT
COMPUTATIONAL MATHEMATICS
8th SEMESTER

BTMT 8th Semester
[Compulsory]

Formal Language and Automata Theory

Introduction

Introduction to language theory, alphabets, definition of phrase structure grammar, production rules, sentences, sentential forms, language, derivation. Chomsky Hierarchy of languages.

Regular Languages

Regular grammars, regular language models, finite state machines (deterministic and non-deterministic), regular expressions, equivalence of regular expressions, closure properties. Pumping lemma of regular sets.

Finite Automata

Finite automaton, deterministic and non-deterministic finite automata and their equivalence.

Context -Free Languages

Context free grammar, derivation trees, ambiguity simplification, normal forms, applications.

Pushdown Automata

Pushdown automata, definitions, construction of PDA for simple CFLs, linear bounded automata, closure properties. Pumping Lemma for CFL.

Turing Machines

Turing machines, deterministic and non-deterministic Turing machines, Multi-tape Turing machines, Universal Turing machines, techniques for construction of Turing machines, unrestricted grammar, Chomsky Hierarchy, computable functions, computably enumerable languages, decidable languages, algorithmic solvable problems. Alternative models of computation such as post machine. Lambda Calculus.

Reference Books

a) *J. E. Hopcropt and J.D. Ullman, Introduction to Automata Theory, Language and Computing, Norasa Publishing, 2000.*
b) *M. Sipser, Introduction to theory of computation, Cengage Learning, 3rd Edition, 2014.*
c) *A. Singh, Elements of Computation theory, Springer Nature, 2011.*
d) *P. Linz, Introduction to formal language and automata, Jones and Bartlett, 6th Edition, 2016.*

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BTMT 8th Semester
[Compulsory]

Artificial Intelligence

Introduction

The foundation of AI. Importance of AI and related fields.

Logic

Review of clausal form in propositional logic, resolution principle, review of predicate logic, Skolemization, unification, resolution principle for predicate logic.

Rules

Working memory, rule base, conflict set, conflict resolution strategies, backward and forward chaining and meta rules.

Reasoning under Uncertainty

Probabilistic reasoning, Bayesian networks, certainty factor methods, Dampster-Shafer theory.

Structure Representation

Semantic networks, frames, conceptual dependency, scripts, inheritance, default values.

General Issues in Knowledge Representation and Interference

Logical agents, reasoning and resolution, adequacy, richness, granularity, ease of representation and use, modeling uncertainty, the fame problem, declarative and procedural representation.

Problem Solving by Searching

State space representation, heuristics, heuristic evaluation function and problem reduction. Searching for solutions. Informed and uninformed search strategies.

Search Methods

Generate and test, hill climbing, means-ends analysis, depth-first, breadth-first, best first, exploiting domain constraints, dependency-directed back tracking, minimax, alpha- beta pruning, iterative deepening, A*, AO*.

Planning

Planning by forward and backward reasoning, nonlinear planning, scheduling.

Ethical Issues of AI

Reference Books

a) *E. Rich and K. Knight, Artificial Intelligence, McGraw Hill Education, 3rd Edition, 2017.*

b) *Russell, Peter Norvig, Artificial Intelligence a Modern Approach-Stuart, Pearson, 3rdEdition, 2010.*

c) *P.H.Winston, Artificial Intelligence, Addison- Wesley, 3rd Edition, 1994.*

d) *D.W. Patterson, Introduction of Artificial Intelligence and expert systems, PHI, 3rd Edition, 1990.*

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BTMT 8th Semester
[Compulsory]

Deep Learning

Introduction

Historical context and motivation for deep learning, basic supervised classification task, optimizing logistic classifier using gradient descent, stochastic gradient descent, momentum and adaptive sub-gradient method. Back propagation. Vanishing gradient problem.

Neural Networks

Feed forward neural networks, deep networks, regularizing a deep network, model exploration and hyper-parameter tuning.

Convolution Neural Networks

Introduction to convolution neural networks, stacking, striding and pooling, CNN architectures, applications like image and text classification. Advanced CNNs for computer vision.

Sequence Modeling

Recurrent Nets, unfolding computational graphs, Recurrent Neural Networks (RNNs), bidirectional RNNs, encoder-decoder sequence to sequence architectures, deep recurrent networks, advanced RNN: LSTM, GRU.

Advanced Deep architectures

Generative Adversarial Networks (GANs). Advanced GANs.

Auto Encoders

Under complete auto encoders, regularized auto encoders, sparse auto encoders, denoising auto encoders, representational power, layer, size and depth of auto encoders, stochastic encoders and decoders.

Structuring Machine Learning Projects

Orthogonalization, evaluation metrics, size of the training, validation and test sets, cleaning up incorrectly labeled data, bias and variance with mismatched data distributions, transfer learning, multi-task learning.

Reference Books

a) *Ian Goodfellow, Deep Learning, MIT Press, Illustrated Edition, 2017.*
b) *Jeff Heaton, Deep Learning and Neural Networks, Heaton Research Inc, 1st Edition, 2015.*
c) *Mindy L Hall, Deep Learning, VDM Verlag, 2011*
d) *Li Deng, Dong Yu, Deep Learning: Methods and Applications , Foundations and Trends in Signal Processing, Now Publishers Inc, 2014.* https://doi.org/10.1561/2000000039

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BTMT 8th Semester
[Elective – I]

Engineering Economics and Accountancy

Engineering Economics

Meaning, nature, scope and subject matter.

Utility

Definition, total, marginal and average, cardinal utility theory, indifference curves theory.

Demand

Factors effecting demand, elasticity of demand, different types of elasticity, classification of goods based on various elasticity of demand.

Production

Production function, Iso-quant, returns to scale, total, average and marginal product, law of variable proportions, Cobb-Douglas production function, ISO-cost curve, derivation of cost curve from production function, production optimization, expansion path.

Cost

Short run and long run cost (the 'Envelope Curve'), shape of different types of cost curves, revenue**,** total revenue and marginal revenue**,** relation between marginal revenue and price elasticity of demand.

Firm

Different types of firm and its characteristics, traditional theory of firm, objectives of firm.

Introduction to Accounting

Definition of accounting and accountancy, objectives of accounting, users of accounting information, double entry system of Book-Keeping, Journal and Ledger, cash book, trial balance.

Final Accounts

Basic concepts, uses and preparation of trading account, profit and loss account and balance sheet. issue and forfeiture of share and re-issue of company.

Introduction to Costing

Elements of cost, direct materials, direct labor, direct expenses, overheads, production, office and administration, selling and distribution, allocation of overhead, machine hour rate, labor hour rate, practical problems.

Reference Books

a) *A. Koutsoyiannis, Modern Microeconomics, Macmillan, 2nd Edition, 1979.*
b) *A. Sen, Microeconomics: Theory and Applications, Oxford University Press, Indian Branch, 2000.*
c) *R.S. Pindyck and D.L. Rubinfeld, Microeconomics, Prentice-Hall, 8th Edition, 2017.*
d) *Hal Varian, Microeconomic Analysis,Viva Books, 3rd Revised Edition, 2019.*
e) *Mukherjee and Haniff, Modern Accountancy, Volume I, McGraw Hill Education, 3rd Edition, 2018.*
f) *Basu and Das, Theory and Practice of Costing, Rabindra Library, 9th Edition,2001.*

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BTMT 8th Semester
[Elective – I]

Computer Networks and Security (Theory)

Introduction

Network criteria, physical structure (type of connection, topology), categories of network (LAN, MAN, WAN), internet, brief history, protocols and standards, reference models: OSI reference model, TCP/IP reference model. Design issues of layers.

Physical Level

Overview of data, signal, transmission and transmission media (guided and unguided), circuit switching and packet switching, telephone network.

Data Link Layer

Types of errors, framing (character and bit stuffing), error detection and correction methods, flow control. Protocols: stop and wait ARQ, Go-Back- N ARQ, selective repeat ARQ, HDLC, medium access sublayer: point to point protocol, LCP, NCP, token ring, reservation, polling. Multiple access protocols: pure ALOHA, slotted ALOHA, CSMA, CSMA/CD, CSMA/CA. Traditional Ethernet. Fast Ethernet.

Network Layer

Internetworking and devices: repeaters, hubs, bridges, switches, router, gateway. Addressing: IP addressing, sub netting. Routing: techniques, static vs. dynamic routing. Unicast routing protocols: RIP, OSPF, BGP. Other protocols: ARP, IP, ICMP, IPV6. Congestion Control algorithms. Quality of service: Leaky bucket algorithm, Token bucket algorithm.

Transport Layer

Process to process delivery, socket address, UDP, TCP.

Application Layer

Introduction to DNS, SMTP, SNMP, FTP, HTTP and WWW.

Security

IDPS and firewalls, cryptography basics, symmetric and asymmetric cryptography: DES, AES, RSA, hashing, digital signature, digital Certificates.

Reference Books

a) *J. Kurose and K. Ross, Computer Networking: A Top-Down Approach, Pearson, 7th Edition, 2016.*

b) *A. S. Tanenbaum , Computer Networks, Pearson Education India, 5th Edition , 2013.*

c) *L.L. Peterson and B.S. Davie, Computer Networks: A Systems Approach, Morgan Kaufman, 6th Edition, 2020.*

d) *S. William, Cryptography and Network Security - Principles and Practice, Pearson, 6th Edition, 2013.*

e) *Forouzan and Mukhopadhyay, Cryptography and Network Security, Mc Graw Hill India, 3rd Edition, 2015.*

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BTMT 8th Semester
[Elective – I]

Non Stationary Data Analysis

Exploratory Analysis of Time Series

Introduction, examples, simple descriptive techniques, trend, seasonality, stochastic and deterministic approaches, numerical and experimental data sets, challenges in data analysis and data graphical representation, interpretation, statistical tests**,** significance and power of a test, choice of the critical region, constructing test statistics: the fisher discriminate, mean and variance test, testing goodness-of-fit, stationary time series process (ARMA Processes), ARIMA Process, GARCH Process/Model.

Analysis of Stochastic Series

Model identification and non-stationary time series models, forecasting with classical regression models, forecasting with autocorrelations, forecasting with lagged dependent variable, forecast error statistics and evaluation, singularity detection**,** spectral density function, the period gram, spectral analysis, correlogram, wavelet cross-correlation, multi-resolution analysis, examples and applications.

Clustering and Classification of Non stationary data**.**

Reference Books

a) *Box and Jenkins, Time Series Analysis, Prentice-Hall, 5th Edition, 1991.*

b) *Peck and Devore, Statistics: The Exploration and Analysis of Data, Thomson-Brooks/Cole , 7th Edition,2012.*

c) *D. Montgomery, C.L. Jennings and M. Kulahci, Introduction to Time Series Analysis and Forecasting, Wiley, 1st Edition 2008.*

d) *C. Chatfield, The Analysis of Time Series, Chapman and. Hall/CRC , 6th Edition, 2004.*

e) *Petre Stoica and L. Moses Randolph, Introduction to Spectral Analysis, Prentice Hall, 6th Edition,1997.*

f) *H. Robert, Shumway and S. Stoffer David, Time Series Analysis and Its Applications with R*

Examples, Springer Texts in Statistics , 3rd Edition, 2006.

g) *M. Rao Raghuveer and Ajit S. Bopardikar, Wavelet Transform, Pearson Education, 1st Edition,1998.*

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BTMT 8th Semester
[Elective – I]

Operation Research – I

Goal Programming

Introduction, difference between linear programming and goal programming approach, concept of goal programming, graphical solution-method of goal programming, modified simplex method of goal programming.

Dynamic Programming

Introduction, nature of dynamic programming, deterministic processes, non-sequential discrete optimization, allocation problems, assortment problems, sequential discrete optimization, long-term planning problem, multi-stage decision process, application of dynamic programming in production scheduling and routine problems.

Inventory Control

Inventory control, deterministic including price breaks and multi-item with constraints. Probabilistic (with and without lead time). Fuzzy and dynamic inventory models.

Queuing Theory

Basic structure of queuing models. Poisson queues, M/M/I, M/M/C or finite and infinite queue length, Non-Poisson queue- M/G/I, Machine-Maintenance (steady state).

Replacement and Maintenance Models

Introduction. Failure Mechanism of items, replacement of items deteriorates with time, replacement policy for equipment when value of money changes with constant rate during the period. Replacement of items that fail completely individual replacement policy and group replacement policy. Other replacement problems staffing problem. Equipment renewal problem.

Simulation

Introduction. Steps of simulation process, advantages and disadvantages of simulation. Stochastic simulation and random numbers. Monte–Carlo simulation. Random number. Generation. Simulation of

inventory problems, simulation of Queuing problems, role of computers in simulation. Application of simulations.

Reference Books

a) *A.P. Verma, Introduction to Operations Research, S.K. Kataria and Sons, 3rd Edition 2014.*

b) *A. Taha Hamdy, Operations Research: An Introduction, Pearson Education India, 10th Edition, 2017.*

c) *P K Gupta, Operations Research, S Chand, 5th Edition, 1976.*

d) *J K Sharma, Operations Research, Theory and Applications, Macmillan India Ltd, 3rd Edition,2006.*

e) *D.S Hira and P K Gupta, Operations Research, S Chand,4th Edition, 2015.*

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BTMT 8th Semester
[Elective – I]

Mathematical Modelling and Simulation – I

Mathematical Models

Deterministic and stochastic. Single species population models. P-V Logistic equation. Population growth model-an age structured model.

Interactions Between Two Species

Host-Parasite type of interactions, competitive type of interactions. Trajectories of interactions of H-P and competitive types between two species. Effect of migration on H-P interactions. Some consequences of Lotka-Volterra equations. Generalized L-V equations. Constant of motion in the dynamical system.

Stochastic Processes and Need of Stochastic Models

Pure birth process, pure death process, birth and death process. Linear birth-death-immigration-emigration processes. Effects of both immigration and emigration on the dynamics of population.

Biological Mechanisms Responsible for "Time-Delay"

Discrete and continuous time-delay. The single species logistic model with the effect of time-delay. Stability of equilibrium position for the logistic model with general delay function. Stability of logistic model for discrete time lag. Time-delayed H-P model together with their stability analysis.

Mathematical Theory of Epidemics

Some basic definitions. Simple epidemic model, general epidemic model. Kermack-McKendrik threshold theorem. Recurring epidemic model. A comparative study of these models.

Control of an Epidemic

Stochastic epidemic model without removal. Models having multiple infections. Epidemic model with multiple infections. Stochastic epidemic model with removal. Stochastic epidemic model with removal, immigration and emigration. Special discussion on the stochastic epidemic model with carriers.

Simple Extensions of SIR Model

Different case studies - (i) loss of immunity, (ii) inclusion of immigration and emigration, (iii) immunization. SIR endemic disease model.

Reference Books

a) *X. Q. Zhao, Dynamical Systems in Population Biology, Canadian Mathematical Society, 3rd Edition,2003.*

b) *R M Andersson and R M May, Infectious Diseases of Humans. Oxford University Press, Revised ed. Edition , 1992.*

c) *J. N. Kapur, Mathematical Models in Biology and Medicine, East West Press Pvt Ltd ,1st Edition, 1985.*

d) *R. Habermann, Mathematical Models: Mechanical Vibrations, Population Dynamics, and Traffic Flow : An Introduction to Applied Mathematics, Prentice Hall, 1st Edition 1977.*

e) *E. C. Pielou, An Introduction to Mathematical Ecology, Wiley, 1st Edition, 1970.*

f) *R. Rosen, Foundation of Mathematical Biology (vol. Iand II): Supercellular Systems, Academic Press. 2013.*

g) *Mark Kot, Elements of Mathematical Ecology, Cambridge University Press, 2001.*

h) *J. D. Murray, Mathematical Biology, Springer-Verlag, Berlin 1989.*

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BTMT 8th Semester
[Elective – I]

Compiler Design

Introductory Concepts

Analysis-synthesis model of compilation, various phases of a compiler, cross compilers, bootstrapping.

Lexical Analysis

Interface with input, parser and symbol table, token, lexeme and patterns, difficulties in lexical analysis, error reporting and implementation. Regular definition, transition diagram and LEX.

Syntax Analysis

Context free grammars, ambiguity, associativity, precedence, top down parsing, recursive descent parsing, transformation on the grammars, predictive parsing, bottom up parsing, operator precedence grammars, LR parsers (SLR,LALR, LR), YACC. SYNTAX DIRECTED TRANSLATION: inherited and synthesized attributes, dependency graph, evaluation order, bottom up and top down evaluation of attributes, L- and S-attributed definitions.

Type Checking

Type system, type expressions, structural and name equivalence of types, type conversion, overloaded functions and operators, polymorphic functions.

Run Time System

Storage organization, activation tree, activation record, parameter passing, symbol table, dynamic storage allocation.

Intermediate Code Generation

Intermediate representations, translation of declarations, assignments and intermediate code generation for control flow. Boolean expressions and procedure calls, implementation issues.

Code Generation and Instruction Selection

Issues, basic blocks and flow graphs, register allocation, code generation, DAG representation of programs, code generation from dags, peep hole optimization, code generator generators, specifications of machine.

Code Optimization

Source of optimizations, optimization of basic blocks, loops, global dataflow analysis, solution to iterative dataflow equations, code improving transformations, dealing with aliases, data flow analysis of structured flow graphs.

Reference Books

a) *Aho Ullman, Shetty, Compilers: Principles, Techniques and Tools, Pearson ,2nd Edition,2008.*

b) *Kenneth C. Louden, Compiler Construction: Principles and Practice,Thomson Books Course Technology Inc, International Edition, 1997.*

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BTMT
COMPUTATIONAL MATHEMATICS
9th SEMESTER

BTMT 9th Semester
[Compulsory]

Complexity Theory and Approximation Algorithms

Computability

Review of decidability, acceptance problem, halting problem, problem reduction, Rice theorem. Undecidable problems: about finite automata, about pushdown automata, post's correspondence problem. Undecidable logical theories, recursion theorem.

Complexity Theory

Complexity classes, space complexity, time complexity, classes P and NP, polynomial time reductions, NP-completeness, Cook-Levin theorem, vertex cover problems, Hamilton path problem. Subset sum problem, Hierarchy theorems, circuit complexity.

Approximation Algorithms

Set cover, max-SAT, knapsack, bin packing, scheduling, spanners, steiner trees, cuts, clustering, facility location, traveling salesman tour, network design, metric embeddings. Design techniques: greedy, local search, dynamic programming, linear program formulations, dual fitting, primal-dual method, rounding of linear/semi definite programs, random sampling, derandomization, power of two solutions. Lower bounds on approximations and the relevant complexity classes.

Reference Books

a) *M. Sipser, Introduction to theory of computation, Cengage Learning, 3rd Edition, 2014.*
b) *A. Singh, Elements of Computation Theory, Springer, 2009.*
c) *David P. Williamson and David B. Shmoys, The Design of Approximation Algorithms, Cambridge University Press, Illustrated edition , 2011.*
d) *Vijay V. Vazirani, Approximation Algorithms, Springer, Illustrated Edition, 2010.*
e) *Dorit S. Hochbaum , Approximation Algorithms for NP-hard Problems edited, Course Technology, 1996.*
f) *Sariel Har-Peled, Geometric Approximation Algorithms, American Mathematical Society, 2011.*

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BTMT 9th Semester
[Compulsory]

Social Media Data Analysis (Theory)

Online Social Networks (OSNs)

Introduction, types of social networks (e.g. Twitter, Facebook), measurement and collection of social network data, social networks-basic structure and measures, basics of text processing over social data, entity linking and entity resolution for social data.

Studying Characteristics of OSNs

Information diffusion, experimental studies over OSNs, sampling.

Fundamentals of Social Data Analytics

Topic models, random walks, heterogeneous information networks.

Applied Social Data Analytics

Recommendation systems, community identification and link prediction.

Other Advanced Topics

Online experiments for computational social science, big data sampling.

Reference Books

a) *Matthew A. Russell, Mining the Social Web: Data Mining Facebook, Twitter, Linkedin, Google+, Github and More, O'Reilly Media, 2nd Edition 2013.*
b) *Jennifer Golbeck, Analyzing the social web, Morgan Kaufmann, 1st Edition, 2013.*
c) *Charu Aggarwal, Social Network Data Analytics, Springer, 2011.*

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BTMT 9th Semester
[Compulsory]

Big Data Analytics (Practical)

Identification of Spam and non-spam (ham) mails from your mail account, movie reviews for recommendation (IMdb data sets are available), share market values prediction (Yahoo Finance, BSE and many other data sheets are available), text analysis and search (in different languages)-an assignments could be search based on "context", image analysis and search.

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BTMT 9th Semester
[Elective-II]

Data Communication

Introduction

Basic goals of communication, signals for communication: time-domain and frequency domain representation of signals. Analog/digital/sampled, periodic/a periodic, deterministic/random signals. Fourier series, Fourier transform frequency spectrum, filtering and bandwidth. Message transducers and signal converters. Communication channel: important characteristics of a communication channel. Available communication channels (media) and their properties. Baseband data communication: basic concepts of analog and digital communication in the baseband. Various encoding formats for data. Attenuation and distortion problems and remedies. Maximum data rate of a channel. Analog modulation and demodulation techniques: AM/FM/PM, principle of demodulating various kinds of modulated signals. Coherent and incoherent receiver digital modulation-ASK/FSK/PSK, Binary and M-array data modulation, continuous phase modulation-binary and M-array CPFSK, MSK, partial response CPM. Pulse modulation and pulse coded modulation schemes-PAM/PWM/PPM, PCM/DPCM/ADPCM/DM etc. Reliable and efficient asynchronous and synchronous data communication: block error handling and channel coding. Bit and character oriented framing. Transparent data communication. Error detection and correction in a frame LRC/VRC/Checksum/ CRC and Hamming code.

Protocols for Data Communication

Stop and wait protocol and its efficiency, sliding window protocols-go-back-n and selective repeat. Modem technologies: QAM/MSK/CPFSK/ADSL/Cable Modem.

Wireless Communication

Data communication over radio/microwave/satellite/infrared links. Principles of spread spectrum communication- DSSS, FHSS.

Optical Communication Technology

Basic principles and components for point-to-point communication. Multimedia communication and data compression.

Reference Books

a) *S. Haykin, Communication Systems, John Wiley, 3rd Edition, 1994.*
b) *H. Taub and D. Schilling, Principles of Communication Systems, Tata McGraw Hill, 3rd Edition, 2007.*
c) *W. Stallings, Data and Computer Communications, Pearson education Asia (IPE), 6th Edition, 2000.*

d) *F. Halshall, Data Communications, Computer networks and Open Systems, Pearson Education Asia (IPE),4th Edition, 1996.*
e) *B. A. Forouzan, Data Communications and Networking, Tata McGraw Hill, 3rd Edition, 2003.*
f) *D. Bertrekas and R. Gallagar, Data Networks, Prentice Hall (EEE), 2nd Edition, 1992.*
g) *J. G. Proakis and M. Salehi, Communication System Engineering, Pearson, 2nd Edition, 2002.*
h) *Schiller, Mobile Communications, Pearson Education Asia, 2nd Edition, 2000.*

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BTMT 9th Semester
[Elective –II]

Human Computer Interaction

Introduction to HCI methods. Interaction styles and general design. Various user interfaces and interaction strategies. Programming usable interfaces, software architectures for user interface. Cognitive models, communication and collaboration models, collaborative systems. Screen design. Task analysis. Usability evaluation, groupware and coordination technologies, HCI and World Wide Web.

Reference Books

a) *Alan Dix, Janet Finley, Gregory Abowd, Russell Beale, Human Computer Interaction, Pearson, 3rd Edition, 2004.*
b) *B. Shneiderma., Designing the User Interface, Addison Wesley (Indian Reprint), A joint venture by IIS, 2000.*
c) *Wickens, Lee, Liu and Gordon-Becker, Introduction to Human Factors Engineering, Pearson, 2nd Edition, 2004.*
d) *Shneiderman, Plaisant, Cohen and Jacobs, Designing the User Interface: Strategies for Effective Human-Computer Interaction, Addison Wesley, 5th Edition, 2009.*

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BTMT 9th Semester
[Elective – II]

Operation Research – II

Stochastic Programming

Chance constraint programming techniques.

Geometric Programming

Geometric programming (both unconstrained and constrained), fuzzy geometric programming.

Games

Preliminaries concepts of continuous game, bimatrix games, nash equilibrium, solution of bimatrix games through quadratic programming (relation with non-linear programming). Multiobjective linear and non-linear programming, complete optimal solution, Pareto and Weak Pareto optimal solution, utility function method, global criterion method, fuzzy programming technique.

Optimal Control

Performance indices, methods of calculus of variation, transversally conditions, simple optimal problems of mechanics, Pontryagin's principle (with proof assuming smooth condition), linear regulator, application of dynamic programming in proving Pontryagin's Principle, Bang-Bang control.

Sequencing

Problem with n jobs two machines, n jobs three machines and n jobs m machines.

Reliability

Concepts, reliability definition, system reliability, system failure rate, reliability of the systems connected in series or/ and parallel.

Information Theory

Introduction, communication process-memory less channel, the channel matrix, probability relation in a channel, noiseless channel. Measure of information, properties of entropy function, measure of other information quantities, marginal and joint entropies, conditional entropies, expected mutual information, axiom for an entropy function, properties of entropy function. Channel capacity, efficiency and redundancy.

Encoding

Objectives of encoding, Shannon-Fano encoding procedure, necessary and sufficient condition for noiseless encoding.

Reference Books

a) *A.P. Verma, Introduction to Operations Research, S.K. Kataria and Sons, 3rd Edition 2014.*

b] *A. Taha Hamdy, Operations Research: An Introduction, Pearson Education India, 10th Edition, 2017.*

c) *P K Gupta, Operations Research, S Chand, 5th Edition, 1976.*

d] *J K Sharma, Operations Research, Theory and Applications, Macmillan India Ltd, 1997.*

e) *D.S Hira and P K Gupta, Operations Research, S Chand, 2015.*

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BTMT 9th Semester
[Elective – II]

Mathematical Modelling and Simulation – II

Some Mathematical Aspects of Oscillations of the Biological Systems

Introduction, biological clock, model for the circadian oscillator. Pharmacokinetics. Mathematical models in pharmacokinetics, compartmental analysis. Technique. Two compartment model-clinical bromsulphalein (BSP) Test. Basic equations for an n-compartment system. Distributions of drugs in n-compartment model for (i) given initial dose, (ii) repeated medication, (iii) constant rate of infusion and (iv) truncated infusion. Compartment model for diabetes mellitus. Stochastic compartment models. Drug action. Some general principles for real biological oscillations. Cellular mechanism and genesis of Atherosclerosis.

Arterial Biomechanics

Importance of studies on the mechanics of blood vessels. Structure and functions of blood vessels. Mechanical properties. Viscoelasticity, linear discrete viscoelastic (spring-dashpot) models: Maxwell fluid, Kelvin solid, Kelvin chains and Maxwell models. Creep compliance, relaxation modulus. Hereditary integrals, Stieltjes Integrals. Constituents of blood. Structure and functions of the constituents of blood. Mechanical properties of blood. Equations of motion applicable to blood flow. Non-Newtonian fluids-Power law, Bingham plastic, Herschel-Bulkley and Casson fluids. Steady non- Newtonian fluid flow in a rigid circular tube. Fahraeus-Lindqvist effect. Pulsatile flow in both rigid and elastic tubes. Blood flow through arteries with mild stenosis. Shear stress on surface of the stenosis. Two-layered flow in a tube with mild stenosis. Large deformation theory. Various forms of strain energy functions. The base vectors and metric tensors. Green's deformation and Lagrangian strain tensors. Cylindrical model, Constitutive equations for blood vessels. Equations of motion for the vascular wall.

Biological Diffusion and Diffusion-Reaction Models

Fick's laws of diffusion, one-dimensional diffusion model and its solution, some solutions of two-dimensional diffusion equation, various modifications of diffusion equation to diffusion-reaction models arising in pharmacokinetics and ecology. Hemodialyser and dialysis of blood, basic equations for a circular-duct and a parallel-plate dialyser, Pecletnumber, sherwood number. Solutions of basic equation for a circular-duct dialyser by (i) separation of variables method and (ii) Galerki's method. Solution for parallel-plate dialyser.

Reference Books

a) *D. A. MacDonald, Blood Flow in Arteries, The Williams and Wilkins Company, Baltimore, 2nd Edition, 1974.*
b) *Y. C. Fung, Biomechanics of Soft Biological Tissues, Springer Verlag, 1st Edition, 1981.*
c) *R. Habermann, Mathematical models : mechanical vibrations, population dynamics, and traffic flow : an introduction to applied mathematics, Prentice Hall, 1977.*
d) *R. W. Poole, An Introduction to Quantitative Ecology, McGraw- Hill, 1974.*
e) *E. C. Pielou, An Introduction to Mathematical Ecology, Wiley, New York , 1977.*

f) *R. Rosen, Foundation of Mathematical Biology (vol. Iand II), Academic Press, 2013.*
g) *W Flugge, Visco elasticity, Springer-Verlag, 2nd Edition, 1975.*
h) *M. Zamir and E. L. Ritman, The Physics of Pulsatile Flow. Springer, 2012.*
i) *J. N. Kapur, Mathematical Models in Biology and Medicine, East West Press Pvt Ltd ,1985.*

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BTMT 9th Semester
[Elective – III]

Operating System

Introduction

What is an operating system, function of operating system, operating system structure: system components, operating system services, system calls.

Processes

Process concept, process state and state transitions, process control block, suspend and resume of process, interrupt processing, context switching.

Process Synchronization and Inter Process Communication

The critical-section problem, Dekker's algorithm, semaphores, synchronization hardware: test-and-set, compare-and-swap, solution of producer-consumer problem.

Deadlocks

System model, deadlock characterization, methods for handling deadlocks, deadlock prevention, deadlock avoidance and banker's algorithm, deadlock detection, deadlock recovery.

Threads

Single and multithreading models, threading issues, P threads, solaris 2 threads, window 2000 threads, linux threads, java threads.

CPU Scheduling

Basic concepts, scheduling levels, scheduling criteria, pre-emptive and non-preemptive scheduling, scheduling algorithms, multi-processor scheduling.

Memory Management

Memory organization, storage hierarchy, storage management strategies, swapping, contiguous and non contiguous memory allocation, virtual memory: paging, segmentation, segmentation with paging, notion of locality and working sets, thrashing, page replacement algorithms.

File-System Interface

File concepts, file organization, access methods, directory structure, file-system mounting, file sharing, protection.

File-System Implementation

File-system structure, file system implementation, directory implementation, allocation methods, free-space management, efficiency and performance, recovery.

Disk Scheduling

Disk structure, disk caching, disk scheduling, disk management, swap-space management, RAID structure, disk attachment, stable-storage implementation.

Protection

Goals of protection, domain of protection, implementation of access matrix, revocation of access rights, capability-based systems, language-based protection.

Security

The security problem, user authentication, program threats, system threats, securing systems and facilities, intrusion detection, cryptography, computer-security classifications.

Reference Books

a) *Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, Operating System Concepts, John Wiley and Sons, Inc., 9th Edition, 2018.*

b) *H. M. Deitel, Operating System, Pearson Education, 3rd Edition, 2004.*

c) *Pramod Chandra P. Bhatt, An Introduction to Operating System Concepts and Practice, PHI Pvt Ltd, 2nd revised Edition, 2007.*

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BTMT 9th Semester
[Elective – III]

Decision Theory and Computational Statistics

Decision Theory

Games and statistical games, Statistical decision problem, decision function, risk function, prior and posterior distribution, Baye's risk and Baye's rules.

Least favourable prior, minimaxity, admissibility and complete classes, admissibility of Baye's rules, existence of minimal complete class and Baye's rules.

The supporting and separating hyperplane theorems, essential completeness of the class of nonrandomized rules, minimax and complete class theorems.

Solving for minimax rules, essential completeness of class of rules based on sufficient statistics, continuity of risk function, Invariant decision problems, admissible and minimax invariant decision rules.

Computational Statistics

Analysis of variance, one- way and two – way classification, concept of design of experiment, some standard design: completely randomized design, randomized block design, latin squares, Graeco latin squares and factorial design confounding and blocking in factorial design, fractional factorial design.

Simple and multiple regression models, classical techniques of time series analysis, ANOVA, MANOVA, multivariate analysis of covariance model (MANCOVA), smoothing and decomposition, factor analysis.

Reference Books

a) *James O Berger, Statistical Decision Theory and Bayesian Analysis, Springer series, 2nd Edition, 2010*

b) *James O. Berger, Statistical Decision Theory, Foundation, Concepts and Methods, Springer series in Statistics, 1st Edition 1980*

c) *James E. Gentle and Wolfgang Karl Hardle and Yuichi Mori, Handbook of computational statistics: Concepts and methods, Springer, 1st Edition. 2004.*

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BTMT 9th Semester
[Elective – III]

Stochastic Calculus

Review of Brownian motion and stochastic integration with respect to Brownian motion, extension of stochastic integral for a larger class of integrands, stopping times, local martingales.

Stochastic integration with respect to right continuous with left limits (RCLL) square integrable martingales, Doob Meyer decomposition, Ito's formula for martingales, continuous martingales, the representation theorem for martingales, stochastic differential equations, diffusion processes, Girsanov's representation theorem, local time, Tanaka's formula, multiple Weiner-Ito integrals.

References Books

a) *K.L.Chung and R.J.Williams, Introduction to Stochastic Integration, Birkhäuser; 2nd Edition, 2013.*

b) *Hui-Hsiung Kuo, Introduction to Stochastic Integration, Springer; 6th Edition, 2005.*

c) *N. Ikeda and S. Watanabe, Stochastic Differential Equations and Diffusion Processes, Elsevier, 2nd Edition, 2014.*

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BTMT 9th Semester
[Elective – III]

Mobile Computing

Introduction to Personal Communications Services (PCS)

PCS architecture, mobility management, networks signaling.

Global System for Mobile Communication (GSM) Overview

GSM architecture, mobility management, network signaling.

General Packet Radio Services (GPRS)

GPRS architecture, GPRS network nodes.

Mobile Data Communication

WLANs (Wireless LANs), IEEE 802.11 standard, mobile IP, Bluetooth, routing algorithms for mobile ad -hoc networks.

Wireless Application Protocol (WAP)

The mobile internet standard, WAP gateway and protocols, wireless mark-up languages (WML).

Third Generation (3G) Mobile Services

Introduction to international mobile telecommunications 2000 (IMT 2000) vision, wideb and code division multiple access (W-CDMA), and CDMA 2000, quality of services in 3G.

Wireless Local Loop (WLL)

Introduction to WLL architecture, wireless local loop technologies, global mobile satellite systems, case studies of the IRIDIUM and GLOBALSTAR systems.

References Books

a) *Yi-Bing Lin and Imrich Chlamtac, Wireless and Mobile Networks Architectures, Wiley, 1st Edition, 2008.*

b) *Raj Pandya, Mobile and Personal Communication Systems and Services, Prentice Hall of India, 2001.*

c) *U. Hansmann, Lothar Merk, Martin Nicklous, Thomas Stober, Principles of Mobile Computing, Dreamtech Press, 2nd Edition, 2006.*

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BTMT
COMPUTATIONAL MATHEMATICS
10th SEMESTER

Semester – 10th		17– Credits				
Option – 1						
	Dissertation – II	**200**	**0**	**0**	**10**	**10**
	Grand Viva-II	**100**	**0**	**0**	**4**	**4**
	Seminar Presentation-II	**100**	**0**	**0**	**3**	**3**
Option – 2						
	Industrial Project	**200**	**0**	**0**	**0**	**10**
	Project Seminar	**100**	**0**	**0**	**3**	**3**
	Grand Viva-II	**100**	**0**	**0**	**4**	**4**