**Details of Course: B.Sc. (Hons.) - Mathematics**

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**Course Structure** **Credits**

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| --- | --- | --- | --- |
|  |  |  | **Theory + Practical** |
| **I** | **Core Courses (26 Papers)** | | 26 x 03 = 78 |
|  | Core Course Practicals/ Tutorials | | 16 x 01 = 16 |
| **II** | **Interdisciplinary Courses (04 Papers)** | | 04 x 03 = 12 |
|  | Interdisciplinary CoursesPracticals/ Tutorials | | 02 x 02 =04  01 x 01 = 01 |
| **III** | **Elective Courses (04 Papers)** | |  |
|  | a. | Discipline Specific Electives (02 Papers) | 02 x 03 = 06 |
|  |  | Practicals/ Tutorials |  |
|  | b. | Generic Electives/ Interdisciplinary (02 Papers) | 02 x 03 = 06 |
|  |  | Practicals/ Tutorials |  |
| **IV** | **Ability Enhancement Courses** | |  |
|  | Compulsory SS (05 Papers) | | 05 x 03 = 15 |
|  | Compulsory EC (01 Papers) | | 01 x 03 = 03 |
|  | Compulsory ES (01 Papers) | | 01 x 02 = 02 |
| **V** | **Project and Seminar Courses** | |  |
|  | **Seminar (02)** | | 02 x 02 = 04 |
|  | **Project (02)** | | 01 x 02 = 02  01 x 06 = 06 |
| **VI** | **SIP** | | 01 x 06 = 06 |

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**Total Credits** **=** **159**

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**\* SS: Soft Skills; EC: English Communications; ES: Environmental Studies.**

**Summary of Credits for B. Sc. (Hons.) Mathematics Program**

|  |  |  |  |
| --- | --- | --- | --- |
| **Year** | **Semester** | **Credit** | **Total Credit of Year** |
| I | I | 24 | 51 |
| II | 27 |
| II | I | 26 | 52 |
| II | 26 |
| **Sumer Internship Program** | | | 6 |
| III | I | 26 | 52 |
| II | 26 |
| **Total credits:** | | | 162 |

**Program Structure of B.Sc. (Hons.) Mathematics**

**Semester-I**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **S. No.** | **Code** | **Subject Name** | **L** | **T** | **P** | **Credit** |
| 1 | BMAT 1101 | Principles of Mathematics – I | 3 | 1 | - | 4 |
| 2 | BPHT 1101 | Principles of Physics | 3 | - | - | 3 |
| 3 | BCYT 1101 | Principles of Chemistry | 3 | - | - | 3 |
| 4 | BPHT 1102 | Mechanics & Relativity | 3 | - | - | 3 |
| 5 | BPHL 1101 | Physics Practical | - | - | 4 | 2 |
| 6 | BCYL 1101 | Chemistry Practical | - | - | 4 | 2 |
| 7 | BECT 1101 | English Communication | 2 | - | 2 | 3 |
| 8 | BCST 1101 | Computer Fundamentals & Office Automation | 3 | - | 2 | 4 |
|  |  | ALL | 17 | 1 | 12 | 24 |
| Total Period | | | 30 | | | |

**Semester-II**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **S. No.** | **Code** | **Subject Name** | **L** | **T** | **P** | **Credit** |
| 1 | BMAT 1201 | Principles of Mathematics – II | 3 | 1 | - | 4 |
| 2 | BMAT 1202 | Differential Equations – I | 3 | 1 | - | 4 |
| 3 | BMAT 1203 | Statics and Dynamics | 3 | - | - | 3 |
| 4 | BMAT 1204 | Discrete Mathematics | 3 | - | - | 3 |
| 5 | BMAT 1205 | Abstract Algebra – I | 3 | 1 | - | 4 |
| 6 | BMAT 1206 | Analytical Geometry | 3 | 1 | - | 4 |
| 7 | BEST 1201 | Environmental Studies | 2 | - | - | 2 |
| 8 | BSSS 1201 | Soft Skills – I | 2 | - | 2 | 3 |
|  |  | ALL | 22 | 4 | 2 | 27 |
| Total Period | | | 28 | | | |

**Semester-III**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **S. No.** | **Code** | **Subject Name** | **L** | **T** | **P** | **Credit** |
| 1 | BMAT 2101 | Differential Equations – II | 3 | 1 | - | 4 |
| 2 | BMAT 2102 | Linear Programming and Game Theory | 3 | - | - | 3 |
| 3 | BMAT 2103 | Graph Theory | 3 | - | - | 3 |
| 4 | BMAT 2104 | Probability and Statistics | 3 | 1 | - | 4 |
| 5 | BMAT 2105 | Abstract Algebra – II | 3 | - | - | 3 |
| 6 | BMAT 2106 | Unix and C Programming | 3 | - | - | 3 |
| 7 | BMAL 2101 | Unix and C Programming Lab | - | - | 2 | 1 |
| 8 | BSSS 2101 | Soft Skills – II | 2 | - | 2 | 3 |
| 9 | BMAS 2101 | Seminar | - | - | 4 | 2 |
|  |  | ALL | 20 | 2 | 8 | 26 |
| Total Period | | | 30 | | | |

**Semester-IV**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **S. No.** | **Code** | **Subject Name** | **L** | **T** | **P** | **Credit** |
| 1 | BMAT 2201 | Real Analysis – I | 3 | 1 | - | 4 |
| 2 | BMAT 2202 | Complex Analysis | 3 | 1 | - | 4 |
| 3 | BMAT 2203 | Linear Algebra | 3 | - | - | 3 |
| 4 | BMAT 2204 | Integral Transformations | 3 | - | - | 3 |
| 5 | BMAT 2205 | Number Theory and Trigonometry | 3 | - | - | 3 |
| 6 | BMAT 2206 | Numerical Analysis | 3 | - | - | 3 |
| 7 | BMAL 2201 | Numerical Analysis Using C/C++ | - | - | 2 | 1 |
| 8 | BSSS 2201 | Soft Skills – III | 2 | - | 2 | 3 |
| 9 | BMAP 2201 | Project (Minor)- Report, Seminar & Viva-Voce | - | - | 4 | 2 |
|  |  | ALL | 20 | 2 | 8 | 26 |
| Total Period | | | 30 | | | |

**Summer Internship Program – (8 weeks)**

Summer Internship Program (BMAP- 2202) (Thesis, Presentation and Viva-voce) Credit -06

**Semester-V**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **S. No.** | **Code** | **Subject Name** | **L** | **T** | **P** | **Credit** |
| 1 | BMAT 3101 | Real Analysis – II | 3 | 1 | - | 4 |
| 2 | BMAT 3102 | Finite Element Methods | 3 | 1 | - | 4 |
| 3 | BMAT 3103 | Tensor Calculus | 3 | - | - | 3 |
| 4 | BMAT 3104 | Object Oriented Programming | 3 | - | - | 3 |
| 5 | BMAL 3101 | Mathematical Software Practical - MATLAB | - | - | 2 | 1 |
| 6 |  | Elective – I | 3 | - | - | 3 |
| 7 |  | Elective – II | 3 | - | - | 3 |
| 8 | BSSS 3101 | Soft Skills – IV | 2 | - | 2 | 3 |
| 9 | BMAP 3101 | Seminar | - | - | 4 | 2 |
|  |  | ALL | 20 | 2 | 4 | 26 |
| Total Period | | | 26 | | | |

**List of Electives in Semester V (Select any two)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Code** | **Subject Name** | **L** | **T** | **P** | **Credit** |
| BMAT 3105 | Operations Research | 3 | - | - | 3 |
| BMAT 3106 | Topology | 3 | - | - | 3 |
| BMAT 3107 | Special Function | 3 | - | - | 3 |
| BMAT 3108 | Financial Mathematics | 3 | - | - | 3 |
| BMAT 3109 | Mathematical Modelling | 3 | - | - | 3 |
| BMAT 3110 | Calculus of Variations and Integral Equations | 3 | - | - | 3 |
| BMAT 3111 | Bio-Mathematics | 3 | - | - | 3 |
| BMAT 3112 | Portfolio Optimization | 3 | - | - | 3 |

**Semester-VI**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **S. No.** | **Code** | **Subject Name** | **L** | **T** | **P** | **Credit** |
| 1 | BMAT 3201 | Differential Geometry | 3 | - | - | 3 |
| 2 | BMAT 3202 | Fuzzy Mathematics | 3 | - | - | 3 |
| 3 | BMAT 3203 | Mechanics | 3 | - | - | 3 |
| 4 |  | Elective – III | 3 | - | - | 3 |
| 5 |  | Elective – IV | 3 | - | - | 3 |
| 6 | BMAP 3201 | Project (Major) (Report, Seminar & Viva-Voce) | - | - | 10 | 6 |
| 7 | BSSS 3201 | Soft Skills – V | 2 | - | 2 | 3 |
|  |  | ALL | 17 | - | 12 | 24 |
| Total Period | | | 29 | | | |

**List of Electives in Semester VI (Select any two)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Code** | **Subject Name** | **L** | **T** | **P** | **Credit** |
| BMAT 3104 | Applications of Algebra | 3 | - | - | 3 |
| BMAT 3105 | Cryptography and Coding Theory | 3 | - | - | 3 |
| BMAT 3106 | Fractional Calculus | 3 | - | - | 3 |
| BMAT 3107 | Boolean Algebra and Automata Theory | 3 | - | - | 3 |
| BMAT 3108 | Fluid Dynamics | 3 | - | - | 3 |
| BMAT 3109 | Artificial Neural Network | 3 | - | - | 3 |
| BMAT 3110 | MATHEMATICA | 3 | - | - | 3 |
| BMAT 3111 | Combinatorial Mathematics | 3 | - | - | 3 |

**Semester I**

|  |  |  |  |
| --- | --- | --- | --- |
| **Course: Principles of Mathematics – I** | | | **Semester: I** |
| **Course Code:** BMAT 1101 | **L T P** | **3 1 0** | **Credits: 4** |

**Objective:** To develop understanding of elementary mathematical methods including numbers, operations, proportional reasoning, number theory, algebra, geometry, measurement, data analysis, and probability.

**Syllabus**

**Matrix Algebra** 12 **(20)**

Kinds of Matrices, elementary operations on matrices, inverse of a matrix, Cramer’s rule, linear dependence of rows and columns of a matrix, row rank, column rank and their equivalence, rank of a matrix, applications of matrices in solving system of linear (both homogeneous and non-homogeneous) equations, conditions of consistency for a system of linear equations.

Eigen vectors, Eigen values and the characteristics equation of a matrix, Cayley-Hamilton theorem, powers of matrices, orthogonal matrices, diagonalization of matrices.

**Differential Calculus** 16

Indeterminate forms, L’ Hospital’s rule. A brief review of limit, Continuity and differentiability, successive differentiation, Taylor’s and Maclaurin’s series expansions, tangents and normals of polar curves, derivatives of arc, asymptotes, curvature, Double points, Curve tracing.

Functions of two variables, partial differentiation and change of independent variables (two variables), Jacobians (simple applications-function of a function case), maxima and minima of two independent variables

**Integral Calculus** 12

Integral as limit of a sum, Fundamental theorem of integral calculus (statement only), Beta and Gamma Functions, change of order of integration in double integrals, Drichlet’s theorem and its Liovelle’s extension.

Multiple integrals, area (quadrature), rectification (length of curves), volumes and surfaces, differentiation and integration under the integral sign.

**Suggested Readings**

1. Thomas, G.B. & Finney, R.L. (2005). *Calculus:* 9th ed. New Delhi: Pearson Education.
2. Sharma, G. C., Ray, M. & Seth, S. S. (2010). *Differential Calculus*: 18th ed. New Delhi: Shiva Lal Agarwala & Company.
3. Dhami, H. S. (2006). *Differential Calculus.* New Delhi: New Age International.
4. Apostol, T. M. (1967). *Calculus*. New York: John Willey and Sons.
5. Prasad, G. (2004). *Differential Calculus*. Allahabad: Pothishala publication.
6. Ray, M. (2006). *Integral Calculus*. Agra: Shiva Lal Agarwal and Co.
7. Dhami, H. S. (2006). *Integral Calculus*. New Delhi: New Age International.
8. Prasad G. (2004). *Integral Calculus*. Allahabad: Pothishala Publication.
9. Strauss, M. J., Bradley, G. L. & Smith, K. J. (2007) *Calculus:* 3rd ed. Delhi: Dorling Kindersley.
10. Biswas, S. (2012). *Textbook of Matrix Algebra*: 3rd ed. New Delhi: Prentice Hall.
11. Narayan, S. & Mittal, P. K. (2010). A Textbook of Matrix. New Delhi: S Chand Pub.

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| --- | --- | --- | --- |
| **Course: Principles of Physics** | | | **Semester: I** |
| **Course Code:** BPHT 1101 | **L T P** | **3 0 0** | **Credits: 3** |

**Objective:** To introduce students to physical phenomena, physical principles and the experimental basis of the various fields of physics to enable the students to formulate and tackle problems in physics, including identification of appropriate physical principles and use of special and limiting cases.

**Syllabus**

**Mathematical Physics** 11

Scalar and vector products, polar and axial vectors, triple and quadruple products.

*Vector calculus***:** Scalar and vector fields, differentiation of a vector, gradient, divergence, curl and ∆ operations and their meaning, idea of line, surface and volume integrals, Gauss and Stokes’ theorem.

**Classical Mechanics** 15

*Particle dynamics:* Newton’s laws of motion, conservation of linear momentum, center of mass, conservative forces, work energy theorem, particle collision.

*Rotational kinematics and dynamics:* Rotational motion, forces and pseudo forces, torque and angular momentum, kinetic energy of rotation, rigid body rotation dynamics, moment of inertia, conservation of angular momentum, comparison of linear and angular momentum, motion of a top.

*Oscillations:* Linearity and superposition principle, free oscillation with one and two degrees of freedom, simple pendulum, combination of two simple harmonic motions. Lissajous figures, free and damped vibrations, forced vibrations and resonance, Q factor, wave equation, travelling and standing waves, superposition of waves, phase and group velocity.

**Wave optics** 16

Interference, division of amplitudes, Young’s double split, Fresnel’s biprism, interference in thin films and wedged shaped films.

*Fresnel diffraction:* Diffraction at a single slit and a circular aperture, diffraction at a double split, plane transmission grating, resolving power of a telescope and a microscope, resolving and dispersive power of a plane diffraction grating.

*Polarization:* Polarization by reflection and refraction, Brewster’s law, double refraction, Nicol prism, quarter and half-wave plates, Production and analysis of circularly and elliptically polarized light.

**Suggested Readings**

1. Spiegel, M. R. (1974). *Vector Analysis* Schaum’s Outline Series. Singapore: McGraw-Hill Book Co.
2. Prakash S. (2014). *Mathematical physics: 6th ed.* New Delhi: Sultan Chand & Sons.
3. Rajput, B. S. (2015). *Mathematical Physics*. Meerut: Pragati Prakashan.
4. Ghatak, A. K. (2005). *Optics*. New Delhi: Tata McGraw-Hill Education.
5. Subhramanyam, N., Brijlal, M. & Avadhanulu, N. (2004). *A Text book of Optics*. New Delhi: S. Chand publication.
6. Beiser, A. (2002). *Concepts of Modern Physics.* New Delhi:McGraw-Hill Education.
7. Resnick, R., Halliday, D. & Krane, K. S. (2004). *Physics Vol. I and II* 5th ed. Hoboken: John Wiley & Sons.

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| **Course: Principles of Chemistry** | | | **Semester: I** |
| **Course Code:** BCYT 1101 | **L T P** | **3 0 0** | **Credits: 3** |

**Objective:** To enable students to understand and explain the general principles, laws, and theories of chemistry. This course will develop chemistry skills through technological advancement.

**Syllabus**

**Structure and Bonding**  4

Basic concepts of elements and compounds. Electronic structure of atoms, different types of bonding, qualitative approach to valence bond theory and its limitations. Hybridization, equivalent and non-equivalent hybrid orbitals.

**Molecular Orbital Theory** 4

Symmetry and overlap, molecular orbital diagrams of diatomic and simple polyatomic systems (O2, C2, B3, CO, NO and their ions; HCl, BeF2, CH4, BCl3) (idea of Sp3 mixing and orbital interaction to be given).

**Packing in Crystals** 4

Close packed structures. (1) Spinal, (2) Ilmenite and (3) Perovskite structures of mixed metal oxides, size effects, radius, ratio rules and their limitations. Lattice energy: Born equation (calculations of energy in ion pair and ion-pairs square formation), Madelung constant. Kapustinskii equation and its applications. Born-Haber cycle and its applications.

**Weak Chemical Forces** 4

Van-der-Waals forces, hydrogen bonding, effects of chemical forces on M.P., B.P., and solubility, energetics of dissolution process.

**Oxidation-reduction Reactions** 4

Oxidation number, oxidizing and reducing agents, balancing redox reactions, calculations involving redox reactions.

**Stereochemistry** 4

Bonding in organic molecules and its effects on shape chirality and RS nomenclature as applied to chiral centers, Treatment of chirality upto three chiral centers. Conformation of acyclic and cyclic systems, conformational analysis of Di-substituted Cyclohexanes. Geometrical isomerism and E-2 nomenclature.

**Reaction Mechanism in Organic Chemistry** 4

Electronic displacements in organic molecules. Aromaticity, reactivity of organic molecules. Heterolytic and hemolytic fission, Nucleophiles, Electrophiles, acids and bases and their relative strengths (including carbon acids). Addition, elimination and substitution reactions (including electrophilic, nucleophilic and aromatic types). Arynes and Carbenes as reaction intermediates.

**Functional Group Chemistry** 4

Functional group. Orientation effect in aromatic substitution groups: (1) Hydroxyl group, (2) Phenol, (3) Carbonyl group, (4) Carboxylic acid group and its derivatives: Esters and Amides, (5) Cyno group, (6) Nitro group, and (7) Amino group.

**Organic reactions** 4

(1) Aldol condensation, (2) Cannizaro reaction, (3) Claisen condensation, (4) Darzen reaction, (5) Dickermann reaction, (6) Grignard synthesis, (7) Mannich reaction, (8) Michael reaction, and (9) Perkin reaction, etc.

**Polymerization** 4

Types of polymerization. Forms of polymers: (1) Condensation polymerization, (2) Ring opening polymerization, (3) Addition polymerization, and (4) Zieglar-Natta polymerization. Natural and synthetic rubbers.

**Suggested Readings**

1. Sindhu, P S. (2012). *Modern Chemisty*. New Delhi: S. Chand & Sons.

2. Lee, J. D. (2008). *Conscise Inorganic Chemistry: 5th ed.* Oxford: Oxford University press.

3. Finar, I. L. (2002). *Organic Chemistry*, (Vol. I & II), New Delhi: Pearson Education India.

4. Morrison, R.T. & Boyd, R.N. (1992). *Organic Chemistry*: 6th ed. New Delhi: Pearson Education India.

5. Bahl, A. & Bahl, B.S. (2010). *Advanced Organic Chemistry*. New Delhi: S. Chand.

6. Graham, S. T. W. (2015). *Organic Chemistry: 11th ed.* Hoboken: John Wiley and Sons.

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| --- | --- | --- | --- |
| **Course: Mechanics & Relativity** | | | **Semester: I** |
| **Course Code:** BPHT 1102 | **L T P** | **3 0 0** | **Credits: 3** |

**Objective:** To familiarize students with basic principles of various mechanical operations, construction and working of the equipments including knowledge and proof of the validity of Physical Laws and nonexistence of the hypothetical stationary.

**Syllabus**

**Fundamentals of Dynamics** 3

Dynamics of a system of particles centre of mass, conservation of momentum, idea of conservation of momentum from Newton’s third law, impulse, momentum of variable mass system: motion of rocket.

**Work and Energy Theorem** 9

Work and kinetic energy theorem, conservative and non- conservative forces, potential energy, energy diagram, stable and unstable equilibrium. Gravitational potential energy, elastic potential energy, force as gradient of potential energy, work and potential energy, work done by non-conservative forces, law of conservation of energy. Elastic and inelastic collisions between particles, Center of mass and laboratory frames.

**Rotational Dynamics** 6

Angular momentum of a particle and system of particles, torque, conservation of angular momentum, rotation about a fixed axis, moment of inertia, calculation of moment of inertia for rectangular, cylindrical, and spherical bodies. Kinetic energy of rotation, motion involving both translation and rotation.

**Gravitation and Central Force Motion** 9

Law of gravitation, inertial and gravitational mass. potential and field due to spherical shell and solid sphere. Motion of a particle under central force field, two body problem and its reduction to one body problem and its solution. The energy equation and energy diagram, Kepler’s laws (ideas only), orbits of artificial satellites.

**Elasticity**  3

Relation between elastic constants, twisting torque on a cylinder or wire.

**Fluid Motion**

**Kinematics of Moving Fluids** 2

Poiseuille’s equation for flow of a liquid through a capillary tube.

**Inertial and Non- Inertial Systems** 6

**Reference Frames**

Inertial frames and Galilean transformations, Galilean invariance and conservation laws. Non-inertial frames and fictitious forces, uniformly rotating frame. Physics laws in rotating coordinate systems, centrifugal forces: Coriolis force and its applications. Components of velocity and acceleration in cylindrical and spherical coordinate systems.

**Special theory of Relativity** 10

Michelson-Morley experiment and its outcome, postulates of special theory of relativity, Lorentz transformations. Simultaneity and order of events, Lorentz contraction, time dilation, relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities, variation of mass with velocity, rest mass, massless particles, mass- energy equivalence. Bucherer’s experiment, relativistic Doppler effect. Relativistic kinematics, transformation of energy and momentum, energy-momentum four vector.

**Suggested Readings**

1. Kleppner, D., Kolenkow, R. J. (1973). *An introduction to mechanics*. New Delhi: McGraw-Hill.

2. Kittel, C., Knight, W., Ruderman, M., Helmholz, C., Moyer, B. (2007). *Mechanics.* Berkeley physics course, v.1 New York: Tata McGraw-Hill.

3. Mathur, D. S. (2000). *Mechanics*. New Delhi: S. Chand & Company Limited.

4. Symon, Keith R. (1971) *Mechanics*: 3rd ed. Boston: Addison Wesley.

5. Sears, F. W., Zemansky, M. W. & Young, H. D. (1982). *University Physics.* New Delhi:Narosa Publishing House.

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| --- | --- | --- | --- |
| **Course: English Communication** | | | **Semester: I** |
| **Course Code:** BECT 1101 | **L T P** | **2 0 2** | **Credits: 3** |

**Objective:** To enable students to improve both the ability to communicate and the linguistic competence in the chosen language. A balance of receptive (reading, listening) and productive (speaking, writing) skills are developed through communicative classes and self‐study.

**Syllabus**

**Communication** 12

Language and communication, differences between speech and writing, distinct features of speech, distinct features of writing.

**Writing Skills** 20

Selection of topic, thesis statement, developing the thesis; introductory, developmental, transitional and concluding paragraphs, linguistic unity, coherence and cohesion, descriptive, narrative, expository and argumentative writing.

**Technical Writing** 20

Scientific and technical subjects; formal and informal writings; formal writings/reports, handbooks, manuals, letters, memorandum, notices, agenda, minutes; common errors to be avoided.

**Suggested Readings**

1. Frank, M. (1990). *Writing as thinking: a guided process approach*. Englewood Cliffs: Prentice Hall.

2. Hamp-Lyons, L., & Heasley, B. (2006). *Study writing: a course in written English for academic purposes*. Cambridge: Cambridge university press.

3. Quirk, R., Greenbaum, S., Leech, G., & Startvik, J. (1994). *A comprehensive grammar of the English language*. London: Pearson Longman.

4. Riordan, D. G., Pauley, S. E. (2004). *Technical Report Writing Today:* 8th ed., Biztantra. London: Dreamtech Press.

5. Ober, S. (2007). *Contemporary Business Communication:* 7th ed. Boston: Houghton Mifflin.

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| --- | --- | --- | --- |
| **Course: Computer Fundamentals & Office Automation** | | | **Semester: I** |
| **Course Code:** BCST 1101 | **L T P** | **3 0 2** | **Credits: 4** |

**Objective:** To develop skills to use office automation packages, internet, etc. essential for day-to-day office management, and e-governance.

**Syllabus**

**Introduction to Computer** 8

Definition - History & generation of computer (from first to 5th) - CD, DVD, Blue ray disc, pen drive magnetic tape & Zip disk; CPU: components of CPU - mother board, hard disk, RAM, ROM, processor, SMPS & connecting wire; graphics card, sound card, network card – modem; input, output devices: keyboard, mouse, scanner, digital camera, joystick, pen drive, monitor, printer, plotter. Floppy drive, connecting port, serial, parallel, USB port. Computer networks: data communications, types of computer networks, local area networks & wide area networks.

**Windows** 8

Definition of Operating system, functions of OS, types of OS: single user, multi-user, multi-task, RTOS, single-user, multi-tasking, Windows desktop, GUI: definition, standards, cursors/pointers, icons, GUI menus, GUI-share data, desktop icons and their functions: My computer, creating & editing images with microsoft paint, using the calculator, personalizing windows. Linux: Linux programming & administration, introduction to Linux, features of Linux, components of Linux, Linux process, and thread management, file management system; Linux commands and utilities: cat, tail, cmp, diff, wc, sort, mkdir, cd, rmdir, pwd, cp, more, passwd, who, whoami, mv, chmod, kill, write, wall, merge, mail, news, pipes, filters and redirection utilities; System administration: installing Linux, booting the system, maintaining user accounts, file systems and special files, backups and restoration.

**Introduction to MS Word** 8

MS word, working with documents, opening & saving files, editing text documents, inserting, deleting, cut, copy, paste, undo, redo, find, search, replace, formatting page & setting margins, anchoring & wrapping, setting document styles, table of contents, index, page numbering, date & time, author, etc.. Creating tables- table settings, borders, alignments, insertion, deletion, merging, splitting, sorting, and formula, drawing, inserting clip arts, pictures/files etc., tools, word completion, spell checks, mail merge, templates, creating contents for books, creating letter/faxes, creating web pages, using wizards, tracking changes, security, digital signature. Printing documents – shortcut keys.

**MS Excel**  8

Spread sheet & its applications, opening spreadsheet, Menus - main menu, formula editing, formatting, toolbars, using icons, using help, shortcuts, spreadsheet types. Working with spreadsheets - opening, saving files, setting margins, converting files to different formats (importing, exporting, sending files to others), spread sheet addressing - rows, columns & cells, referring cells & selecting cells, shortcut keys. Entering & deleting data: entering data, cut, copy, paste, undo, redo, filling continuous rows, columns, highlighting values, find, search & replace, inserting data, insert cells, column, rows & sheets, symbols, data from external files, frames, clipart, pictures, files etc, inserting functions, manual breaks, setting formula, finding total in a column or row, mathematical operations (addition, subtraction, multiplication, division, exponentiation), using other formulae. Formatting spreadsheets, introduction to MS office-MS Access and Open Office-base, MS Access, introduction, planning a database, starting Access, Access screen, creating a new database, creating tables, working with forms, creating queries, finding information in databases, creating reports, types of reports, printing & print preview, importing data from other databases viz. MS excel etc.

**Introduction to MS Office-MS Power Point and Open Office-Impress**  8

MS power point: introduction to presentation, opening new presentation, different presentation templates, setting backgrounds, selecting presentation layouts. Creating a presentation, setting presentation style, adding text to the presentation. Formatting a presentation, adding style, colour, gradient fills, arranging objects, adding header & footer, slide background, slide layout. Adding graphics to the presentation, inserting pictures, movies, tables, etc. into presentation, drawing pictures using draw. Adding effects to the presentation: setting animation & transition effect. Printing handouts, generating standalone presentation viewer. Open office - impress, introduction, creating presentation, saving presentation files, master templates & re-usability, slide transition, making presentation cds, printing handouts, operating with MS power point files / slides.

**Suggested Readings**

1. Rajaraman, V. (2010). *Fundamentals of Computers:* 5th ed. New Delhi: PHI Learning.

2. Sinha, P.K., Sinha P. (1992). *Computer Fundamentals*, New Delhi: BPB Publications.

3. Basandra S. (2010). *Computer Today*, New Delhi: Galgotia Publications.

4. Das, S. (2006). *Unix Concepts and Application:* 4th ed. New York: McGraw Hill Education.

5. Sagman, S. (1999). *MS-Office 2000(For Windows)*: 1st ed. Berkeley: Peachpit Press.

6. Tennenbum, A. (2012). *Computer Networks:* 5th ed. New Delhi: Pearson.

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| **Course: Physics Practical** | | | **Semester: I** |
| **Course Code:** BPHL 1101 | **L T P** | **0 0 4** | **Credits: 2** |

**Objective:**  To familiarize students with experimental apparatus, the scientific method, and methods of data analysis relating to inductive process.

**Errors in Measurements** 4

Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error.

**List of Practicals**

**A: General** 24

1. To use a Multimeter for measuring (a) Resistances, (b) A/C and DC Voltages, (c) AC and DC Currents, (d) Capacitances, and (e) Frequencies.
2. To test a Diode and Transistor using (a) a Multimeter and (b) a CRO.
3. To measure (a) Voltage, (b) Frequency and (c) Phase Difference using a CRO.
4. To study the Characteristics of a Series RC Circuit.
5. To estimate the temperature of a torch bulb filament from resistance measurement and to verify Stefan’s law.
6. To convert a given ammeter into a voltmeter and a given voltmeter into an ammeter and hence to calibrate the device and measure the internal resistance in each case.
7. To measure the resistance per unit length of the wire of a bridge and to determine an unknown resistance by Carey Fosters bridge.
8. To measure the current flowing in a circuit by measuring the drop of potential across a known resistance in the circuit using a potentiometer (by measuring the resistance of the potentiometer with a P.O. Box).

**B: Mechanics** 24

1. To determine the Acceleration due to Gravity and Velocity for a freely falling body, using Digital Timing Techniques.
2. Determination of moment of inertia of metallic cylinder / rectangular bar about an axis passing through its C.G. and to determine the rigidity modulus of the material of the suspension wire.
3. Determination of refractive index of a liquid by using travelling microscope.
4. To determine the Moment of Inertia of a Flywheel.
5. To determine the Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille’s method).
6. To determine the Young's Modulus of a Wire by Optical Lever Method.
7. To determine the Modulus of Rigidity of a Wire by Maxwell’s needle.
8. To determine the Elastic Constants of a Wire by Searle’s method.

**Note**

Each Student is required to perform at least 10 Practicals by taking at least 5 Practicals from each of the above sections **A** and **B**.

**Suggested Readings**

1. Sanon, Geeta. (2007). *B. Sc Practical Physics*: 1st ed. New Delhi: R. Chand & Co.
2. Worsnop, B. L. & Flint, H. T. (1971). *Advanced Practical Physics*. New Delhi: Asia Publishing House.
3. Prakash I., Krishna, R. & Jha, A. K. (2012) *A Text Book of Practical Physics*. New Delhi: Kitab Mahal.
4. Khandelwal, D. P. (1985). *A Laboratory Manual of Physics for Undergraduate Classes*. New Delhi: Vani Publication House.
5. Arora, C. L. (1995). *B.Sc. Practical Physics*, New Delhi: S. Chand Limited.

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| **Course: Chemistry Practical** | | | **Semester: I** |
| **Course Code:** BCYL 1101 | **L T P** | **0 0 4** | **Credits: 2** |

**Objectives:** To introduce students to practical aspects of basic areas of Chemistry (organic, inorganic, analytical, physical and biological chemistry). This course will enable students to use standard laboratory equipment, modern instrumentation, and classical techniques to carry out experiments.

**Syllabus**

**List of Practicals**

1. Colorimetric estimation of total iron using 1, 10-phenanthroline
2. Determination of ferrous ion in a solution using ferroin indicator
3. Determination of zinc by using potassium ferrocyanide
4. Estimation of strength of oxalic acid using potassium permanganate as intermediate solution
5. Determination of ph curve of an acid base titration and dissociation constant of weak acid.
6. Dissociation constant of weak electrolyte by conductometry.

**7.** Preparation of: (i) Aspirin (ii) Hippuric Acid (Benzoylglycine) and (iii) Methyl Orange or Phenolphthalein. Characterisation by mp, mmp, and TLC.

8. Two-step Preparations: (i) Nitrobenzene from Benzene, Purification of Nitrobenzene and characterization by refractive index, further nitration.

(ii) *P-*bromoacetanilide from Aniline.

9. Estimation of Glucose, Saponification Value or Iodine Value of a fat or oil.

10. The effect of Detergent on the Surface Tension of Water. (Variation of Surface Tension with Concentration to be studied).

11**.** Determination of the Rate Law for one of the following reactions. All solutions needed to be provided.

(i) Persulphate-iodine Reaction.

(ii) Iodination of Acetone.

**Suggested Readings**

1. Vogel, A.I. (1989). *Text-Book of Practical Organic Chemistry:* 5th ed*.* New Jersey: Prentice Hall.

2. Vogel, A.I. (2005). *Qualitative Chemical Analysis:* 6th ed*.* New Jersey: Prentice Hall.

3. Vogel, A.I. (2002). *Qualitative Inorganic Analysis*: 7th ed. New Jersey: Prentice Hall.

4. Mann, F.G. & Saunders, B.C. (1979). *Practical Organic Chemistry*, New Delhi: Orient Longman.

**Semester II**

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| **Course:** **Principle of Mathematics –II** | | | Semester: II |
| Course Code: BMAT 1201 | L T P | 3 1 0 | Credits: 4 |

**Objective:** To solve differential equations using elementary techniques (separable or linear constant coefficient equations) and to introduce students to fundamental principles of complex variables, illustrate their power on applications, and enable them.

**Syllabus**

**Ordinary Differential Equations** 10

Higher order linear differential equations with constant coefficients, Cauchy’s and Legendre’s linear equations, Method of variation of parameters, Simultaneous first order linear equations with constant coefficients.

**Vector Calculus** 10

Gradient Divergence and Curl, Directional derivative, Irrotational and solenoidal vector fields, Vector integration, Green’s theorem in a plane, Gauss divergence theorem and stokes’ theorem (excluding proofs).

**Function of Complex Variables** 10

Functions of a complex variable, Analytic functions, Necessary conditions, Cauchy – Riemann equation and Sufficient conditions (excluding proofs), Harmonic and orthogonal properties of analytic function, Harmonic conjugate, Construction of analytic functions, Conformal mapping : w= z+c, cz, 1/z, and bilinear transformation. Schwarz Christoffel Transformation.

**Complex Integration** 10

Complex integration, Statement and applications of Cauchy’s integral theorem and Cauchy’s integral formula, Taylor and Laurent expansions, Singular points, Residues, Residue theorem , Application of residue theorem to evaluate real integrals.

**Suggested Readings**  
1. Bali, N. P. & Goyal, Manish & Watkins, C. (2015). *Advanced Engineering Mathematics:* 8th

Ed., New Delhi: Laxmi Publications Pvt Ltd.  
2. Grewal, B. S. (2013). *Higher Engineering Mathematics*”: 41st ed., Delhi: Khanna

Publications.  
3. Dass, H. K. & Verma, R. (2011). *Higher Engineering Mathematics*, New Delhi: S. Chand

Publishing.  
4. Glyn, J. (2012). *Advanced Modern Engineering Mathematics*: 3rd ed., New Delhi: Pearson

Education, 2012.  
5. Neil Peter O. V. (2012), *Advanced Engineering Mathematics:* 7th ed., New Delhi: Cengage

learning, 2012.  
6. Ramana, B. V. (208). *Higher Engineering Mathematics*, New Delhi: Tata McGraw Hill

Publication.

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| **Course:** **Differential Equations I** | | | Semester: II |
| Course Code: BMAT 1202 | L T P | 3 1 0 | Credits: 4 |

**Objective:** To enable students to make mathematical models involving differential equations for problems encountered in engineering, social and physical sciences, and to solve them by using one or a combination of the methods mentioned above.

**Syllabus**

**First Order Differential Equation** 10

Formulation of differential equations, order and degree of a differential equation, equations of first order and first degree, solutions of equations in which variables are separable, homogeneous equations, linear equations and Bernoulli equations, exact differential equations, integrating factors, change of variables.

**Higher Order Differential Equation** 10

Equations of the first order and higher degree, equations solvable for *p, y* and *x*, Clairaut equation, Lagrange’s equation, Trajectories, Orthogonal Trajectory.

**Linear differential Equations with Constant Coefficient** 10

Linear differential equations with constant coefficient, complementary function and particular integral. Homogeneous linear equations. Application of Differential Equations.

**Other Method to Solve Differential Equations of Second Order** 10

Linear differential equations of second order, Complete solution in terms of known integral belonging to the complementary function, Normal form, Change of independent variable, Method of undetermined coefficients, Method of variation of parameters, Simultaneous equations with constant coefficients, Simultaneous equations of form

**Suggested Readings**

# Simmons, George F. (2006). *Differential Equations*: 3rd Editrion. New Delhi: Tata McGraw-Hill Publication.

1. Raisinghania, M. D. (2015). *Ordinary & Partial Differential Equation*: 18th Ed.. New Delhi: S Chand Publisher.

# Bronson, R., Costa, G. (2014). *Schaum's Outline of Differential Equations*: 4th Ed. (Schaums' Outline Series), New Delhi: Tata McGraw-Hill Education.

1. Edwards, C. H. & Penny, D. E. (2005). *Differential Equations and Boundary Value* *Problems: Computing and Modelling*, New Delhi: Pearson education, India.
2. Ross, S. L. (2004). *Differential equations:* 3rd Ed. New Delhi: John Wiley and Sons.

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| **Course:** **Statics and Dynamics** | | | Semester: II |
| Course Code: BMAT 1203 | L T P | 3 0 0 | Credits: 3 |

**Objective:** To familiarize students with basic principles of statics and dynamics and their applications in dynamics problems, predicting the effects of force and motion while carrying out the creative design function of engineering.

**Syllabus**

**Forces** 10

Couples. Co-planar forces. A static equilibrium. Friction. Equilibrium of a particle on a rough curve. Virtual work. Catenary. Forces in three dimensions. Reduction of a system of forces in space. Invariance of the system. General conditions of equilibrium. Centre of gravity for different bodies. Stable and unstable equilibrium.

**Virtual Work** 10

Principle of virtual work for a single particle. Deduction of the conditions of equilibrium of a particle under coplanar forces from the principle of virtual work. The principle of virtual work for a rigid body. Forces which do not appear in the equation of virtual work. Forces which appear in the equation of virtual work. The principle of virtual work for any system of coplanar forces acting on a rigid body. Converse of the principle of virtual work.

**Motion of a Particle in Two Dimensions** 11

Velocities and accelerations in Cartesian, polar, and intrinsic coordinates. Equations of motion referred to a set of rotating axes. Motion of a projectile in a resisting medium. Motion of a particle in a plane under different laws of resistance.

**Central Forces** 11

Stability of nearly circular orbits. Motion under the, inverse square law. Kepler's laws. Time of describing an arc and area of any orbit. Slightly disturbed orbits. Motion of artificial satellites. Problems of motion of varying mass such as falling raindrops and rockets. Tangential and normal accelerations. Motion of a particle on a smooth or rough curve. Principle of conservation of energy. Motion of a particle in three dimensions. Motion on a smooth sphere, cone, and on any surface of revolution.

**Suggested Readings**

1. Verma, R. S. (1962). *A Text Book on Statics*.: 5th Ediution. Allahabad: Pothishala Pvt. Ltd
2. Loney, S.L. ,(2012). *The elements of statics and dynamics –Part I (statics) & Part II(Dynamics)*, Cambridge University Press 1932, Publisher Arihant.
3. Ray M. (1995). *A Textbook on Statics:* 4th Revised Ed.. New Delhi: S Chand Publisher.
4. Synge, J. L. & Griffith, B. A. (1971). *Principles of Mechanics*, New Delhi: Tata McGraw-Hill, Publication.

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| **Course:** **Discrete Mathematics** | | | Semester: II |
| Course Code: BMAT 1204 | L T P | 3 0 0 | Credits: 3 |

**Objective:** impart skills to develop and analyze algorithms as well as enable them to think about and solve problems in new ways.

**Syllabus**

**Introduction**  12

*Set Theory:*Definition of sets, countable and uncountable sets, Venn Diagrams, proofs of somegeneral identities on sets

*Relation:*Definition, types of relation, composition of relations, Pictorial representation ofrelation, equivalence relation, partial ordering relation.

*Function:*Definition, type of functions, one to one, into and onto function, inverse function,composition of functions, recursively defined functions.

*Theorem proving Techniques:* mathematical induction (simple and strong), pigeonhole principle, prove by contradiction.

**Combinatorics**  8

Recurrence Relation, Generating function, Permutation &Combination, Probabilistic Permutation & Combination, Pigeonhole Principle.

**Posets and Lattices** 11

Posets, Hasse Diagram and Lattices:Introduction, ordered set, Hasse diagram of partially,ordered set, isomorphic ordered set, well ordered set, properties of Lattices, bounded I and complemented lattices.

**Propositional Logic** 11

Proposition, First order logic, Basic logical operation, truth tables,tautologies, Contradictions, Algebra of Proposition, logical implications, logical equivalence, predicates, Universal and existential quantifiers.

**Suggested Readings**

1. Liptschutz, S. (2009). *Discrete Mathematics (Schaum’s Outlines)*. 3rd ed. New Delhi: Tata McGraw Hill Education.
2. Trembley, J. P & Manohar, R. (2010). *Discrete Mathematical Structure with Application to Computer Science*, New Delhi: Tata McGraw Hill Reprint.
3. Rosen H. (2012). *Discrete Mathematics & its application with combinatory and graph theory*, 6th ed. New Delhi: Tata McGraw Hill.
4. Sarkar S. K., (2010). *A Textbook of Discrete Mathematics*, 9th Ed., New Delhi: S. Chand Publishing.

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| **Course:** **Abstract** **Algebra I** | | | Semester: II |
| Course Code: BMAT 1205 | L T P | 3 1 0 | Credits: 4 |

**Objective:** To familiarize students with Abstract Algebra including certain structures called groups, rings, fields and some related structures.

**Syllabus**

**Group** 10

Sets, relations, functions, binary operations, Definition of groups with examples and its elementary properties, subgroups, order of an element of a group, cyclic groups, Coset decomposition, Lagrange’s theorem and its consequences, normal subgroup and factor groups. Various types of groups up to order 8.

**Group Mapping** 10

Group Homomorphism, Isomorphism, kernel of a homomorphism, The homomorphism theorems, The isomorphism theorems, Permutation groups, Even and odd permutations, Alternating groups, Cayley’s theorem, and Regular permutation group.

**Ring** 11

Rings and their elementary properties, Integral domain, Field. Subrings, Ideals and their properties, Field of quotients, Quotient rings.

**Ring Mapping** 11

Homomorphism of rings and its properties, Kernel of a homomorphism, Natural homomorphism, Isomorphism and related theorems, Euclidian rings, Unique factorization theorem.

**Suggested Readings**

1. Herstein, N. (2006). *Topics in Algebra*: 2nd ed. New Delhi: Wiley Eastern Ltd.
2. Goyal, J. K. & Gupta K.P. (2015). *Advanced course in Modern Algebra:* 68th ed. New Delhi: Pragati Prakashan.
3. Jacobson, N. (2010). *Basic Algebra Vol I & II*, Hindustan Publishing Comp.
4. Joseph, A. G. (2013). *Contemporary Abstract Algebra,* 8th ed., New Delhi: Cengage Publication.
5. Gopalakrishan, S. (2007). *University Algebra*, New Delhi: New Age International (P) Limited,.
6. Narayan. S. (1967). *Textbook of Modern Abstract Algebra*, 1st ed. New Delhi: S. Chand Publishing.

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| **Course:** **Analytic Geometry** | | | Semester: II |
| Course Code: BMAT 1206 | L T P | 3 1 0 | Credits: 4 |

**Objective:** To familiarize students with learn about analytical geometry two dimensional in polar coordinates, understand about straight lines in three dimensional and to gain knowledge about sphere, cone and cylinder.

**Syllabus**

**Two Dimensions geometry** 21

General equation of second degree, Pair of lines, Parabola, Tangent, normal. Pole and polar and their properties. Ellipse, Hyperbola, Tangent, normal, pole and polar. Conjugate diameters, Asymptotes, Conjugate hyperbola and rectangular hyperbola.

Polar equation of a conic, Polar equation of tangent, normal, polar and asymptotes, General equation of second degree, Tracing of parabola, Ellipse and hyperbola.

**Three Dimensions geometry** 21

Equation of sphere, Tangent plane, Plane of contact and polar plane, Intersection of two spheres, radical plane, Coaxial spheres, Conjugate systems, Equation of a cone, Intersection of cone with a plane and a line, Enveloping cone, Right circular cone.

Equation of cylinder, Enveloping and right circular cylinders, Equations of central conicoids, Tangent plane, Normal, Plane of contact and polar plane, Enveloping cone and enveloping cylinder, Conjugate diameters and diametral planes, Equations of paraboloids and its simple properties.

**Suggested Readings**

1. Loney, S. L. (2005). *The elements of coordinate geometry*, University of Michigan Library

Michigan Historical Reprint Series.

1. Narayan, S. (2007). *Analytical Solid Geometry*: 17th ed.. New Delhi: S. Chand and Company.
2. Jain, P. K. and Ahmad, K. (2015), *Textbook of Analytical Geometry*, 3rd ed. New Delhi: New

Age International.

1. Vashishtha, A. R. & Aggrawal, D. C. (2014) *A Text book of Analytical Geometry*, Meerut:

Krishna Prakashan.

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| **Course:** **Environmental Studies** | | | Semester: II |
| Course Code: BEST 1201 | L T P | 2 0 0 | Credits: 2 |

**Objective:** To familiarize students with environmental issues including environmental pollution (sources, effects and control measure) and national and international concern for environment protection and disaster management.

**Syllabus**

**Fundamentals of Environment**  7

Meaning of Environment, Types and components of environment, nature and scope of the subject,Need for environment studies, Man-environment relationship, Biogeochemical cycles (carbon cycle, oxygen cycle, nitrogen cycle, phosphorus cycle, sulphur cycle).

**Ecology and Ecosystem**  7

Concept of ecology, population ecology, biome ecology, ecosystem ecology, pyramid of numbers, pyramid of energy, food chains and food webs in ecosystem, grazing food chain, detritus food chain, ecological interactions.

**Soil, Water and Air Resources**  6

Soil formation, basic properties of soil, soil erosion, wastelands, Properties of water, hydrological cycle, water resources, ground water, water table, Composition of air, structure of atmosphere.

**Environmental Pollution** 6

Air, water, soil – causes and effects and control measures. Specially: acid rain, ozone layer depletion, green house gas effect and global warming. Waste management: prevention and control measures of solid waste (general). Effects of air pollution on human health, flora and fauna,

**National Concern for Environment** 6

Important environmental protection Acts in India – soil, water, air (prevention and control of pollution) act, wild life conservation and forest act. Functions of central and state pollution control boards. Issues involved in enforcement of environmental legislation.

**Energy Resources and Conservation 6**

Energy resources and their exploitation. Conventional energy sources: coal, oil, biomass and nature gas (overview) – over – utilization. Non-conventional energy sources: hydroelectric power, tidal, wind, geothermal energy, solar collectors, photovoltalc, nuclear-fission and fusion. Energy use pattern and future need projection in different parts of the world, energy conservation policies.

**Natural Hazards and Disaster Management 4**

Natural and man-made disasters- types, causes, onset, impacts (viz earthquake, flood, drought, cyclone, tsunamic, volcanic, landslide, industrial accidents), Forecasting and management.

**Suggested Readings**

1. Agrawal K. M., Sikdar P. K. and Deb S. C., *A Textbook of environment*, Macmillan Publishers India Limited

2. Jeyalakshmi. R, *Principles of Environmental Studies*, 1st Edition, Devi Publications, Chennai, 2006.

3. Sharma. B. K. and Kaur, *Environmental Chemistry*, Goel Publishing House, Meerut, 1994

4. De.A.K., Environmental Chemistry, New Age International (p) lt. New Delhi, 1996

5. Dara S. S., A *Text Book of Environmental Chemistry and Pollution Control*, Chand & Company Ltd., New Delhi, 2004.

6. Nambiar R, *Textbook of Environmental Studies*, Scitech Publication

(India) Pvt. Ltd., Second Edition.

**Semester III**

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| **Course:** **Differential Equations – II** | | | Semester: III |
| Course Code: BMAT 2101 | L T P | 3 1 0 | Credits: 4 |

**Objective:** To introduce students to differential equations and partial differential equations and their applications.

**Syllabus**

**Series Solution** 12

Series solutions of differential equations- power series method, Frobenius method, Bessel and Legendre differential equation and their series solution.

**Partial Differential Equation** 10

Partial differential equations of the first order, Lagrange’s solutions, Solution of some standard type of equations, Charpit’s general method of solution. Partials differential equations of second and higher orders. Classification of linear partial differential equations of second order.

**Homogeneous** **Partial Differential Equation** 6

Homogeneous and non-homogeneous equation with constant coefficients, Partial differential equations reducible to equations with constant coefficients, Monge,s method.

**Application of Partial Differential Equations** 12

Separation of Variables, Classical PDEs and BVPs. One dimensional wave equation, one dimensional heat equation and Laplace’s Equation. Sturm-Liouville Problem: Eigenvalues and Eigenfunctions.

**Suggested Readings**

1. Zill, D. G. (2012). *A first course in differential equations:* 10th ed. New Delhi: Cengage Learning Custom Publishing.
2. Raisinghania, M. D. (2015). *Advanced Differential Equation*: 14th ed. New Delhi: S Chand Publisher.
3. Murray, D. A. (1967). *Introductory Course on Differential Equations*: 2nd ed. New York.Orient Longman (India).
4. Gupta, A. S. (1997). *Calculus of variations with applications*, New Delhi: Prentice Hall of India, 1997.
5. Sneddon, I. N. (2006). *Elements of Partial Differential Equations*, 1st ed. New Delhi: Dover Publications Inc.
6. Simmons, G. F. (207). *Differential Equation (Theory, Technique and Practice)*: 3rd ed. New Delhi: Tata Mc Graw Hill.

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| **Course:** **Linear Programming and Game Theory** | | | Semester: III |
| Course Code: BMAT 2102 | L T P | 3 0 0 | Credits: 3 |

**Objective:** To impart skills to find optimal solutions for the problems which can be specified as Linear Programming Problems (LPP).

**Syllabus**

**Linear Programming Problem**  16

Operations Research (OR) and its Scope, Modeling in OR, Scientific Method in Operations Research, Linear Programming: Definition, mathematical formulation, standard form, Solution space, solution – feasible, basic feasible, optimal, infeasible, multiple, redundancy, degeneracy, Solution of LP Problems - Graphical Method, Simplex Method, Duality in LP, Dual Simplex Method, Economic interpretation of Dual.

**Transporation and Assignment Problem**  8

Transportation Problem, Basic feasible solution using different methods (North-West corner, Least Cost, Vogel’s Approximation Method), Optimality Methods, Unbalanced transportation problem, Degeneracy in transportation problems, Assignment Problem, Hungarian Method for Assignment Problem.

**Sequencing Theory**  8

Elementary inventory models, Replacement models, Group replacement problem, Sequencing theory, *m* machines and *n* jobs problem, Graphical method for sequence problem.

**Game Theory**  10

Game Theory, pure and mixed strategies, Saddle point, Two-Persons-Zero-Sum Game, Game with mixed strategies, Dominance rule, Graphical Method, Inter - relation between the theory of games and linear programming, Solution of game using Simplex method.

**Suggested Readings**

1. Sharma, J. K. (2009). *Operations Research* *–* *Theory and Application*: 4th ed. New Delhi: Laxmi Publication.
2. Hillier & Lieberman (2004). *Introduction to Operations Research*: 8th ed. Tata McGraw Hill Publisher.
3. Hadly, G. (2002). *Linear Programming*: 5th ed. New Delhi: Narosa Publishing House.
4. Taha, H. (2010). *Operations Research* *–* *An Introduction*: 9th ed. New Delhi: Prentice Hall
5. Sharma, S.D. (2014), *Operations Research:* 15th ed. Meerut: Kedarnath Ramnath & Co.

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| **Course:** **Graph Theory** | | | Semester: III |
| Course Code: BMAT 2103 | L T P | 3 0 0 | Credits: 3 |

**Objective:** To introduce the subject of graph theory including all the elementary concepts such as coloring, covering, hamiltonicity, planarity, connectivity and more.

**Syllabus**

**Introduction of Graphs**  10

Graphs, Sub graphs, some basic properties, various example of graphs & their sub graphs, walks, trails, path & circuits, connected graphs, disconnected graphs and component, various operation on graphs, Euler graphs, Hamiltonian paths and circuits, the traveling salesman problem, directed graphs, some types of directed graphs, directed paths and connectedness, Hamiltonian and Euler digraphs.

**Tree** 10

Trees and fundamental circuits, distance diameters, radius and pendent vertices, rooted and binary trees, on counting trees, spanning trees, fundamental circuits, finding all spanning trees of a graph and a weighted graph, trees with directed edges, fundamental circuits in digraph, algorithms of Prim, Kruskal and Dijkstra.

**Planner Graph** 11

Cuts sets and cut vertices, some properties, all cut sets in a graph, fundamental circuits and cut sets, connectivity and separability, network flows, planer graphs, Euler’s formula and its corollaries, Kuratowski’s theorem and its application to planarity detection of graphs, combinatorial and geometric dual, some more criterion of planarity, thickness and crossings.

**Matrices of Graph** 11

Incidence matrix of graph, sub matrices of A(G), circuit matrix, cut set ,matrix, & fundamental circuit matrix and rank of B, path matrix and relationships among ***Af, Bf, Cf,*** adjacency matrices, adjacency matrix of a digraph, matrices A, B and C of digraphs, rank- nullity theorem, coloring and covering and partitioning of a graph, chromatic number, chromatic partitioning, chromatic polynomials, matching, covering, enumeration, types of enumeration, counting of labeled and unlabeled trees.

**Suggested Readings**

1. Deo, N. S. (2004). *Graph theory*: 8th ed. New Delhi: Prentice Hall India.
2. Bondy & Murthy (1977). *Graph theory and application*, 1st ed. New Delhi: Mc Millan.

# Deo, N. S. (2016). *Graph Theory with Applications to Engineering and Computer Science*, 1st ed. New Delhi: Dover Publications; Reprint edition.

1. Robin, J. W. (2010). *Introduction to Graph Theory*: 5th ed. New Delhi: Prentice Hall.
2. West, D. B. (2005). *Introduction to Graph Theory*: 4th ed. New Delhi: Pearson.

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| **Course:** **Probability and Statistics** | | | Semester: III |
| Course Code: BMAT 2104 | L T P | 3 1 0 | Credits: 4 |

**Objective:** To introduces the concept of probability and statistics along with a selected study of discrete & continuous distributions.

**Syllabus**

**Basics of Probability Theory** 10

Sample space and events, algebra of events, axiomatic approaches, conditional probability, basic laws of total probability and compound probability, Byes’ theorem, Independence.

**Probability Distributions** 10

Discrete and continuous random variables, mathematical expectation, variance, moment about a point, central moment, moment generating function, Binomial, Poisson, Normal and Rectangular distributions.

**Multi Dimensional Random Variables** 8

Two-dimensional random variables, joint distribution functions, marginal distributions, covariance, linear regression and correlation, rank correlation, least square method of fitting regression lines.

**Sampling and Testing** 12

Sampling, random sampling, large sample tests of means and proportion. *t*-student, *χ2* (chi square) and *F* distributions (without derivation) and testing of hypothesis based on them. Analysis of variance (ANOVA) for one-way and two-way classified data, Design of Experiment.

**Suggested Readings**

1. Miller, I. & Miller, M. (2013). *John E. Freund's Mathematical Statistics* *with Applications*: 8th

ed. New Delhi: Pearson Education.

1. Hogg, R. V. & Allen C. D. & Joseph, W. M. (2012). *Introduction* *to Mathematical Statistics:*

7th ed. New Delhi:Pearson Education

1. Ross, S. M. (2009). *Introduction to probability and statistics for engineers and* *scientists*: 4th

ed. New Delhi: Elsevier Academic Press.

1. Kapur, J. N. and Saxena, H. C. (2010). *Mathematical Statistics*: 1st ed. New Delhi: S. Chand.
2. Dudewicz, E. J. & Mishra, S. N. (1988). *Modern Mathematical Statistics:* 1st ed. New Delhi:

John Wiley & Sons.

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| **Course:** **Abstract Algebra – II** | | | Semester: III |
| Course Code: BMAT 2105 | L T P | 3 0 0 | Credits: 3 |

**Objective:** To provide an exposure of the advanced topics in rings, modules and Sylow’s theory.

**Syllabus**

**Mapping in a Group** 12

Automorphism, Inner Automorphism, Automorphism Groups, Automorphism Groups of Finite and Infinite Cyclic Groups, Applications of Factor Groups to Automorphism Groups, Characteristic Subgroups, Commutator Subgroup and its Properties.

**Direct Product** 10

Properties of external direct products, the Group of units modulo n as an external direct product, internal direct products, Fundamental Theorem of finite Abelian Groups.

**Group Action** 6

Group actions, Stabilizers and Kernels, Permutation representation associated with a given Group action.

**Applications of Group Actions** 12

Applications of group actions: Generalized Cayley’s theorem, Index theorem. Groups acting on themselves by conjugation, class equation andconsequences, conjugacy in Sn, p-groups, Sylow’s theorems and consequences, Cauchy’s theorem, Simplicity of An for n ≥ 5, Non-Simplicity Tests.

**Suggested Readings**

1. Herstein, N. (2006). *Topics in Algebra*: 2nd Ed.. New Delhi: Wiley Eastern Ltd.
2. Goyal, J. K. & Gupta, K. P. (2015). *Advanced course in Modern Algebra:* 68th ed. New Delhi: Pragati Prakashan.
3. Jacobson, N. (2010). *Basic Algebra Vol I & II*, Hindustan Publishing Comp.
4. Joseph, A. G. (2013). *Contemporary Abstract Algebra:* 8th Ed., New Delhi: Cengage Publication.
5. Gopalakrishan, S. (2007). *University Algebra*, New Delhi: New Age International (P) Limited,.
6. Narayan, S. (1967). *Textbook of Modern Abstract Algebra*, 1st ed. New Delhi: S. Chand Publishing.

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| **Course:** **Unix and C Programming** | | | Semester: III |
| Course Code: BMAT 2106 | L T P | 3 0 0 | Credits: 3 |

**Objective:** To learn in the environment on Unix, to be able to develop large scale software and to gain extended knowledge of C Programming.

**Syllabus**

**Introduction to Computer Systems**  10

Data representation: Number systems, character representation codes, Binary, hex, octal codes and their inter conversions. Binary arithmetic, Floating point arithmetic, signed and unsigned numbers IEEE standards, CPU organization, ALU, registers, memory, the idea of program execution at micro level. Concept of computing, contemporary Operating Systems such as DOS, Windows, UNIX etc. (only brief user level description). Introduction to organization and architecture of mainframe, mini and micro systems.

**Concept of flow chart and algorithm**  8

Algorithms to programs: specification, top-down development and stepwise refinement ,Introduction to the design and implementation of correct, efficient and maintainable programs, structured Programming, Use of high level programming language for the systematic development of programs, programmability and programming languages, Object codes, compilers. Introduction to the Editing tools such as vi or MS-VC editors.

**C Programming**  10

Data types, Identifiers, Storage class, Constant, Operators, expression, Statements, console I/O statements, Selection statements: if-else, switch, Iteration Statements: for, while, do-while, Jump statements: return, go to, break, continue, comments. Function, Call by value, Call by reference, arguments to main(), return statements, recursion, function prototypes, , preprocessor directives.

**Arrays**  4

Single dimensional arrays, two dimensional arrays, multidimensional arrays, variable length arrays. Strings, array of strings. Structures: array of structures, passing structure to function, structure pointers, structure within structures. Unions, bit fields, enumerations.

**Pointers**  4

Pointer variables, pointer operator, pointer expression, array of pointers, multiple indirection, pointers to functions, dynamic allocation functions.

**File I/O**  4

Streams and files, file system basics, fread, fwrite, fseek, random access I/O, fprintf(), fscanf(), standard streams.

**Suggested Readings**

1. Rajaraman, V. (2007). *Computer Basics and C Programming*: 1st ed. New Delhi: Prentice Hall

of India.

1. Kanetkar, Y., Sinha, P. K. and Sinha, P. (2016). *Let Us C: Computer Fundamentals:*

*Concepts, Systems and Applications*: 14th ed. New Delhi: BPB Publications.

1. Venugopal, K. R., (2006). Prasad S. R., *Mastering C*: 1st ed. New Delhi: Tata Mc Graw Hill.
2. Forouzan, B. A., Gilberg R. F. (2005). *Computer Science- A Structured Programming Approach Using:* 3rd ed. New Delhi: Thomson Press [India Ed.].
3. Balagurusamy, E. (2012). *Programming in ANSI C*: 6th ed. New Delhi: Tata McGraw-Hill

Education, 2008.

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| **Course:** **Unix and** **C Programming Lab** | | | Semester: III |
| Course Code: BMAL 2101 | L T P | 0 0 2 | Credits: 1 |

**Objective:** To make student learn fundamentals of shell script and shell programming.

**List of Practical’s:**

1. Practice of all internal and External DOS Commands

2. Practice of all UNIX commands and write simple shell script.

3. WAP to perform simple arithmetic operations using different data types.

4. WAP to swap two numbers without using third variable.

5. WAP to find out whether the given number is prime or not.

6. WAP using conditional operator to determine whether a year is leap year or not.

7. WAP to print the ASCII code and their equivalent characters.

8. WAP to print corresponding days of a week using switch case.

9. WAP to print factorial of a number using recursion.

10. WAP to print Fibonacci series using function.

11. WAP to print an array and find greatest element of the array.

12. WAP to arrange elements of a given array in ascending order.

13. WAP for Matrix multiplication and find the inverse of resultant matrix.

14. WAP to print name, price & no. of pages of 3 books using structures.

15. WAP to remove the trailing blanks in a string input by the user, and print the resulting string using pointer.

**Semester IV**

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| **Course:** **Real** **Analysis – I** | | | Semester: IV |
| Course Code: BMAT 2201 | L T P | 3 1 0 | Credits: 4 |

**Objective:** To develop a deeper and more rigorous understanding of Calculus including defining terms and proving theorems about functions, sequences, series, limits, continuity, derivatives, the Riemann integrals, and sequences of functions. The course exposes students to specialized techniques in problem solving.

**Syllabus**

**Sets Theory**  10

Bounded and unbounded sets, Infimum and supremum of a set and their properties, Order completeness property of R, Archimedian property of R, Density of rational and irrational numbers in R, Dedekind form of completeness property, Equivalence between order completeness property of R and Dedekind property. Order completeness in , Neighbourhood, Open set, Interior of a set, Limit point of a set, Closed set, Countable and uncountable sets, Derived set, closure of a set, Bolzano- Weierstrass theorem for sets.

**Sequence**  10

Sequence of real numbers, Bounded sequence, limit points of a sequence, limit interior and limit superior convergent and non-convergent sequences, Cauchy’s sequence, Cauchy’s general principle of convergence, Algebra of sequences, Theorems on limits of sequences, Subsequences, Monotone sequences, Monotone convergence Theorem.

**Series**  10

Infinite series and its convergence, Test for convergence of positive term series, Comparison test, Ratio test, Cauchy’s root test, Raabe’s test, Logarithmic test, Integral test, Alternating series, Leibnitz test, Absolute and conditional convergence.

**Mean Value Theorems**  10

Continuous and discontinuous functions, Types of discontinuities, Theorems on continuity, Uniform continuity, Relation between continuity and uniform continuity, Derivative of a function, Relation between continuity and differentiability, Increasing and decreasing functions, Darboux theorem, Rolle’s theorem, Lagrange’s mean value theorem, Cauchy’s mean value theorem, Taylor’s theorem with Cauchy’s and Lagrange’s form of remainders.

**Suggested Readings**

1. Bartle, R. G. & Sherbert, D. R., (2002). *Introduction to Real Analysis: 3rd* *ed.* Singapore: John Wiley and Sons ( Asia) Pvt. Ltd.
2. Malik, S. C. and Arora, S. (2017). *Mathematical Analysis*: 5th ed. New Delhi: New Age International.
3. Saran, N.(2014). *Theory of Function of Real Variable*: 15th ed. Meerut: Pragati Prakashan.
4. Ross, K. A. (2013). Elementary Analysis: *The Theory of Calculus, Under graduate Texts in* *Mathematics*: 2nd ed. New Delhi: Springer (SIE), Indian reprint.
5. Ghorpade, S. R. & Limaye, B. V., *A course in Calculus and Real Analysis,* *Undergraduate Text in Math*. Springer (SIE). Indian reprint, 2004.
6. Apostol, T. M. (1974). *Mathematical Analysis*, 2nd Edition. Addison-Wesley Series in Mathematics.

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| **Course:** **Complex Analysis** | | | Semester: IV |
| Course Code: BMAT 2202 | L T P | 3 1 0 | Credits: 4 |

**Objective:** To provide an introduction to the theories of functions of complex variables. It begins with the exploration of the algebraic, geometric and topological structures of the complex number field. The concepts of analyticity, Cauchy-Riemann relations and harmonic functions are then introduced.

**Syllabus**

**Elementary Complex Numbers**  10

Elementary functions, Exponential functions, Trigonometric functions, Hyperbolic functions, Logarithmic functions, Analyticity of Log functions, Inverse trigonometric and Hyperbolic functions. Mapping by elementary functions, Analytic Function.

**Singularity and Residue**  10

Convergence of sequences and series, Taylor series, Laurent series, Maclaurin series, Singularities and Residues, Evaluation of integrals by Cauchy’s Residue theorem. Entire functions, Jensen’s formula, Meromorphic functions.

**Conformal mappings**  10

Conformal mappings, Power series representation of analytic functions, Analytic functions as mappings, Riemann sphere, Linear transformations, Mobius transformation, Cross ratios, Mobius transformation on circles. Fixed points, Cross ratio, Inverse points and critical mappings, conformal mappings.

**Mapping Theorems**  10

Counting zeros, The open mapping theorem, Maximum modulus principle, Schwarz lemma, Fundamental theorem of calculus in the complex plane. Harmonic functions, Mean value property, Poisson formula.

**Suggested Readings**

1. Churchill, R. V. & Brown, J. W. (2013). *Complex Variables and Applications*: 9th ed. New Delhi: Tata Mc Graw Hill Publishing.
2. Vashishtha, A. R. (2014). *Complex Analysis*: 13th ed. New Delhi: Krishna Prakashan.
3. Punnuswamy, S. (2011). *An Introduction to Complex Analysis:* 5th ed. New Delhi: Narosa Publication.
4. Saff, E. B. & Snidder, A. D. (2002). *Fundamental of Complex Analysis with Applications to* *Engg. and Science*: 3rd Ed.. New Delhi: Pearson Education.
5. David, W. A. (2009). *Complex Variables with Applications*: 5th ed. New Delhi: Pearson Education.

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| **Course:** **Linear Algebra** | | | Semester: IV |
| Course Code: BMAT 2203 | L T P | 3 0 0 | Credits: 3 |

**Objective:** To demonstrate competence with the basic ideas of linear algebra including concepts of Vector space and Inner product space, independence, theory of matrices, linear transformations, bases and dimension, Eigen-values, Eigen-vectors and Diagonalization.

**Syllabus**

**Vector Space**  10

Definition, examples and basic properties of a vector space. Subspaces. Linear independence. Linear combinations and span. Basis and dimension. Sum and intersection of subspaces. Direct sum of subspaces.

**Transformations of Vector Space**  10

Definition and examples of linear transformations. Properties of linear transformations. Rank and kernel. The rank and nullity of a matrix. Rank-Nullity Theorem and its consequence. The matrix representation of a linear transformation. Change of basis. Isomorphism.

**Inner Product Space**  10

Scalar product in and Inner product spaces. Orthogonality in inner product spaces. Normed linear spaces. Inner product on complex vector spaces. Orthogonal complements. Orthogonal sets and the Gram-Schmidt process. Unitary matrices.

**Matrix Algebra**  10

Eigenvalues and eigen vectors. Characteristic equation and polynomial. Eigenvectors and eigenvalues of linear transformations and matrices. The Caley-Hamilton Theorem. Similar matrices and diagonalization. Eigenvalues and eigenvectors of symmetric and Hermitian matrices. Orthogonal diagonalization. Quadratic forms and conic sections.

**Suggested Readings**

1. Hoffman & Kunze, (1972). *Linear Algebra*: 3rd ed. New Delhi: Prentice Hall of India.
2. Vasishtha, A. R., Sharma, J. N. & Vasishtha, A. K. (2012). *Linear Algebra*: 14th ed. Meerut: Krishna Prakashan Media
3. Gupta, K. P. (2016). *Linear Algebra*: 12th ed. Meerut: Pragati Prakashan.
4. David, C. L. (2007). *Linear algebra and its applications,* 3rd ed. New Delhi: Pearson Education asia, Indian Reprint.
5. Nakos, G. & Joyner D. (1998). *Linear algebra with Applications*: 1st ed. Singapore: Cole Publishing Company, International Thomson Publishing, Asia.
6. Stephen, H. F, & Arnold J. I. (2014). *Space-* *Linear Algebra:* 4th ed. New Delhi: Prentice Hall of India.
7. Krishnamurty, V., Mainra, V.P., & Arora, J. L. (2002). *An introduction to Linear Algebra*: 1st ed. New Delhi: East West Press.

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| **Course:** **Integral Transformations** | | | Semester: IV |
| Course Code: BMAT 2204 | L T P | 3 0 0 | Credits: 3 |

**Objective:** To present the foundations of many basic Mathematical transformation tools and concepts related to Engineering.

**Syllabus**

**Laplace Transformation**  10

Introduction, Laplace Transform, Important formulae, Laplace Transform of the derivative of f(t), Laplace Transform of derivative of order n . Laplace Transform of integral of f(t). Laplace transform of t.f(t) , f(t)/t, Unit step function, Second shifting Theorem , Periodic Functions, convolution Theorem , Evaluation of integrals.

**Inverse Laplace Transformation**  10

Multiplication by s , Division by s , First shifting property, Second shifting property , Inverse Laplace transform of Derivatives Inverse Laplace transform of integrals, Partial fraction method , Inverse Laplace transform by convolution , Solution of differential equations by Laplace transforms , Solution of Simultaneous differential equations by Laplace Transforms.

**Fourier Transformation**  15

Fourier Integral Theorem (statement only), Fourier Transform of a function, Fourier Sine and Cosine Integral Theorem (statement only), Fourier Cosine & Sine Transforms. Fourier, Fourier Cosine & Sine Transforms of elementary functions.

Properties of Fourier Transform: Linearity, Shifting, Change of scale, Modulation. Examples. Fourier Transform of Derivatives. Examples. Convolution Theorem (statement only), Inverse of Fourier Transform, Examples.

**Z Transformation**  5

Z- Transformation, Inverse Z – Transformations, Properties, Initial and final value theorems, convolution theorem, Difference equations, solution of difference equations using Z- Transformation

**Books Recommended**

1. Sneddon, I.N. (1972). *The use of Integral Transforms*. New York: McGraw Hill, 1972.
2. Vasistha, A. R. & Gupta R. K.; *Integral Transforms*; Meerut: Krishna Prakashan.
3. Churchill, R. V.; *Operational Mathematics*; New Delhi: Mc Graw Hill Publishing.
4. Davies & Brian, *Integral Transforms and Their Applications*, New Delhi: Springer.
5. Goyal, J. K. & Gupta K. P., *Integral Transforms*, Meerut: Pragati Prakashan.

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| **Course:** **Number Theory and Trigonometry** | | | Semester: IV |
| Course Code: BMAT 2205 | L T P | 3 0 0 | Credits: 3 |

**Objective:** To present a rigorous development of Number Theory using axioms, definitions, examples, theorems and their proofs to enable students to effectively express the concepts and results of Number Theory and to construct mathematical proofs of statements and find counter examples to false statements in Number Theory.

**Syllabus**

**Divisibility**  10

G.C.D.(greatest common divisors), L.C.M.(least common multiple) Primes, Fundamental Theorem of Arithemetic. Linear Congruences, Fermat’s theorem. Wilson’s theorem and its converse. Linear Diophanatine equations in two variables.

**Residue system 10**

Complete residue system and reduced residue system modulo m. Euler’s ø function Euler’s generalization of Fermat’s theorem. Chinese Remainder Theorem. Quadratic residues. Legendre symbols. Lemma of Gauss; Gauss reciprocity law. Greatest integer function [x]. The number of divisors and the sum of divisors of a natural number n (The functions d(n) and V(n)). Moebius function and Moebius inversion formula.

**Trigonometrically functions 10**

De Moivre’s Theorem and its Applications. Expansion of trigonometrical functions. Direct circular and hyperbolic functions and their properties.

**Trigonometry series 10**

Inverse circular and hyperbolic functions and their properties. Logarithm of a complex quantity. Gregory’s series. Summation of Trigonometry series.

**Suggested Readings**

1. Jones, G. A. & Jones, J. M. (2007). *Elementary Number Theory*, Springer UTM.
2. Niven, Zuckerman, H. S & Montgomery, H. L. (2000). *Introduction to the Theory of Numbers*, New Delhi: Wiley, 2000.
3. Burton (2005). *Elementary Number Theory*, New Delhi: Tata McGraw-Hill.
4. Loney S. L., *Plane Trigonometry Part – II*, London: Macmillan and Company.
5. Verma, R. S. & Sukla, K. S., *Text Book on Trigonometry*, Allahabad: Pothishala Pvt. Ltd.
6. Ninen, Ivan and Zuckerman, H. S. (1991), *An Introduction to the Theory of Numbers*: 5th Ed., New Delhi: Willey.

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| **Course:** **Numerical Analysis** | | | Semester: IV |
| Course Code: BMAT 2206 | L T P | 3 0 0 | Credits: 3 |

**Objective:**  To familiarize the students with ideas of convergence analysis of numerical methods and other analytical aspects associated with numerical computation, role of approximation theory in the process of developing a numerical recipe for solving an engineering problem and geometric ideas associated with the development of numerical schemes.

**Syllabus**

**Solution of Algebraic and Transcendental Equations**  10

Bisection method, False position method, Fixed-point iteration method, Newton’s method and its convergence, Chebyshev method. Solution of system of non-linear equations by Iteration and Newton-Raphson method. Program in C for Bisection method, False position method and Newton’s method.

**Interpolation**  10

Finite difference operators and finite differences; Interpolation and interpolation formulae: Newton’s forward and backward difference, Central difference: Sterling’s and Bessel’s formula, Lagrange’s interpolation formula and Newton’s divided difference interpolation formula, Hermite interpolation. Program in C for Newton’s forward and backward formula, Newton’s divided difference formula.

**Direct Methods to Solve System of Linear Equations**  10

Gauss elimination method, Gauss-Jordan method, LU decomposition; Indirect methods: Gauss-Jacobi and Gauss-Seidal methods. The algebraic eigen value problems by Householder and Power method. Algorithms and program in C for Gauss-Jacobi and Gauss-Seidal method.

**Numerical Differentiation and Numerical Integration**  10

Newton cotes formulae, Trapezoidal rule, Simpson’s rule, Romberg formula and their error estimation. Numerical solution of ordinary differential equations by Euler’s method, Picard’s method, Taylor series and Runge-Kutta methods. Program in C for Trapezoidal and Simpson’s rule.

**Suggested Readings**

1. Gerald, F. & Wheatley, P. O. (2008), *Applied Numerical Analysis*, 7th ed. New Delhi: Pearson Education, India.
2. Bradie B., (2007). *A Friendly Introduction to Numerical Analysis*, New Delhi: Pearson Education, India.
3. Goyal, M. (2012). *Computer Based Numerical and Statistical Techniques*; 3rd ed. New Delhi: University Science Press.
4. Jain, M. K.; Iyengar, S. R. K. & Jain R. K. (2007). *Numerical Methods for Scientific and* *Engineering Computation*, 5thed. New age International Publisher, India.

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| **Course:** **Numerical Methods Using C, C++** | | | Semester: IV |
| Course Code: BMAL 2201 | L T P | 0 0 2 | Credits: 1 |

**Objective:** To gain an understanding of the algorithms and pitfalls encountered when performing numerical operations on computational systems and to gain practical programming experience with C/C++ and MATLAB, including algorithm design and the proper understanding and use of available numerical algorithms.

Practical /Programs based on methods covered in the syllabus. There should be minimum 10 programs.

**List of Practical:**

1. Develop a C program to find a root of a non-linear equation using **Bisection method**.
2. Develop a C program to find a root of a non-linear equation using **False Position method.**
3. Develop a C program to find a root of a non-linear equation using **Secant method.**
4. Develop C program to find a root of a non-linear equation using **Newton-Raphson method.**
5. Develop a C program to find a root of a non-linear equation using **Barirstow's method**
6. Develop a C program to implement **Simpsons 1/3rd Rule.**
7. Develop a C program to solve linear equation using **Gauss Elimination method.**
8. Develop a C program to solve linear equation using **Gauss Seidel method**.
9. Develop a C program to compute the **Gauss Jacobi Interactive methods**
10. Develop a C program to compute the interpolation value using **Newton’s Forward Difference formula.**

**Semester V**

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| **Course:** **Real** **Analysis – II** | | | Semester: V |
| Course Code: BMAT 3101 | L T P | 3 1 0 | Credits: 4 |

**Objective:** To introduce students to functions, sequences and series in n-dimensional real space and the concept of distance between sets in a metric space.

**Syllabus**

**Riemann Integral 10**

The Riemann Integral and its properties. Integrability of continuous and monotonic functions. Functions of bounded variation, their relation with monotonic functions, and integrability.

**Sequence and series of functions**  **8**

Point wise convergence, Uniform convergence, and its relation to continuity, integration, and differentiation. Weierstrass M-test. The fundamental theorem of calculus. Mean value theorems of integral calculus. Convergence of improper integrals. Comparison tests, Abel's and Dirichlet's tests.

**Function of Several Variables**  **7**

Limit and continuity for Function of two and three variables. Partial derivatives. Sufficient condition for continuity. Relevant results regarding repeated limits and double limits, Differentiability and its sufficient condition, differential as a map, chain rule, Euler’s theorem and its converse.

**Metric Space**  **8**

Definition and examples, neighbourhoods, limit points, interior, and boundary points. Open and closed sets. Closure, interior, and boundary of a set. Subspaces. Cauchy sequences and complete spaces. Cantor's intersection theorem and the contraction mapping principle. Dense and nowhere dense subsets. Baire Category Theorem.

**Fourier Series 7**

Introduction, Euler’s Formulae for Fourier Series, Fourier Series for functions of period 2π, Fourier Series for functions of period 2l, Dirichlet’s conditions, Sum of Fourier series. Fourier Series of even and odd functions. Half Range Fourier Series: Sine Series, Cosine Series.

**Suggested Readings**

1. Bartle, R. G. & Sherbert, D. R., (2002). *Introduction to Real Analysis:* 3rd ed. Singapore: John Wiley and Sons (Asia) Pvt Ltd.
2. Malik, S. C. & Arora S. (2017). *Mathematical Analysis*: 5th ed. New Delhi: New Age International.
3. Saran, N. (2014). *Theory of Function of Real Variable*: 15th ed. Meerut: Pragati Prakashan.
4. Ross, K. A. (2004). *Elementary Analysis,* *The Theory of Calculus, Under graduate Texts in* *Mathematics*, New Delhi: Springer (SIE), Indian reprint.
5. Vashishtha, A. R. & Sharma, J. N. (2014), *Real Analysis*: 43rd ed. Meerut: Kishna Prakashan.
6. Ghorpade, S. R & Limaye, B. V. (2004). *A course in Calculus and Real Analysis,* *Undergraduate Text in Math:* 3rd ed*.* New York: Springer-Verlag.
7. Apostol, T. M. (1974). *Mathematical Analysis*: 2nd ed. New Delhi: Addison-Wesley Series.

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| **Course:** **Finite Element Methods** | | | Semester: V |
| Course Code: BMAT 3102 | L T P | 3 1 0 | Credits: 4 |

**Objective:** To apprise the students about the basics of the Finite Element Technique and a numerical tool for the solution of different classes of problems in solid mechanics. Different application areas will be dealt with after introducing the basic aspects of the method.

**Syllabus**

**Introduction to finite element methods 10**

comparison with finite difference methods, Methods of weighted residuals, collocations, least squares and Galerkin’s method. Variational formulation of boundary value problems equivalence of Galerkin and Ritz methods.

**Finite element methods for ODE 10**

Applications to solving simple problems of ordinary differential equations, Linear, quadratic and

Higher order elements in one dimensional and assembly, solution of assembled system.

**Finite element methods in Higher Dimension 10**

Simplex elements in two and three dimensions, quadratic triangular elements, rectangular elements, serendipity elements and isoperimetric elements and their assembly, discretization with curved boundaries.

**Finite element methods for PDE 10**

Interpolation functions, numerical integration, and modeling considerations, Solution of two dimensional partial differential equations under different Geometric conditions.

**Suggested Readings**

1. Reddy, J. N (2005). *Introduction to the Finite Element Methods*: 3rd ed. New Delhi: Tata McGraw Hill.
2. Bathe K. J. (2014). *Finite Element Procedures*: 2nd ed. New Delhi: Prentice Hall India.
3. Cook, R. D.; Malkus, D. S. &. Plesha, M. E. (2008). *Concepts and Applications of Finite Element Analysis*: 4th ed. New Delhi: John Wiley and Sons.
4. Hughes Thomas J. R. (2003), *The Finite Element Method: Linear Static and Dynamic Finite Element Analysis*: 1st ed. New Delhi: Dover Publication.
5. Buchanan George R. (1995). *Finite Element Analysis (*Schaums' Outline Series), New Delhi: Tata McGraw Hill.
6. Reddy J. N. (2005). *An Introduction to the Finite Element Method*: 3rd ed. New Delhi: Tata McGraw-Hill.
7. Logan D. L. (2012), *A First Course in the Finite Element Method, Thomson- Engineering:* 5th ed. New Delhi: Cengage Learning India Private Limited.

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| **Course:** **Tensor Calculus** | | | Semester: V |
| Course Code: BMAT 3103 | L T P | 3 0 0 | Credits: 3 |

**Objective:** To introduce students to the fundamentals of vector and tensor algebra and their applications in handling diverse problems which occur in real life situations.

**Syllabus**

**Systems of Different orders 15**

Summation Convention Kronecker Symbols -Transformation of coordinates in Sn –Invariants, Covariant and Contravariant vectors, Tensors of Second Order, Mixed Tensors, Zero Tensor-Tensor Field, Algebra of Tensors, Equality of Tensors, Symmetric and Skew, symmetric tensors, Outer multiplication, Contraction and Inner Multiplication -Quotient Law of Tensors, Reciprocal Tensor of Tensor, Relative Tensor, Cross Product of Vectors.

**Types of Tensors 10**

Contravariant and covariant vectors. Invariants. Contravariant, covariant and mixed tensors. The Kronecker delta. Algebra of tensors Symmetric and skew-symmetric tensors. Addition and scalar multiplication. Contraction. Outer and Inner products of tensors. Quotient law. Reciprocal Tensor.

**Riemannian space 8**

Line element and metric tensor. Reciprocal metric tensor. Raising and lowering of indices with the help of metric tensor. Associated tensor. Magnitude of a vector. Inclination of two vectors. Orthogonal vectors.

**Christoffel symbols 7**

Christoffel symbols and their laws of transformations. Covariant differentiation of vectors and tensors. Riemann-Christoffel Curvature Tensor,Intrinsic Differentiation.

**Suggested Readings**

1. Borisenko, A. I.; Tarapov, I. E. & Silverman, R. A. (1980), *Vector and Tensor Analysis with Applications:* 1st ed. New Delhi: Dover Publications Inc.
2. Kay. D. C. (2011). *Schaums Outline of Tensor Calculus:* revised ed. New Delhi: McGraw-Hill Education.
3. Shaikh, A. A. & De, U.C. (2008). *Tensor Calculus:* 1st ed. New Delhi: Narosa Book Distributors.
4. Islam, N. (2006). *Tensors & their Applications*: 1st ed. New Delhi: New Age International.

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| **Course:** **Object Oriented Programming** | | | Semester: V |
| Course Code: BMAT 3104 | L T P | 3 0 0 | Credits: 3 |

**Objective:** To Understand fundamentals of object-oriented programming in Java, including defining classes, invoking methods, using class libraries, etc.

**Syllabus**

**Object Modeling** **8**

Objects and classes, links and association, generalization and inheritance, aggregation, abstract class, multiple inheritance, meta data, candidate keys, constraints. Dynamic Modeling: Events and states, operations, nested state diagrams and concurrency, advanced dynamic modeling concepts, a sample dynamic model.

**Functional Modeling** **8**

Data flow diagram, specifying operations, constraints, a sample functional model.OMT (object modeling techniques) methodologies, examples and case studies to demonstrate methodologies, comparisons of methodologies, SA/SD, JSD.

**Java Programming** **8**

Introduction, Operator, Data types, Variables, Methods & Classes, Multithread Programming, I/O, Java Applet.

**Java Library** **8**

String Handling, Input/Output exploring Java.io, Networking, Exception Handling, Event Handling, Introduction to AWT, Working with window, Graphics, AWT Controls, Layout Manager and Menus, Images.

**Software Development using Java**  **8**

Java Swing, Migrating from C++ to java, Application of java, JDBC.

**Suggested Readings**

1. Herbert, S. (2014). *Java*: *The Complete Reference: 9*th ed. New Delhi: Tata Mc Graw Hil.

2. Balagurusamy E. (2014). *Programming in JAVA*: 5th ed. New Delhi: Tata Mc Graw Hil.

# 3. Booch (2009). Object-Oriented Analysis and Design with Applications, New Delhi: Prentice Hall of India.

4. Stroustrup Bjarne (2002). *C++ Programming Language*, 3rd ed., New Delhi: Addison Wesley.

5. Balagurusamy E. (2008), *Object Oriented Programming with C++*, New Delhi: Tata Mc Graw Hil.

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| **Course:** **Mathematical Software Practical- MATLAB** | | | Semester: V |
| Course Code: BMAL 3101 | L T P | 0 0 2 | Credits: 1 |

**Objective:** To introduces MATLAB programming, and demonstrate its use for scientific computations. The basics of simulation technique would make students to build computer model.

**Syllabus**

**MATLAB basics:**

The MATLAB environment - Basic computer programming - Variables and constants, operators and simple calculations - Formulas and functions - MATLAB toolboxes

**Matrices and vectors:**

**-** Matrix and linear algebra review - Vectors and matrices in MATLAB - Matrix operations and functions in MATLAB

**Computer programming:**

Algorithms and structures - MATLAB scripts and functions (m-files) - Simple sequential algorithms - Control structures (if…then, loops)

**MATLAB programming:**

Reading and writing data, file handling - Personalized functions - Toolbox structure - MATLAB graphic functions

**Numerical simulations:**

Numerical methods and simulations - Random number generation - Montecarlo methods

**Suggested Reading:**

1. Moore, H. (2009). *MATLAB for Engineers:* 4th ed. New Delhi: Pearson.

# Pratap, R. (2010). *Getting Started With Matlab Quick Introduction For Scientists And Engineers*, 5th ed. New Delhi: Oxford University Press.

# Ahlersten, K., *An Introduction to Matlab*, Available: http://bookboon.com/no/an-introduction-to-matlab-ebook.

# Bansal, R. K., Goel A. & Sharma, M. Kumar (2009), *MATLAB and Its Applications in Engineering:* 2nd ed*.* New Delhi: Pearson Education India.

# Alam, S. N., Alam S. S. (2013). *Understanding Matlab: A Textbook for Beginners*: 2nd ed. New Delhi: I K International *Publishing* House Pvt. Ltd.

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| **Course:** **Operations Research (Elective for Semester V)** | | | Semester: V |
| Course Code: BMAT 3105 | L T P | 3 0 0 | Credits: 3 |

**Objective:** To familiarize the students with standard methods of optimization problems.

**Syllabus**

**Linear Programming Problem 15**

Convex sets and their properties. Lines and hyper planes convex set Important Theorems,polyhedral convex set Convex combination of vectors, convex hull, Convex polyhedron, convex cone, simplex and convex function, General formulation of linear programming Matrix form of LP problem, definitions of standard LPP., Fundamental Theorem of linear programming. Simplex method, computational procedure of simplex method, problem of degeneracy and method to resolve degeneracy.

**Duality in LPP 8**

Revised simplex method in standard form I, Duality in linear programming dualitytheorems, Integer linear programming, Gomory’s cutting plane method, Branch and Bound method.

**Dynamic programming** **10**

Bellman’s principle of Optimality, solution of problems with afinite number of stages. Application of dynamic programming in production, inventory control and linear programming.

**Non linear programming** **7**

Non linear programming unconstrained problems of maximum and minimumLagrangian method Kuhn Tucker necessary and sufficient conditions, Wolfe’s method, Beale’s method

**Suggested Readings**

1. Hillier & Lieberman (2004). *Introduction to Operations Research*: 8th ed. Tata McGraw Hill Publisher.
2. Sharma, S.D. (2014), *Operations Research:* 15th ed. Meerut: Kedarnath Ramnath & Co.
3. Swarup, K., Gupta, P. K. & Manmohan, *Operations research*, S.Chand & Co.
4. Taha, H. (2010). *Operations Research* *–* *An Introduction*: 9th ed. New Delhi: Prentice Hall
5. Gupta, R. K. (2014). *Operations Research*: 8th ed. Meerut: Krishna Prakashan Mandir.
6. Sharma, J. K. (2009). *Operations Research* *–* *Theory and Application*: 4th ed. New Delhi: Laxmi Publication.
7. Hadly, G. (2002). *Linear Programming*: 5th ed. New Delhi: Narosa Publishing House.

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| **Course:** **Topology (Elective for Semester V)** | | | Semester: V |
| Course Code: BMAT 3106 | L T P | 3 0 0 | Credits: 3 |

**Objective:** To explore the foundations of mathematics (logic and set theory) at a level and depth appropriate for someone aspiring to study higher-level mathematics and/or to become a professional mathematician and to present an introduction to the field of topology, with emphasis on those aspects of the subject that are basic to higher mathematics.

**Syllabus**

**Basic concepts in Topology 10**

Topology on a set, a topological space with examples, topologies on the real number system, the extended real line, the discrete 2- spaces, and various other examples.

**Topological Space 8**

Neighbourhood of a point/set, open and closed sets, interior, boundary, closure, limit point, derived set of a set. Base and sub - base of a topology. Separable space, first, and second countable space.

**Mapping in Topology 10**

Continuous map, open and closed maps, homomorphism, topological invariants, Pasting lemma, Subspaces, product of two spaces, arbitrary product spaces, quotient of a space, cylinder, cone, reduced suspension of a space, the unit closed interval, I=[0,1] of the real line, the Euclidean n- space, the unit circle and the n-sphere, n-torus, the projective n-spaces.

**Compact space 7**

Compactness, Compact space, Properties of compact spaces, compactness of a metric space. Connectedness, connected space, path connected space, components.

**Separation axioms 5**

T1, T2, T3, T3½, T4, regular, completely regular and normal space.

**Suggested Readings**

1. Munkres, J. R. (2002). *Topology*: 2nd ed. New Delhi: Narosa Publishing House.
2. Seymour, Lipschutz (2011). *Shaum’s outlines series of Topology*: 5th ed. New Delhi: Tata McGraw Hill.
3. Joshi, K. D. (1983). *Introduction to General Topology*: 1st ed. New Delhi: Wiley Eastern, 1983.
4. Simmons, G. F. (2004). *Introduction to Topology and Modern Analysis*: 1st ed. New Delhi: Tata McGraw Hill.
5. Gupta, K. P. (2015). *Topology*: 22nd ed. Meerut: Pragati Prakashan.

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| **Course:** **Special Function (Elective for Semester V)** | | | Semester: V |
| Course Code: BMAT 3107 | L T P | 3 0 0 | Credits: 3 |

**Objective:** To analyze properties of special functions by their integral representations and symmetries and to classify differential equations by their singularities to obtain properties of solutions of PDE by their symmetries.

**Syllabus**

**Gamma and Beta Functions 8**

The Euler or Mascheroni Constant γ, Gamma Function, A series for Г' (z) / Г (z), Difference equation Г(z+1) = zГ(z), Euler's integral for Г(z), Beta function, value of Г(z) Г(1=z).

**Hypergoemetric and Generalized Hypergeometric functions 8**

Function 2F1 (a, b; c; z) A simple integral form evaluation of 2F1 (a, b; c; z) Contiguous function relations, Hypergeometrical differential equation and its solutions , F (a, b; c; z) as function of its parameters, Elementary series manipulations, Simple transformation, Relations between functions of z and 1 –z

**Bessel function and Legendre polynomials 8**

Definition of Jn (z), Bessel's differential equation, Generating function, Bessel's integral with index half and an odd integer, Generating function for Legendre polynomials Rodrigues formula, Bateman's generating function, Additional generating functions, Hypergeometric forms of Pn (X) , Special properties of Pn(X), Some more generating functions, Laplace's first integral form, Othergonality.

**Hermite polynomial 8**

Definition of Hermite polynomials Hn(x), Pure recurrence relations, Differential recurrence relations, Rodrigue's formula, Other generating functions, Othogonality, Expansion of polynomials, more generating functions.

**Laguerre Polynomials 8**

The Laguerre Polynomials Ln(X), Generating functions, Pure recurrence relations, Differential recurrence relation, Rodrigo's formula, Orthogonal, Expansion of polynomials, Special properties, Other generating functions.

**Suggested Readings**

1. Rainville, E. D (1971). *Special Functions*: 1st ed. New York: Chelsea Pub Co.
2. Srivastava, H. M., Gupta K.C. and Goyal S. P. (1986). *The H functions of One and Two Variables with applications*: 1st ed. New Delhi: South Asian Publication,.
3. Saran, N. & Sharma, S. D. (1986). *Special Functions with application*: 1st ed. Meerut: Pragati prakashan.
4. Lebdev, N. N. (1995). *Special Functions and Their Applications*: 1str ed. New Jersey: Prentice Hall, Englewood Cliffs.
5. Mathai and Saxena(1973). *Generalized Hypergeometric function with Application Statistics and physical Sciences*: Lecture Notes No 348, New York: Springer Verlag.

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| **Course:** **Financial Mathematics (Elective for Semester V)** | | | Semester: V |
| Course Code: BMAT 3108 | L T P | 3 0 0 | Credits: 3 |

**Objective:** To Introduce the main theme of mathematical finance, financial markets terminology, time value of money, bonds and bonds pricing, yield, term structure of interest rates, financial instruments, types of derivatives and concept of arbitrage.

**Syllabus**

**Basic principles 10**

Comparison, arbitrage and risk aversion, Interest (simple and compound, discrete and continuous), time value of money, inflation, net present value, internal rate of return (calculation by bisection and Newton-Raphson Methods), comparison of NPV and IRR. Bonds, bond prices and yields.

**Interest Rate 10**

Macaulay and modified duration, term structure of interest rates: spot and forward rates, explanations of term structure, running present value, floating-rate bonds, immunization, convexity, putable and callable bonds.

**Returns 10**

Asset return, short selling, portfolio return, (brief introduction to expectation, variance, covariance and correlation), random returns, portfolio mean return and variance, diversification, portfolio diagram, feasible set, Markowitz model (review of Lagrange multipliers for 1 and 2 constraints).

**Fund Theorems 10**

Two fund theorem, risk free assets, One fund theorem, capital market line, Sharpe index. Capital

Asset Pricing Model (CAPM), betas of stocks and portfolios, security market line, use of CAPM in investment analysis and as a pricing formula, Jensen’s index.

**Suggested Readings**

1. Luenberger, David, G. (2013). *Investment Science*: 2nd ed. New Delhi: Oxford University Press.
2. Hull & John, C. (2014). *Futures and Other Derivative*: 9th ed. New Delhi: Prentice-Hall India, 2006.
3. Ross, Sheldon. *An Elementary Introduction to Mathematical Finance*: 3rd ed. New York: Cambridge University Press, USA.
4. Clarence H. Richardson (2008). *Financial Mathematics*: 1st ed. Vancouver: Read Books.
5. Kevin J. Hastings (2015). *Introduction to Financial Mathematics*: 1st ed. London: Chapman and Hall/CRC.

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| **Course:** **Mathematical Modelling (Elective for Semester V)** | | | Semester: V |
| Course Code: BMAT 3109 | L T P | 3 0 0 | Credits: 3 |

**Objective:** To introduce Mathematical Modelling, that is, the construction and analysis of Mathematical Models inspired by real life problems. The course will present several Modelling techniques and the means to analyze the resulting systems.

**Syllabus**

**Introduction to Mathematical Modeling 15**

Modeling process, Elementary mathematical models; Role of mathematics in problem solving. Single species population model: The exponential model and the Logistic model, Harvesting model and its critical value.

**Modeling with Ordinary Differential Equations 15**

Overview of basic concepts in ODE and stability of solutions: steady state and their local and global stability; Some applications in Epidemiology and ecology.

**Modeling with Difference Equations 10**

Overview of basic concepts concerning matrices, Eigen-values and Eigenvectors; Fixed points, stability and iterative processes; Applications to population growth.

**Suggested Readings**

1. Kapur, J. N. (2008), *Mathematical Modelling: 8th ed.* New Delhi: New Age International Pub.
2. Kapur, J. N. (1980). *Mathematical Models in Biology and Medicine*: 1st ed. New Delhi: East-West Press
3. Fred B. & Carlos, C. C. (2011). *Mathematical Models in Population Biology and Epidemiology*, New York: Springer.
4. Frank, R. G., William P. F. & Maurice D. W. (2008). *A First Course in Mathematical Modelling*, 4th ed., New Delhi: Cengage Learning.
5. Walter, J. M. (2004). *Concept of Mathematical Modelling*, New Delhi: Dover Publications.

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| **Course:** **Calculus of Variation and Integral Equation (Elective for Semester V)** | | | Semester: V |
| Course Code: BMAT 3110 | L T P | 3 0 0 | Credits: 3 |

**Objective:** To know different kinds of kernels and techniques for solving each kind, to know number of numerical methods for solving integral equations and the relation between differential and integral equations, and how to change from one to another.

**Syllabus**

**Basics of Calculus of Variation 8**

Functionals and extremals, Necessary and sufficient conditions for extrema, variation and its properties.

**Boundary Value Problem 8**

Euler equations, cases of several dependent and independent variables, variational methods for boundary value problems in ordinary and partial differential equations, functionals dependent on higher derivatives, parametric forms, pimple applications.

**Integral Equation 8**

Classification of linear integral equations, relation between differential and integral equations. Volterra Integral Equation of first kind.

**Fredholm Integral Equations 8**

Fredholm equations of second kind with separable kernels, Fredholm alternative theorem, Eigen values and Eigen functions.

**Successive Approximation 8**

Method of successive approximation for Fredholm and Volterra equations, Resolvent kernel.

**Suggested Readings**

1. Elsgotc, L. (2003). *Differential Equations and Calculus of Variations:* 1st ed. Honolulu: University Press of the Pacific.
2. Gupta, A. S. (1999). *Calculus of Variations*: 3rd ed. New Delhi: Prentice Hall of India.
3. Chambers, L. G. (1976). *Integral Equations A short Course*: 1st ed. Germany: Int. Text Book company Ltd.
4. Abdul, J. J. (1999). *Introduction to Integral Equations with Applications*, New Delhi: Addison-Wesley.
5. Kumar, N. (2004). *An Elementary Course on Variational Problems in Calculus*, New Delhi: Narosa.
6. Cordumeanu, C. (1991). *Integral Equations and Applications:* 1st Reissue ed. Cambridge: Cambridge University Press, 1991.

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| **Course:** **Bio Mathematics (Elective for Semester V)** | | | Semester: V |
| Course Code: BMAT 3111 | L T P | 3 0 0 | Credits: 3 |

**Objective:** To familiarize students about a bridging step, that is undertaing a mathematical treatment of something biological, that would facilitated mathematical representation or model of the biological entity.

**Syllabus**

**Mathematical Biology and the Modeling process** **10**

An overview. Continuous models: Malthus model, logistic growth, Allee effect, Gompertz growth, Michaelis-Menten Kinetics, Holling type growth, Bacterial growth in a Chemostat, Harvesting a single natural population, Prey predator systems and Lotka Volterra equations, Populations in competitions, Epidemic Models (SI, SIR, SIRS, SIC), Activator-Inhibitor system, Insect Outbreak Model: Spruce Budworm, Numerical solution of the models and its graphical representation.

**Qualitative analysis of continuous models 10**

Steady state solutions, stability and linearization, multiple species communities and Routh-Hurwitz Criteria, Phase plane methods and qualitative solutions, bifurcations and limit cycles with examples in the context of biological scenario.

**Spatial Models 10**

One species model with diffusion, Two species model with diffusion, Conditions for diffusive instability, Spreading colonies of microorganisms, Blood flow in circulatory system, Travelling wave solutions, Spread of genes in a population.

**Discrete Models 10**

Overview of difference equations, steady state solution and linear stability analysis, Introduction to Discrete Models, Linear Models, Growth models, Decay models, Drug Delivery Problem, Discrete Prey-Predator models, Density dependent growth models with harvesting, Host-Parasitoid systems (Nicholson-Bailey model), Numerical solution of the models and its graphical representation. Case Studies: Optimal Exploitation models, Models in Genetics, Stage Structure Models, Age Structure Models.

**Suggested Readings**

1. Keshet, L. E. (2005). *Mathematical Models in Biology*: 1st ed. Pennsylvania, USA: SIAM.
2. Murray, J. D. (2008). *Mathematical Biology:* 3rd ed. *New York:* Springer.
3. Fung, Y. C. (1993). *Biomechanics*: 2nd ed. *New York:* Springer.
4. Kot, M. (2001). *Elements of Mathematical Ecology*, Cambridge: Cambridge University Press.

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| **Course:** **Portfolio Optimization (Elective for Semester V)** | | | Semester: V |
| Course Code: BMAT 3112 | L T P | 3 0 0 | Credits: 3 |

**Syllabus**

**Objective:** To understand the process of choosing the proportions of various assets to be held in a portfolio, in such a way as to make the portfolio better than any other according to some criterion.

**Syllabus**

**Financial markets 12**

Investment objectives. Measures of return and risk. Types of risks. Risk free assets. Mutual funds. Portfolio of assets. Expected risk and return of portfolio. Diversification.

**Market Theory 12**

Mean-variance portfolio optimization- the Markowitz model and the two-fund theorem, risk-free

assets and one fund theorem, efficient frontier. Portfolios with short sales. Capital market theory.

**Capital Market 12**

Capital assets pricing model- the capital market line, beta of an asset, beta of a portfolio, security

market line. Index tracking optimization models. Portfolio performance evaluation measures.

**Suggested Readings**

1. Reilly, F. K. & Keith (2011). C. B. *Investment Analysis and Portfolio Management*, 10th ed., New Delhi: Cengage.
2. Markowitz, H. M. (2000), *Mean-Variance Analysis in Portfolio Choice and Capital Markets*: revised ed. New York: Blackwell, 1987.
3. Best M. J. (2011), *Portfolio Optimization*, Chapman and Hall, CRC Press, 2010.
4. Luenberger D. G. (2013). *Investment Science*, 2nd ed., London: Oxford University Press, 2013.

**Semester VI**

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| **Course:** **Differential Geometry** | | | Semester: VI |
| Course Code: BMAT 3201 | L T P | 3 0 0 | Credits: 3 |

**Objective:** To provide an introduction to the differential geometry of curves and surfaces in space, both in its local and global aspects, with special emphasis on a geometric point of view, as a basis for further study or for applications.

**Syllabus**

**Space Curve 10**

Definition of space curves, arc length, natural equation of a line. Intersection of curves, intersection of curve and surface, order of contact. Tangent, normal, osculating plane, principal normal and binormal at a point of a curve.

**Surface 10**

Curvature, torsion, Frenet – Serret formulae, plane curves, osculating circle and osculating sphere. Fundamental theorem for space curves. **Surfaces:** Definition of a surface, tangent plane and normal at a point of a surface, surfaces of revolution, conicoids and helicoids.

**Envelopes and developable surfaces 10**

Ruled surfaces, First fundamental form (Metric), metric potentials, direction coefficients and angle between two curves on a surface. Second fundamental form, lines of curvatures, principal curvatures. Meusnier’s theorem, Euler’s theorem, Dupin’s indicatrix, Mean curvature, Gaussian curvature.

**Geodesics and Geodesic Parallels 10**

Geodesic property, Equation of Geodesics, Surface of revolution, Torsion of Geodesic. Curves in Relation to Geodesics: Bonnet’s theorem, Joachimsthal’s theorems, Vector curvature, Geodesic curvature, κg, Other formulae for κg, Bonnet’s formula.

**Suggested Readings**

1. Struik, D. J. (1988). ***Lectures on classical Differential Geometry***, 2nd ed. New Delhi: Addison-Wesley.
2. Willmore, T. J. (1997). ***An Introduction to Differential Geometry***: Revised ed. New Delhi: Oxford Univ. Press, India.
3. Spain, B.; Oliver, & Boyd (1965). ***Tensor Calculus*: 1st ed. New York: Oliver and Boyd.**
4. Somasundaram, D. (2008), ***Differential geometry: A first course***: 4th ed. New York: Narosa.
5. Singh, A. K., Mittal, P. K. (2000). *A Textbook of Differential Geometry*, 10th ed. New Delhi: Har-Anand Publications.

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| **Course:** **Fuzzy Mathematics** | | | Semester: VI |
| Course Code: BMAT 3202 | L T P | 3 0 0 | Credits: 3 |

**Objective:** To provide the fundamentals of classical set theory and fuzzy set theory, to provide an emphasis on the differences and similarities between fuzzy sets and classical sets theories.

**Syllabus**

**Fuzzy Sets : Basics 5**

Classical sets vs Fuzzy Sets – Need for fuzzy sets – Definition and Mathematical representations – Level Sets – Fuzzy functions - Zadeh’s Extension Principle

**Operations on Fuzzy Sets 8**

Operations on [0,1] – Fuzzy negation, triangular norms, t-conforms, fuzzy implications, Aggregation Operations, Fuzzy Functional Equations

**Fuzzy Relations 8**

Fuzzy Binary and n-ary relations – composition of fuzzy relations – Fuzzy Equivalence Relations – Fuzzy Compatibility Relations – Fuzzy Relational Equations

**Possibility Theory 5**

Fuzzy Measures – Evidence Theory – Necessity and Belief Measures – Probability Measures vs Possibility Measures

**Approximate Reasoning 7**

Fuzzy Decision Making  - Fuzzy Relational Inference – Compositional Rule of Inference - Efficiency of Inference  - Hierarchical

**Fuzzy Controllers 7**

Introduction to fuzzy logic controller (FLC), Fuzzy expert systems, classical control theory versus fuzzy control, examples, working of FLC through examples, Details of FLC, Mathematical formulation of FLC, Introduction of fuzzy methods in decision making.

**Suggesting Reading:**

1. Ganesh, M. (2006). *Introduction to Fuzzy Sets and Fuzzy Logic:* 2nd ed. New Delhi: Prentice Hall India.
2. Pundir & Pundir (2015). *Fuzzy Sets and their Applications*: 2nd ed. Meerut: Pragati Prakashan
3. Klir, G. J. and Yuan, B. (1995). *Fuzzy sets and Fuzzy Logic–Theory and Applications:* 1st ed. New Delhi: Prentice Hall India.
4. Ross, T. J. (2010), *Fuzzy Logic with Engineering Applications*: 3rd ed. New Delhi: Wiley-Blackwell.

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| **Course:** **Mechanics** | | | Semester: VI |
| Course Code: BMAT 3203 | L T P | 3 0 0 | Credits: 3 |

**Objective:** To familiarize the students with the various topics viz. conservation laws, virtual work, dynamics of rigid bodies and canonical transformation in the framework of Newtonian Mechanics.

**Syllabus**

**Virtual Work 10**

Generalized coordinates. Virtual work. D’Alemberts principle. Unilateral and bilateral constraints. Holonomic and Non-holonomic systems. Scleronomic and Rheonomic systems.

**Motion in Conservative Fields 10**

Lagrange’s equations of first and second kind. Uniqueness of solution. Energy equation for conservative fields. Euler’s dynamical equations. Rotating coordinate system. Motion related to rotating earth. Faucaull’s pendulum and torque free motion of a rigid body about a fixed point. Motion of a symmetrical top and theory of small vibrations.

**Hamilton’s Variables 10**

Hamilton canonical equation. Homogeneity of space and time conservation principles, Noethers theorem.Cyclic coordinates. Routh’s equations. Hamilton’s principle. Principle of least action. Poisson’s Bracket. Poisson’s identity. Jacobi-Poisson Theorem. Time dependent Hamilton-Jacobi equation and Jacobi’s Theorem.

**Canonical Transformation 10**

Lagrange Brackets. Condition of canonical character of transformation in terms of Lagrange rackets and Poisson brackets. Invariance of Lagrange brackets and Poisson brackets under canonical transformations.

**Suggested Readings**

1. Chorlton, F. (2004). *A Text book of Dynamics*: 2nd ed. New Delhi: CBS Publishers.
2. Goldstein, H. (2011). *Classical Mechanics*: 5th ed. New Delhi: Pearson Education.
3. Rana, N. C. and Jog P. S. (2001). *Classical Mechanics*: 1st ed. New Delhi: McGraw-Hill.
4. Louis, N. H. & Janet, D. F. (1998). *Analytical Mechanics,* Cambridge: Cambridge University Press
5. Loney, S. L. (2012). *Dynamics of A Particle and of Rigid Bodies:* 2nd ed.New Delhi:G. K. Publishers
6. Ramsey, A. S. (1952). *Dynamics Part-1 and 2*: 1st ed. Cambridge: Cambridge University Press.
7. Synge & Griffith (2011). *Principle of Mechanics*: 1st ed. New Delhi: Tata McGraw-Hill.

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| **Course:** **Applications of Algebra (Elective for Semester VI)** | | | Semester: VI |
| Course Code: BMAT 3204 | L T P | 3 0 0 | Credits: 3 |

**Objective:** To disseminate the students with various block designs, coding theory, advanced matrices and application of linear transformations.

**Syllabus**

**Balanced Incomplete Block Designs (BIBD) 8**

Definitions and results, incidence matrix of a BIBD, construction of BIBD from difference sets, construction of BIBD using quadratic residues, difference set families, construction of BIBD from finite fields.

**Coding Theory** 10

Introduction to error correcting codes, linear cods, generator and parity check matrices, minimum distance, Hamming Codes, decoding and cyclic codes. Symmetry groups and color patterns: review of permutation groups, groups of symmetry and action of a group on a set; colouring and colouring patterns, Polya theorem and pattern inventory, generating functions for non-isomorphic graphs.

**Special Types of Matrices 12**

Idempotent, nilpotent, involution, and projection tri diagonal matrices, circulant matrices, Vandermonde matrices, Hadamard matrices, permutation and doubly stochastic matrices, Frobenius- König theorem, Birkhoff theorem. Positive Semi-definite matrices: positive semi-definite matrices, square root of apositive semi-definite matrix, a pair of positive semi-definite matrices, and their simultaneous diagonalization. Symmetric matrices and quadratic forms: diagonalization of symmetric matrices, quadratic forms, constrained optimization, singular value decomposition, and applications to image processing and statistics.

**Applications of Linear Transformations 10**

Fibonacci numbers, incidence models, and differential equations. Least squares methods: Approximate solutions of system of linear equations, approximate inverse of an m×n matrix, solving a matrix equation using its normal equation, finding functions that approximate data. Linear algorithms: LDU factorization, the row reduction algorithm and its inverse, backward and forward substitution, approximate inverse and projection algorithms.

**Suggested Readings**

1. Herstein, I. N. & Winter, D. J. (1990). *Primer on Linear Algebra*, New York: Macmillan Publishing Company.

2. Nagpaul, S. R. & Jain, S. K. (2005). *Topics in Applied Abstract Algebra*, Belmont: Thomson Brooks and Cole.

3. Klima, R. E. Sigmon, Stitzinger, N. E. (2000). *Applications of Abstract Algebra with Maple*, Boca Raton: CRC Press LLC.

4. Lay, D. C. (2007), *Linear Algebra and its Applications*: 3rd ed. New Delhi: Pearson Education Asia, India.

5. Zhang, F. (1999). *Matrix theory*: 1st ed. New York: Springer-Verlag.

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| **Course:** **Cryptography and Coding Theory (Elective for Semester VI)** | | | Semester: VI |
| Course Code: BMAT 3205 | L T P | 3 0 0 | Credits: 3 |

**Objective:**  To introduce information theory, the fundamentals of error control coding techniques and their applications, and basic cryptography and to develope the necessary mathematical skills to analyse the efficiency and security of cryptosystems in a rigorous mathematical setting.

**Syllabus**

**Cryptography Principles 14**

Public Key Cryptography Principles & Applications, Algorithms: RSA, Message Authentication: One way Hash Functions: Message Digest, MD5, SHA1. Public Key Infrastructure: Digital Signatures, Digital Certificates, Certificate Authorities.

**Network Attacks 15**

Buffer Overflow, IP Spoofing, TCP Session Hijacking, Sequence Guessing, Network Scanning: ICMP, TCP sweeps, Basic Port Scans; Denial of Service Attacks: SYN Flood, Teardrop attacks, land, Smurf Attacks.IP security Architecture: Overview, Authentication header, Encapsulating Security Pay Load, combining Security Associations, Key Management. Virtual Private Network Technology: Tunneling using IPSEC.

**Network Management Security 11**

Requirements, Secure Socket Layer, and Secure Electronic Transactions, Network Management Security: Overview of SNMP Architecture- SNMPV1, SNMPV3.Firewall Characteristics & Design Principles, Types of Firewalls: Packet Filtering Router, Application Level Gateway or Proxy, Content Filters, Bastion Host.

**Suggested Readings**

1. Stallings, W. (2013). *Networks Security Essentials: Application & Standards: 5th ed.*New Delhi: Pearson Education.
2. Behrouz, A. F. (2012). *Data Communication and Networking*: 5th ed. New Delhi: Tata McGraw Hill.
3. Stallings, W. (2013). *Cryptography and Network Security, Principles and Practice:* 6th ed. New Delhi: Pearson Education, 2000.

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| **Course:** **Fractional Calculus (Elective for Semester VI)** | | | Semester: VI |
| Course Code: BMAT 3206 | L T P | 3 0 0 | Credits: 3 |

**Objective:** To familiarize students with the real number fractional powers or complex number powers of the differentiation operator and the integration operator.

**Syllabus**

**The Riemann Liouville Fractional Calculus:** **10**

Fractional Integrals of some functions namely binomial function, exponential, the hyperbolic and trigonometric functions, Bessel’s functions, Hyper-geometric function and the Fox’s H-function. Dirichlet’s Formula,

**Derivatives of Fractional Integral: 10**

Derivatives of the Fractional Integral and the Fractional Integral of Derivatives. Laplace Transform of the Fractional integral, Leibniz’s Formula for Fractional Integrals. Derivatives, Leibniz’s Formula of Fractional Derivatives.

**The Weyl Fractional Calculus: 10**

Definition of Weyl Fractional Integral Weyl Fractional Derivatives, A Leibniz Formula for Weyl Fractional Integral and simple applications.

**Fractional Differential Equations: 10**

Introduction, Laplace Transform, Linearly Independent Solutions, Solutions of the homogeneous Equations, Solution of the Non-homogeneous Fractional Differential Equations, Reduction of Fractional Differential Equations to ordinary differential equations. Semi Differential equations.

**Suggested Readings**

1. Oldham, K. B. & Spanier, J. (2006). *The Fractional Calculus: Theory and Applications of Differentiation and Integration to Arbitrary Order*, New Delhi: Dover Publications Inc.
2. Miller, K. S. & Ross, B. (1993). *An Introduction to the Fractional Calculus and Fractional Differential Equations*, New York: Wiley-Blackwell.
3. Herrmann R. (2014). *Fractional Calculus,* *An Introduction for Physicists*, 2nd ed., Singapore: SGP: World Scientific *Publishing* Company, 2014.

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| **Course:** **Boolean Algebra and Automata Theory (Elective for Semester VI)** | | | Semester: VI |
| Course Code: BMAT 3207 | L T P | 3 0 0 | Credits: 3 |

**Objective:** To study of abstract machines and automata, as well as the computational problems that can be solved using them.

**Syllabus**

**Basics of Boolean Algebra 10**

Definition, examples and basic properties of ordered sets, maps between ordered sets, duality principle, lattices as ordered sets, lattices as algebraic structures, sublattices, products and homomorphisms. Definition, examples and properties of modular and distributive lattices, Boolean algebras, Boolean polynomials, minimal forms of Boolean polynomials, Quinn‐McCluskey method, Karnaugh diagrams, switching circuits and applications of switching circuits.

**Alphabets Strings and Languages 10**

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

**Context Free Grammars and Pushdown Automata 10**

Context free grammars (CFG), parse trees, ambiguities in grammars and languages, pushdown automaton (PDA) and the language accepted by PDA, deterministic PDA, Non- deterministic PDA, properties of context free languages; normal forms, pumping lemma, closure properties, decision properties.

**Turing Machines**  **10**

Turing machine as a model of computation, programming with a Turing machine, variants of Turing machine and their equivalence. Undecidability, Recursively enumerable and recursive languages, undecidable problems about Turing machines: halting problem, Post Correspondence Problem, and undecidability problems About CFGs.

**Suggested Readings**

1. Davey, B. A. and Priestley, H. A. (2002). *Introduction to Lattices and Order*: 2nd ed. Cambridge: Cambridge University Press.
2. Edgar, G. G. & Michael M. (2003). *Discrete Mathematics with Graph Theory:* 2nd ed. Singapore: Pearson Education .
3. Rudolf, L. & Günter, P. (2004). *Applied Abstract Algebra*, 2nd ed., Undergraduate Texts in Mathematics, New Delhi: Springer (SIE), Indian reprint.
4. Hopcroft, J. E.; Motwani, R. & Ullman, J. D.b (2001). *Introduction to Automata Theory, Languages,* *and Computation,* 2nd ed., New Delhi: Addison-Wesley.
5. Anderson, J. A. (2006). *Automata Theory with Modern Applications*: 1st ed. Cambridge: Cambridge University Press.

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| **Course:** **Fluid Dynamics (Elective for Semester VI)** | | | Semester: VI |
| Course Code: BMAT 3208 | L T P | 3 0 0 | Credits: 3 |

**Objective:** To understand basic concept of fluid flow and the calculation of various properties of the fluid, such as flow velocity, pressure, density, and temperature, as functions of space and time.

**Syllabus**

**Equation of Fluid Motion 10**

Lagrangian and Eulerian methods, Equation of continuity, Boundary surface, Stream lines, Velocity potential, Euler’s equation of motions, Bernoulli’s theorem, Helmholtz equations, Cauchy’s integral, Equation of motion under impulsive forces, Principal of energy.

**Motion in two dimensions 10**

Velocity potential and current functions, Sources and sinks, Doublet and images, Circle theorem, Motion of circular and elliptic cylinder in two dimensions, Blasius theorem, Joukowski transformation, Motion in three dimensions, Three dimensional sources, Sinks and doublets, Image of source in front of sphere, Motion of spheres, Stroke’s stream function.

**General theory of irrotational motion 7**

Permanence of irrotational motion circulation, Stroke’s theorem, Kelvin’s circulation theorem, Green’s theorem, Kelvin’s minimum energy theorem, Conformal Representation, Kutta and Joukowski transformation, Theorems of Schwartz and Christoffel.

**Vortex motion 6**

Rectilinear vortices, Rectilinear vortex with a circular section, An infinite row of parallel rectilinear vortices, Karman stream, Use of conformal transformation, Vortex pairs.

**Wave Motion 7**

Stationary waves, Long waves, Energy surface waves, Deep-water waves, Progressive waves reduced to steady motion. Waves at the common surfaces of two liquids, Group velocity. General theory of stress strain, Navier-Stroke’s equations.

**Suggested Readings**

1. Rathy, R. K. (1976)., *An introduction to Fluid Dynamics*, London: Oxford & IBH publishing company
2. Raisinghania, M. D. (2003). *Fluid Dynamics:* 5th ed. *New Delhi:* S. Chand Publ.
3. Chorton, F. (1985). *Text book of Fluid Dynamics:* 1st ed.New Delhi: CHS Publishers.
4. Landay, L. D. & Lipschitz E. M. (1985). *Fluid Mechanics*: 1st ed. London: Pergamon Press.
5. Kundu & Cohen (2004). *Fluid Mechanics*: 2nd ed. ‎Amsterdam: Elsevier pub.

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| **Course:** **Artificial Neural Network (Elective for Semester VI)** | | | Semester: VI |
| Course Code: BMAT 3209 | L T P | 3 0 0 | Credits: 3 |

**Objective:** To provide a comprehensive foundation to Artificial Neural Networks and to demonstrate neural network applications on real-world tasks.

**Syllabus**

**Introduction 6**

Neural network, Human Brain, Models of a Neuron, Neural networks viewed as Directed Graphs, Network Architectures, Knowledge Representation, Artificial Intelligence and Neural Networks , Error Correction learning, Memory based learning, Hebbian learing,

**Single Layer Perceptrons 12**

Competitive, Boltzmann learning, Credit Assignment Problem, Memory, Adaption, Statistical nature of the learning process, Adaptive filtering problem, Unconstrained Organization Techniques, Linear least square filters, least mean square algorithm, learning curves, Learning rate annealing techniques, perception –convergence theorem, Relation between perception and

Bayes classifier for a Gaussian Environment

**Multilayer Perceptron 12**

Back propagation algorithm XOR problem, Heuristics, Output representation and decision rule, Computer experiment, feature detection,

*Back Propagation:* back propagation and differentiation, Hessian matrix, Generalization, Cross validation, Network pruning Techniques, Virtues and limitations of back propagation learning, Accelerated convergence, supervised learning.

**Self Organization Maps 6**

Two basic feature mapping models, Self organization map, SOM algorithm, properties of feature map, computer simulations, learning vector quantization, Adaptive patter classification, Hierarchal Vector quantilizer, contexmel Maps.

**Neuro Dynamics 6**

Dynamical systems, stavility of equilibrium states, attractors, neurodynamical models, manipulation of attractors’ as a recurrent network paradigm

**Suggested Reading:**

1. Hhaykin, S. (1998). *Neural networks A comprehensive foundations*, 2nd Ed., New Delhi: Pearson Education.
2. Vegnanarayana B. (2005), *Artificial neural networks*: 2nd ed. New Delhi: Prentice Halll of India.
3. Min, F. L. (2003). *Neural networks in Computer intelligence*, New Delhi: Tata McGraw Hill.
4. Freeman, J. A., Kapura D. M. S. (2004). *Neural networks,* New Delhi: Pearson Education 2004

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| **Course:** **MATHEMATICA (Elective for Semester VI)** | | | Semester: VI |
| Course Code: BMAT 3210 | L T P | 3 0 0 | Credits: 3 |

**Objective:** To learn the basic commands of Mathematica including algebraic manipulation and plotting and to use this knowledge to explore limits numerically, algebraically, and graphically using Mathematica.

**Syllabus**

**Introduction 12**

Introduction to Mathematica and to the Wolfram Language (knowledge-based language, built-in support for real-world entities, Wolfram|Alpha and the Wolfram Demonstrations Project).

Typesetting and presenting your work and data(2D type settingand LaTeX output, 2D/3D charts, deploying interactive documents, 100+ supported file formats for import and export).

**Computation by MATHEMATICA 10**

Numerical and symbolic computations (arbitrary-precision arithmetic and automatic precision tracking, dynamic interactivity).

Lists, strings, rules, patterns and pattern matching. Different programming paradigms (procedural, functional and rule-based).

Graphics and image manipulation(the 30+ members of the plot family, pixels and voxels, the built-in image editor).

**Applications of MATHEMATICA 10**

Linear and polynomial algebra. Exact and numerical optimization. Calculus and differential equations (analytic and numerical solutions of ODEs and PDEs). Plane and solid geometry. Probability and statistics (descriptive statistics, built-in support for 100+ distributions).

**Latex 8**

Introduction, Tables, BibTeX and graphics. Presentations, drawing and programming.

**Suggested Reading:**

1. Wolfram, S. (2003). *The Mathematica Book:* 5th ed. Champaign (USA): Wolfram Media, Inc.

# Wellin, P. (2013). *Programming with Mathematica: An Introduction*: 1st ed. Cambridge: Cambridge Publication.

# Wegon, S. (2010). *Mathematica in Action*, 3rd ed. New York: Springer.

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| **Course:** **Combinatorial Mathematics (Elective for Semester VI)** | | | Semester: VI |
| Course Code: BMAT 3204 | L T P | 3 0 0 | Credits: 3 |

**Objective:** To give an introduction to fundamental combinatorial objects, their uses in other fields of mathematics and its applications, and their analysis.

**Syllabus**

**Introduction 11**

Introduction to Basic ideas. Selection and Binomial Coefficients: Permutations, Ordered selections, Unordered selections, Remarks on Binomial theorem.

**Pairing problems 12**

Pairing within a set, Pairing between sets, an optimal assignment problem, Gale’s optimal assignment problem. Recurrence: Fibonacci type relations, using generating functions, Miscellaneous methods.

**Inclusion-Exclusion principle 10**

The Principle, Rook polynomials. Block Diagram and Error- correction Codes: Block designs, Square block designs,

**Hadamard Configurations 07**

Error Correcting Codes. Steiner Systems. Golay’s Perfect code.

**Suggested Readings**

1. Ian, A. (1989). *A First course in Combinatorial Mathematics*: 2nd ed. New York: Springer.
2. Grimaldi, R. P. (2003). *Discrete Mathematics and Combinatorial Mathematics*: 5th ed. New

Delhi: Pearson Education.

1. Sharad, S. S. (2013). *Combinatorial Techniques*: 2nd ed. New Delhi: Hindustan Book Agency.