

## BS-MS Major in Physics

Semester II						
Sr. No	Course Code	Course Name	L	T	P	C
1	MA 102	<a href="#">Linear Algebra</a>	3	1	0	4
2	MA 103	<a href="#">Differential Equations -I</a>	3	1	0	4
3	CS 201	<a href="#">Data Structures and Algorithms</a>	3	0	0	6
4	CS 211	<a href="#">Data Structures and Algorithms Laboratory</a>	0	0	3	3
5	PH 102	<a href="#">Electricity and Magnetism</a>	2	1	0	6
6	BB 201	<a href="#">Biomolecules</a>	2	1	0	6
7	CH 203	<a href="#">States of matter</a>	3	0	0	3
8	CH 201	<a href="#">Organic chemistry</a>	3	0	0	3
9	CH 113	<a href="#">Hands On Science Laboratory - II</a>	0	0	3	3
10	NO 102/ NO 104	National Sports Organization (NSO)/National Service Scheme (NSS)	0	0	0	PP/NP
		<b>Total Credits</b>				<b>38</b>

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1	<b>Title of the course (L-T-P-C)</b>	<b>Linear Algebra (3-1-0-4)</b>
2	<b>Pre-requisite courses(s)</b>	Nil
3	<b>Course content</b>	Vectors in $\mathbb{R}^n$ , notion of linear independence and dependence, linear span of a set of vectors, vector subspaces of $\mathbb{R}^n$ , basis of a vector subspace. Systems of linear equations, matrices and Gauss elimination, row space, null space, and column space, rank of a matrix. Determinants and rank of a matrix in terms of determinants. Abstract vector spaces, linear transformations, matrix of a linear transformation, change of basis and similarity, rank-nullity theorem. Inner product spaces, Gram-Schmidt process, orthonormal bases, projections and least squares approximation. Eigenvalues and eigenvectors, characteristic polynomials, eigenvalues of special matrices (orthogonal, unitary, Hermitian, symmetric, skew-symmetric, normal). Algebraic and geometric multiplicity, diagonalization by similarity transformations, spectral theorem for real symmetric matrices, application to-quadratic-forms.
4	<b>Texts/References</b>	<ol style="list-style-type: none"><li>1. H. Anton, Elementary linear algebra with applications (8th Edition), John Wiley (1995).</li><li>2. G. Strang, Linear algebra and its applications (4th Edition), Thomson (2006)</li><li>3. S. Kumaresan, Linear algebra - A Geometric approach, Prentice Hall of India (2000)</li><li>4. E. Kreyszig, Advanced engineering mathematics (10th Edition), John Wiley (1999)</li></ol>

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1	<b>Title of the course</b> (L-T-P-C)	<b>Differential Equations -I</b> <b>(3-1-0-4)</b>
2	<b>Pre-requisite courses(s)</b>	<b>Nil</b>
3	<b>Course content</b>	Exact equations, integrating factors and Bernoulli equations. Orthogonal trajectories. Lipschitz condition, Picard's theorem, examples on non-uniqueness. Linear differential equations generalities. Linear dependence and Wronskians. Dimensionality of space of solutions, Abel-Liouville formula. Linear ODE's with constant coefficients, the characteristic equations. Cauchy-Euler equations. Method of undetermined coefficients. Method of variation of parameters. Laplace transform generalities. Shifting theorems. Convolution theorem.
4	<b>Texts/References</b>	<ol style="list-style-type: none"><li>1. E. Kreyszig, Advanced engineering mathematics (10th Edition), John Wiley (1999)</li><li>2. W. E. Boyce and R. DiPrima, Elementary Differential Equations (8th Edition), John Wiley (2005)</li></ol>

## BS-MS Major in Physics

1	<b>Title of the course</b> (L-T-P-C)	<b>Data Structures and Algorithms</b> <b>(3-0-0-6)</b>
2	<b>Pre-requisite courses(s)</b>	<b>Exposure to Computer Programming</b>
3	<b>Course content</b>	<b>Introduction:</b> data structures, abstract data types, analysis of algorithms. <b>Creation and manipulation of data structures:</b> arrays, lists, stacks, queues, trees, heaps, hash tables, balanced trees, tries, graphs. Algorithms for sorting and searching, order statistics, depth-first and breadth-first search, shortest paths and minimum spanning tree.
4	<b>Texts/References</b>	<ol style="list-style-type: none"><li>1. Introduction to Algorithms, 3rd edition, by T. Cormen, C. Leiserson, R. Rivest, C. Stein, MIT Press and McGraw-Hill, 2009.</li><li>2. Data structures and algorithms in C++, by Michael T. Goodrich, Roberto Tamassia, and David M. Mount, Wiley, 2004.</li></ol>

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<b>1</b>	<b>Title of the course</b> (L-T-P-C)	<b>Data Structures and Algorithms Laboratory</b> <b>(0-0-3-3)</b>
<b>2</b>	<b>Pre-requisite courses(s)</b>	<b>Exposure to Computer Programming (CS 102)</b>
<b>3</b>	<b>Course content</b>	Laboratory course for CS 211 is based on creating and manipulating various data structures and implementation of algorithms.
<b>4</b>	<b>Texts/References</b>	<ol style="list-style-type: none"><li>1. Introduction to Algorithms, 3rd edition, by T. Cormen, C. Leiserson, R. Rivest, C. Stein, MIT Press and McGraw-Hill, 2009.</li><li>2. Data structures and algorithms in C++, by Michael T. Goodrich, Roberto Tamassia, and David M. Mount, Wiley, 2004.</li></ol>

# **BS-MS Major in Physics**

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1	<b>Title of the course</b> (L-T-P-C)	<b>Electricity and Magnetism</b> <b>(2-1-0-6)</b>
2	<b>Pre-requisite courses(s)</b>	<b>Nil</b>
3	<b>Course content</b>	<ul style="list-style-type: none"> <li>• Review of vector calculus: Spherical polar and cylindrical coordinates; gradient, divergence and curl.</li> <li>• Divergence and Stokes` theorems.</li> <li>• Divergence and curl of electric field, Electric potential, properties of conductors.</li> <li>• Poisson`s and Laplace`s equations, uniqueness theorems, boundary value problems, separation of variables, method of images, multipoles.</li> <li>• Polarization and bound charges, Gauss` law in the presence of dielectrics, Electric displacement D and boundary conditions, linear dielectrics.</li> <li>• Divergence and curl of magnetic field, Vector potential and its applications.</li> <li>• Magnetization, bound currents, Ampere`s law in magnetic materials, Magnetic field H, boundary conditions, classification of magnetic materials.</li> <li>• Faraday`s law in integral and differential forms, Motional emf, Energy in magnetic fields, Displacement current, Maxwell`s equations,</li> <li>• Electromagnetic (EM) waves in vacuum and media, Energy and momentum of EM waves, Poynting`s theorem. Reflection and transmission of EM waves across linear media.</li> </ul>
4	<b>Texts/References</b>	<ol style="list-style-type: none"> <li>1. Introduction to Electrodynamics (4th ed.), David J. Griffiths, Prentice Hall, 2015.</li> <li>2. Classical Electromagnetism, J. Franklin, Pearson Education, 2005.</li> </ol>

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1	<b>Title of the course (L-T-P-C)</b>	<b>Biomolecules (2-1-0-6)</b>
2	<b>Pre-requisite courses(s)</b>	<b>None</b>
3	<b>Course content</b>	<p><b>Major classes of biological molecules:</b> Comparison of the alphabets and sources of structural diversity of proteins, nucleic acids, carbohydrates, and lipids.</p> <p>Proteins: Ramachandran plot, evolution of protein structure, structure-function</p> <p>Relationships: myoglobin and adaptations in myoglobin structure in deep diving mammals; allostery in hemoglobin; Bohr effect (for pH and carbon dioxide); adult and foetal hemoglobin.</p> <p>Post-translational modifications: special types of covalent bonds found in proteins.</p> <p>Protein folding: Natively folded and natively disordered proteins; Mini proteins and peptide toxins; Anfinsen's observations, Levinthal paradox, cooperativity in protein folding, free energy landscape of protein folding and pathways of protein folding, molten globule state, diseases associated with protein folding.</p> <p><b>Carbohydrates:</b> Sources of structural diversity; structure-function relationship in glycogen and cellulose, Difficulty associated with sequencing of glycans.</p> <p>Lipids: Structure and properties of storage and membrane lipids.</p> <p>Self-assembly of lipids: packing parameter; Bio membrane organization–sidedness and function.</p> <p>Membrane bound proteins-structure, properties and function, transport phenomena.</p> <p><b>Nucleic acids:</b> Historical perspective leading up to the proposition of DNA double helical structure with emphasis on the innovativeness of experimental design; Secondary structure of RNA; chromatin organization.</p> <p><b>Enzymes:</b> General principles of catalysis; quantitation of enzyme activity and efficiency. Henri-Michaelis-Menten and Briggs-Haldane relationships; Transition state: definition Pauling's intuition and proposal, catalytic antibodies; Catalytic strategies; Isozymes: Haldane relationship between kinetic constants and equilibrium constants; Zymogens.</p> <p><b>Bioenergetics:</b> basic principles; equilibria and concept of free energy; coupled interconnecting reactions in metabolism; oxidation of carbon fuels; recurring motifs in metabolism. Relevant metabolic pathways may be included to discuss relevant concepts.</p>
4	<b>Texts/References</b>	<p>1. Rodney F Boyer, Concepts in Biochemistry. John Wiley &amp; Sons; 3rd Ed (2 December 2005).</p>



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		<ol style="list-style-type: none"><li>2. Thomas Miilar, Biochemistry Explained: A Practical Guide to Learning Biochemistry CRC Press; 1 edition (30 May 2002)</li><li>3. Lubert Stryer et al., Biochemistry.W. H. Freeman; 6th Edition edition (14 July 2006)</li><li>4. David L Nelson, and Michael M Cox et al., Lehninger principles of biochemistry WH Freeman 7th ed. 2017 edition (1 January 2017)</li></ol>
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1	<b>Title of the course (L-T-P-C)</b>	<b>States of matter (3-0-0-3)</b>
2	<b>Pre-requisite courses(s)</b>	<b>Fundamental concepts and applications of chemistry (CH101)</b>
3	<b>Course content</b>	<p>The Gaseous State: Gas laws, Equation of state, Concept of temperature, pressure, partial pressure, density, Mole concept.</p> <p>Kinetic Theory of Gases: Maxwells distribution of molecular velocities, Collisions theory. Viscosity of gases. Energy distribution function, Phase rule and equilibria.</p> <p>Real Gases: Deviations from ideal behavior, Compressibility factors, van der Waals and Virial equation, Reduced equation of state, Law of corresponding states, Critical phenomena, Intermolecular forces.</p> <p>The solid and liquid states and their properties.</p>
4	<b>Texts/References</b>	<ol style="list-style-type: none"><li>1. K. L. Kapoor, A Textbook of Physical Chemistry, States of Matter, and Ions in Solution (SI Units) - Vol. 1   6th Edition</li><li>2. P. Atkins, Julio de Paula, J. Keeler, Atkins' Physical Chemistry: International Eleventh Edition</li></ol>

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1	<b>Title of the course (L-T-P-C)</b>	<b>Organic chemistry (3-0-0-3)</b>
2	<b>Pre-requisite courses(s)</b>	<b>Fundamental concepts and applications of chemistry (CH101)</b>
3	<b>Course content</b>	<p><b>Reactive Intermediates:</b> An overview of the chemistry of carbenes, nitrenes, radicals, carbocations, carbanions and benzyne. Introduction to substitution, elimination, addition, oxidation, reduction, rearrangement types of reactions.</p> <p><b>Epoxidation named reactions:</b> Jacobsen and Sharpless.</p> <p><b>Olefination named reactions:</b> Wittig, Julia, Wharton, Peterson, Tebbe.</p> <p><b>Cross-Coupling named reactions:</b> Buchwald-Hartwig, Negishi, Sonogashira, Suzuki, Wurtz, Ullmann, McMurry, Heck, Stille.</p> <p><b>Pericyclic reactions:</b> Diels-alder cycloaddition, Ene reaction, Cope rearrangement, Claisen rearrangement (Johnson, Ireland and Eschenmoser).</p> <p><b>Organic chemistry in industry:</b> Pharmaceuticals, dye, and agrochemicals</p>
4	<b>Texts/References</b>	<ol style="list-style-type: none"> <li>1. Jerry March and Michael Smith, "Advanced Organic     a. Chemistry," 7<sup>th</sup> Ed., Wiley, 2015.</li> <li>2. F. A. Carey and R. J. Sundberg, "Advanced Organic Chemistry,     Part A and B," 5<sup>th</sup> Ed., Springer, 2008.</li> <li>3. J. Clayden, N. Greeves, and S. Warren, "Organic Chemistry,"     2nd Ed., Oxford University Press, 2014.</li> <li>4. W. Carruthers and I. Coldham, "Modern Methods of Organic     Synthesis," 4<sup>th</sup> Ed., Cambridge University Press, 2015.</li> <li>5. Laszlo Kurti and Barbara Czako, "Strategic applications of named     reactions in organic synthesis," 1<sup>st</sup> Ed., Elsevier, 2005.     a. R. B. Grossman, "Art of writing reasonable organic reaction         mechanisms," 2<sup>nd</sup> Ed., Springer, 2010.</li> <li>6. P. Bruice, "Organic Chemistry" 7<sup>th</sup> Ed., Pearson, 2013.</li> <li>5. Penny Chaloner, "Organic chemistry: A mechanistic approach, CRC Press;     1st edition, 2014</li> </ol>