BSMS Sem IV – Course Details- Jan 2025

1	Course code	BIO221
2	Course Title	Biochemistry
3	Credits	4
4	Course Coordinator	Dr. Raju Mukherjee
5	Type of Course/Open for	**L**- lectures alone
6	Pre requisites	none
7	Objectives & Outcomes	This course aims to provide students with a comprehensive grounding in the fundamentals of Biochemistry. We start with the very basic molecule necessary for life and go on to discover the structure, function and interrelationships between important biomolecules that collectively carry out the essential functions of life. Next modules discus the concept of thermodynamics, enzyme catalysis and introduces the concepts underlying routine and advanced methodologies that are used in analysing biomolecules. The last module constitutes an overview of metabolic pathways.
8	Course contents	Biomolecules: Structural and functional aspects of proteins, nucleic acids and carbohydrates; RNA, ribozymes. (12 L) Thermodynamic principles: Free energy and equilibrium and binding; Protein folding, dynamics and interaction; Introduction to techniques for analysis of biomolecular structures. (5L) Enzyme biochemistry: Catalysis, Inhibition, Activation, Mechanism, Allosteric enzymes. (4 L) Biochemical/analytical techniques: Isolation, Purification, Electrophoresis, Chromatography, Mass spectrometry, Micro-calorimetry. This module may involve demonstration of few of the techniques. (5L) Metabolism and metabolomics: Overview of Amino acid, lipid, carbohydrate, nucleotide and glycogen metabolism; metabolic pathways - glycolysis, TCA cycle, electron transport chain and oxidative phosphorylation. (10L)
9	Grading Scheme	1. 20 % Quiz 2. 35 % Mid semester 3. 10 % Short seminar presentation 4. 35 % End semester
10	Suggested readings	Biochemistry: Jeremy M. Berg, Lubert Stryer , John L. Tymoczko, Gregory J. Gatto (available in library). Lehlinger's principles of Biochemistry: D L Nelson and M M Cox, 6th Edition (available in Library). Biochemical Calculations: How to Solve Mathematical Problems in General Biochemistry. Irwin Segel. 2nd Edition (available in library). Research articles and reviews will be provided for short seminar presentation.

1	**Course code**	BIO222
2	**Course Title**	**Cell Biology**
3	Credits	4
4	Course Coordinator	Dr. Sanjay Kumar
5	Nature of Course	L -Lectures alone
6	Pre requisites (if any)	Nil
7	Objectives & Outcomes	Objectives: Students who successfully complete this course will be able to: 1. Outline the structure of the biomolecules found in all living organisms. 2. Describe the function and structure of cellular organelles. 3. Describe the mechanisms of transport across organelles 4. Discuss the mechanisms of cell to cell signaling 5. Discuss how to isolate cells, and how to isolate their organelles and constituent macromolecules 6. Develop presentation skills Open in semesters/programs - Open to Sem VI BSMS (Mandatory) & PhD Outcomes: The objective of this course are to sensitize the students to the fact that as we go down the scale of magnitude from cells to organelles to molecules, the understanding of various biological processes becomes deeper and inclusive.

8	Course contents	Module 1: Dynamic organization of cell: Universal features of cells; cell chemistry and biosynthesis: chemical organization of cells; internal organization of the cell - cell membranes: structure of cell membranes and concepts related to compartmentalization in eukaryotic cells; intracellular organelles: endoplasmic reticulum and Golgi apparatus, lysosomes and peroxisomes, ribosomes, cellular cytoskeleton, mitochondria, chloroplasts and cell energetics; nuclear compartment: nucleus, nucleolus and chromosomes; membraneless organelles. (8L) Module 2: Cellular signalling, transport and trafficking Molecular mechanisms of membrane transport, nuclear transport, transport across mitochondria and chloroplasts; intracellular vesicular trafficking from endoplasmic reticulum through Golgi apparatus to lysosomes/cell exterior. (8L) Module 3: Cellular processes cell differentiation: stem cells, their differentiation into different cell types and organization into specialized tissues; cell-ECM and cell-cell interactions; cell receptors and trans- membrane signalling; cell motility and migration; cell cycle: cell cycle phases, switches, checkpoints, mitosis & meiosis; cell death: different modes of cell death and their regulation. (11L) Module 4: Manipulating and studying cells Isolation of cells and basics of cell culture; observing cells under a microscope, different types of microscopy; analyzing and manipulating DNA, RNA and proteins. (5L)
9	Evaluation /assessment	End-sem examination- 35%
		Mid-sem examination- 35% Quiz/ Assignments- 20% Assignments/Seminar/Presentations- 10%
10	Suggested readings	Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2008). Molecular Biology of the Cell (6th Ed.). New York: Garland Science. Lodish, H. F. (2016). Molecular Cell Biology (8th Ed.). New York: W.H. Freeman. Krebs, J. E., Lewin, B., Kilpatrick, S. T., & Goldstein, E. S. (2014). Lewin's Genes XI. Burlington, MA: Jones & Bartlett Learning. Cooper, G. M., & Hausman, R. E. (2013). The Cell: a Molecular Approach (6th Ed.). Washington: ASM ; Sunderland. Hardin, J., Bertoni, G., Kleinsmith, L. J., & Becker, W. M. (2012). Becker's World of the Cell. Boston (8th Ed.). Benjamin Cummings. Watson, J. D. (2008). Molecular Biology of the Gene (5th ed.). Menlo Park, CA: Benjamin/Cummings.

1	**Course Code**	**CHM222**
2	**Course Title**	**Advanced Inorganic Chemistry**
3	Credits	4 Credits
4	Type of Course/Open in/to	BSMS IV Semester
5	Name of Course Coordinator & participating faculty	Dr. Rana Saha* and Dr. Arun Kumar Bar
6	Objective and Outcome	This course will introduce the students to the principles behind the chemistry of inorganic compounds including metal ions and their principal applications. This course also details the bondings in heart-core inorganic compounds – main group chemistry and chemistry of halogens. The course also details the bonding in transition metal complexes including coordination and organometallic complexes, the redox behavior, and the associated fundamental applications. By the end of the course, the students will be able to derive the structures and stability of various inorganic compounds and metal complexes. They will also learn the fundamentals of redox behavior and its associated applications, as well as the fundamental applications of these compounds and metal complexes in biological systems.
7	Pre-requisite	CHM111, CHM121 and CHM211
8	Course Content	**Unit-I** ● Periodicity of transition metal elements (1-2h). ● Introduction to inorganic metal complexes (1-2h). ● Ligand-field theory and stability of transition metal complexes (6-7h). ● Redox chemistry (10-11h). ● Fundamentals of organometallic compounds (1-2h). **Unit-II** ● Reactions, kinetics, and mechanisms of metal complexes (6h). ● Introduction to main group compounds (4h). ● Chemistry of halogens and noble gases (5h). ● Introduction to inorganic chemistry of biological systems (2h). ● Applications of inorganic complexes (3h).
9	Grading Scheme	a. 30% quizzes - 2 quizzes 15% each (one before mid-sem, one after mid-sem) b. 35% mid-sem exam 35% end-sem exam
10	Suggested Readings	1. ***Inorganic Chemistry:*** *Principle of Structure and Reactivity*, 4th edition, James E. Huheey, Ellen A. Keiter, Richard L. Keiter. (Pearson Education Asia), Third Indian Reprint, 2001. Published by Addison Wesley Longman (Singapore) Pte. Ltd., Indian Branch, 482 F. I. E. Patparganj, Delhi 110092, India. Printed in India by Thomson Press (1) Ltd.

		2. ***Inorganic Chemistry***, Shriver and Atkins (2006) International Student Edition, 4th edition, Oxford University Press 3. ***Inorganic Chemistry***, Catherine E. Housecroft & Alan G. Sharpe, 5th Edition, Pearson Education Limited

1	Course code	ECS221
2	Course Title	Fundamentals of Earth and Environmental Sciences
3	Credits	03
4	Course Coordinator	Dr.Utpal Saikia*, Dr. Sukhmeen Kaur Kohli, Dr. Chandan Kumar B
5	Nature of Course	L-lecture alone
6	Prerequisites	NIL
7	Objectives & Outcomes	**Objectives:** This syllabus aims to provide students with a basic understanding of environmental science and its interdisciplinary nature, as well as the importance of studying the relationship between humans and their environment. It offers students a comprehensive understanding of the interactions between natural systems and human activities. The pupil will learn the various aspects related to Earth, such as the internal structure of the Earth, Earth Materials (minerals, rocks), Plate Tectonics, and various processes that operate near and below the Earth's surface. Also, students will learn how geophysical aspects are applied to understand the Earth's physical processes and properties. **Outcomes:** The student gains a broad understanding of environmental systems, natural resources, and interactions within the Earth's environment. By the end of the course, students will be familiar with fundamental concepts, terminology, and foundational practices used in the Earth sciences.
8	Course contents	**1.** ***Introduction to Environmental Sciences*** Environmental Science Introduction; Multidisciplinary Nature of Environmental Science; Environmental interactions, Habitat, Organism and Environmentalism; Changing attitudes to the natural world. Valuing the Environment - Concepts and methods; Economic growth, the environment and sustainable development. *0.* ***Biological and Physical Resources*** Evolution and evolutionary strategies, Adaptation, Wildlife and Habitat, Biodiversity, Human Population and demographic change, An overview of atmosphere, hydrosphere, cryosphere, and lithosphere, Eutrophication and the life cycle of lakes; Salt water, brackish water, and desalination; Soil, and land use, Soil erosion and its control, Mining and processing of fuels, Mining and processing of minerals. *0.* ***Introduction to the Earth as a syste****m* Earth and Planetary system, Interaction between subsystems, Time Scale and its implications, Crust-Mantle-Core dynamics. ***0.*** ***Earth Materials*** Atom to minerals: the nutrients of rocks; Fundamental properties of minerals; An overview of mineral classification, Common rock forming minerals: concepts of silicates. Introduction to petrology; Rock cycles: relation between different rock types ***0.*** ***Seismic waves and their relation to Earth's interior*** Propagation and characteristics of seismic waves; Identification of seismic phases and their applications, Earthquake source parameters, Earthquake source mechanism, and its tectonic implications. ***0.*** ***Concepts of geomagnetism and gravity***

		The dynamic of earth's magnetic field; Rock magnetism; Paleomagnetism in plate tectonics; Gravity and shape of the earth; Gravity anomalies.
9	Evaluation components with weightage.	. End- sem examination- 40% a. Mid-sem examination- 30% b. Quiz/Seminar/assessment- 30%
10	Suggested readings	1. Basics of Environmental Science 2nd Edition, Michael Allaby, Routledge (Taylor and Francis Group), 2000 2. Understanding Earth *by* John P. Grotzinger& Thomas H. Jordan 3. Changing Earth: Exploring Geology and Evolution *by* James S. Monroe & Reed Wincander 4. Atmospheric science – An Introductory Survey *by* J.M. Wallace and P.V. Hobbs, 2nd Edition, Academic Press, London, 2006. 5. Essentials of Meteorology – An Invitation to the Atmosphere *by* C Donald Ahrens. 6. Solid Earth: An Introduction to Global Geophysics, 2nd Edition (2004), by Fowler, C. M. R Additional study materials will be provided as the course advances.

1	Course code	HSS221
2	Course Title	History of Science
3	Credits	3
4	Course Coordinator(s)	Dr. Nirmala K * and Dr. Bhanusree Reddy
5	Nature of Course *L-Lecture*	L IV (core course)
6	Pre-requisites	Nil
7	Objectives & Outcomes	This course aims to provide an introductory framework of the documented developments in science, technology and medicine with historical insights and a special focus on Indian knowledge systems. Outcomes • Analyze the features of scientific thinking and how science has developed over the centuries • Evaluate the contributions of both science and scientists to society and culture from a historical perspective • Creating awareness about the history and rich culture of India • Understanding the scientific value of the traditional knowledge of India

8	Course contents	Part A: History of Science Introduction: Genesis of science and scientific method, history of scientific ideas (1 hour) Civilization and the sciences: Ancient Civilizations (Greek, Roman, Chinese, Sumerian, Arabic) and relation of science with society, culture and knowledge making, Astronomy through the ages: geocentric and heliocentric cosmologies and their cultural impacts, History of medicine and mathematics across the world, exploring the seas (5 hours) Scientific Revolution: Ideas in the 16th to 18th centuries inspiring scientific communities and new knowledge: Galileo, Copernicus, Kepler, Natural selection: Darwin and Wallace, Wegner and Continental shift (5 hours) A new era: Science and political power: Atomic Bomb and Nuclear age, The story of DNA, Environmental Degradation: Rachel Carson, Bhopal gas, Chernobyl and Fukushima Tragedies (4 hours) Looking to the future: Human genome sequencing, Gene Editing Technologies, Space travel, Machine Intelligence, challenges and opportunities for the future. (1 hour) Part B: Indian Knowledge Systems Indian Civilization and arts: Harappan civilization and Vedic culture, Ancient Education System: Takṣhasila and Nalanda University. Art and architecture, Mural, Miniature, Classical and Folk paintings (6 Hours) Development of the Knowledge system: Indian numerals, concept of zero, sulvasutras, Brahmagupta, Contributions of Aryabhata, Bhaskara in mathematics and astronomy, Ayurveda, Charaka and Sushruta Samhita (6 Hours)
9	Evaluation / Assessment Pattern (with % weightage)	End-sem examination - 35 Mid-sem examination – 35 Quiz/Seminar/Assignments -30
10	Bibliography / Suggested Literature	· Science – a history by John Gribbin · The dawn of Science - T Padmanabhan and V Padmanabhan · Textbook on The Knowledge System of Bhārata by Bhag Chand Chauhan

Course Details for MTH221 : January Session 2025

1	Course Code	MTH221
2	Course Title	Introduction to Abstract Algebra
3	Credits	4
4	Course Coordinator	Dr. Venketasubramanaian C G venketcg@labs.iisertirupati.ac.in Dr. Sourav Das (Participating Faculty) souravdas@labs.iisertirupati.ac.in
5	Nature of Course	L
6	Pre-requisites	None
7	Objectives & Outcomes	**Objectives:** This course gives a basic introduction to fundamental objects studied in modern abstract algebra : groups, rings, and fields. Particular emphasis will be given to the study of groups and polynomial rings. **Open in semesters/programs - 4/BSMS** **Outcomes:** On completion of the course the student is well prepared to take further advanced courses in mathematics as well as theoretical physics.

8	Course Contents	Groups: Definition and examples, finite groups, cyclic groups, dihedral groups, subgroups, homomorphisms, matrix groups, permutation groups, rigid transformations, symmetry of geometric objects, abelian groups, structure of finite abelian groups. Normal subgroups, cosets, quotient groups, Lagrange's theorem and the isomorphism theorems. Rings and Fields: Definition and examples, homomorphisms, integral domains, ideals. Polynomial rings (especially over $\mathbb{Z}, \mathbb{Q}, \mathbb{R}$ and $\mathbb{C}$), division algorithm for polynomials, unique factorization of polynomials.
9	Evaluation/Asessment	2 Quizzes of 15% weightage, Midsem 35% and Endsem 35%
10	Suggested Readings	[1] J. A. Gallian, *Contemporary Abstract Algebra*, Cengage India Private Limited, 2019. [2] J. B. Fraleigh, *A First Course in Abstract Algebra*, Pearson Education India, 2013. [3] S. Lang, *Undergraduate Algebra*, Third edn., 2005. [4] M. Artin, *Algebra*, Pearson, 2011.

Course Details for MTH222 : January Session 2025

1	Course Code	MTH222
2	Course Title	Introduction to Real Analysis
3	Credits	4
4	Course Coordinator	Dr. Gururaja H A gururaja@labs.iisertirupati.ac.in Dr. Souradeep Majumder (Participating Faculty) souradeep@labs.iisertirupati.ac.in
5	Nature of Course	L
6	Pre-requisites	None
7	Objectives & Outcomes	**Objectives:** This course gives an introduction to the study of real number system and functions defined on it. Properties of sequences and series of real numbers are studied in depth along with a detailed study of continuity of real valued functions. Gereralization of these notions to metric spaces are also dicussed in this course. **Open in semesters/programs - 4/BSMS** **Outcomes:** On completion of this course the student is well prepared to take further advanced courses in analysis.

8	Course Contents	Review of real number system: Field properties, Order properties, Finite and Infinite sets, Countable and Uncountable sets, LUB Axiom and Consequences, Construction of the field of real numbers (optional). Sequences: Limit Theorems, Monotone sequences, Bolzano Weierstrass Theorem, Cauchy criterion. Series: Convergence, Absolute Convergence, Tests for convergence. Continuity: Continuous real valued functions on a subset of R, algebra of continuous functions, Continuous functions on Intervals, Uniform Continuity, Monotone and Inverse Functions. Metric spaces: Definition and basic properties, some examples, closed sets, open sets, continuity, sequences in a metric space, examples of complete and incomplete metric spaces.
9	Evaluation/Asessment	2 Quizzes of equal weightage, Midsem 30% and Endsem 40%
10	Suggested Readings	[1] W. Rudin *Principles of mathematical analysis*, McGraw-Hill, 1976. [2] T. Apostol, *Mathematical analysis: A modern approach to advanced calculus*, Pearson/Narosa Publishing House, 1974. [3] R. Bartle & D. Sherbert, *Introduction to real analysis*, Wiley, 2011. [4] A. Kumar & S. Kumaresan, *A basic course in real analysis*, CRC Press, 2015.

1	Course Code	**PHY221**
2	Course Title	**Classical Mechanics I**
3	Credits	4
4	Course Coordinator	Dr. Tapan Chandra Adhyapak
5	Nature of Course	L+T
6	Prerequisites	None This course will be a prerequisite for Classical Mechanics II, Statistical Mechanics, Quantum Mechanics & Nonlinear Dynamics in later semesters
7	Course Objective & Outcome	**Objectives:** • Introducing the mathematical structure of Classical mechanics using variational principle • Convey its structural beauty through symmetry and symplectic structure • Developing problem solving skills and application to specific problems. **Outcomes:** • Understanding the mathematical structure of Classical Mechanics • Making use of this structure and symmetries to solve problems.
8	Course contents	• Lagrangian formalism: Euler-Lagrange equation from variational principle, constraints and Lagrange multipliers, symmetries and conservation laws. **[9 Lectures]** • Central force motion: orbits under central force, Kepler's laws, classical scattering. **[9 Lectures]** • Rigid body dynamics: Euler angles, angular velocity and momentum, rotation about a fixed point, Euler equations, heavy symmetric top, applications. **[8 Lectures]** • Small oscillations: normal modes, applications. **[3 Lectures]** • Hamiltonian formalism: Hamilton's equations, canonical transformations, Poisson brackets, symplectic formulation, canonical invariants, infinitesimal canonical transformation.**[7 Lectures]**
9	Evaluation /assessment	1. Two quizzes: 30% 2. Mid-Sem Exam: 30% 3. End-Sem Exam: 40%
10	Suggested readings	1. The Variational Principles of Mechanics: Cornelius Lanczoz, Dover Publications 2. Classical Mechanics: Goldstein, Herbert., Pearson (Third Edition) 3. Pragati's Classical Mechanics by Gupta, S.L., Meerut Pragati Prakashan

1	Course Code	**PHY222**
2	Course Title	**Mathematical Methods in Physics I**
3	Credits	4
4	Course Coordinator	Dr. Sunil Kumar S.
5	Nature of Course	L+T
6	Prerequisites	None
7	Course Objectives & Outcomes	**Objective:** Mathematical tools and techniques are required to study formulating and solving physics problems. **Outcomes**: • The essential mathematical methods used in physics will be covered. • Develop a substantial understanding of these methods and their applications in different fields of physics.
8	Course contents	1. **Differential Equations**: First-order Differential equations, Second-order ordinary differential equations, Singular Points, Series Solutions, Frobenius' Method. **[8 lectures]** 2. **Introduction to partial differential equations**: Separation of variables **[4 lectures]** 3. **Special Functions**: Legendre polynomial and spherical harmonics, Bessel functions, Hermite and Laguerre Polynomial. **[10 lectures]** 4. **Fourier series, Integral Transforms**: Laplace, Fourier **[4 lectures]** 5. **Review of Linear Algebra**: Determinants, matrices, orthogonal matrices, Hermitian and Unitary Matrices, Diagonalization, Functions. **[8 lectures]** 6. **Functions Complex variables**: Complex algebra, Cauchy-Riemann conditions, Laurent expansion, Singularities, Residues, Cauchy Principal Value, Pole, Expansion of Meromorphic functions. Conformal Mapping. **[8 lectures]**
9	Evaluation /assessment	1. End-sem exam: 40 2. Mid-sem exam: 30 3. Quiz – (2): 30
10	Suggested readings	1. Essential Mathematical Methods for Physicists, H. J. Weber & W. B. Arfken, Elsevier Academic Press 2. Mathematical Methods in Physical Science, Mary L. Boas, Wiley 3. Mathematics for Physicists, P. Dennery and A. K. Dover 4. Vector analysis and an introduction to tensor analysis, M. R. Spiegel, McGraw Hill 5. Matrices & Tensors in Physics, A. W. Joshi, A New Age International Publishers

1	Course code	**PHY220**
2	Course Title	**Advanced Physics Lab I**
3	Credits	3
4	Course Coordinator & participating faculty(if any)	Dr. Nihar Ranjan Sahoo* Dr. Ravi Kumar Pujala
5	Nature of Course	P
6	Prerequisites	PHY211 (Foundations of Physics III: Quantum Physics) IDC211 (Thermodynamics)
7	Objectives & Outcomes	• Verify physical concepts in electricity, magnetism, optics, thermodynamics, and quantum physics through experiments • Develop the skills of data recording, data analysis, and error estimation. • Demonstrate physical concepts in electricity, magnetism, optics, thermodynamics, and quantum physics through experiments • Demonstrate the skills of data recording, data analysis, and error estimation.
8	Course contents	1. Study of Stefan-Boltzmann's law of radiation. 2. Determination of the specific charge of the electron (e/m) from the path of an electron beam. 3. Millikan's oil drop experiment: Determination of the charge of an electron in the oil drop suspended between the capacitor plates. 4. Determination of the thermal conductivity of a bad conductor (Borofloat Glass) using Lee's disc method. 5. Measurement of the temperature dependence of the resistance of a thermistor. 6. Verification of gas laws and determination of the adiabatic exponent C_p/C_v of various gases using the gas elastic resonance apparatus. 7. Stirling Engine: Determination of the burner's thermal efficiency, Calculation of the total energy produced by the engine through the determination of the cycle area, Assessment of the mechanical work per revolution, and Calculation of the mechanical power output as a function of the rotation frequency, with the assistance of the torque meter. 8. Determination of the torque due to a magnetic moment in a uniform magnetic field 9. Determination of the horizontal component of the Earth's magnetic field 10. Study the emission spectra of Hg and Na using a diffraction grating.

9	Evaluation /assessment	• Record evaluation and daily viva - 60% • End sem. exam (Practical)- 40%
10	Suggested readings	1. The Art of Experimental Physics, D.W. Preston and E.R. Dietz, John Wiley (1991). 2. An introduction to error analysis: the study of uncertainties in physical measurements, J. R. Taylor, University Science Books, 2nd Edition (1997). 3. Introduction to Electrodynamics. David J. Griffiths, Prentice Hall, 3rd Edition (1999). 4. Optics, Eugene Hecht, Addison-Wesley, 4th Edition (2001). 5. Concepts of Modern Physics, A. Beiser, McGraw Hill Education, 7th Edition (2017).