Summer courses 2025: Time-table, schedule, and course contents.

PHY202v.2: Overview of mathematical methods, 2 Credits	Dr. Ananth V.
MTH102(new) = MTH202(old), Probability and statistics, 3 credits,	Dr. Santhosh K P
PHY102: Electromagnetism 3 CREDITS	Dr. Prasenjit D.
PHY201: Waves and optics 3 CREDITS	Dr. Ambresh S.
PHY101: Mechanics 3 CREDITS	Prof. Yogesh S.
HSS202: Philosophy of Science (old course) 2 CREDITS	Dr. Philose K.
CHM101: Basic inorganic chemistry 3 CREDITS	Dr. Vignesh K. R. and Dr. Pritam M. Dr. Moitree L. [tutor]
CHM102: Atoms molecules and symmetry (old course) 3 CREDITS	Dr. Arijit D.
MTH101 = MTH204 Symmetry 3 CREDITS	Prof. Krishnendu G.

Summer courses 2025: Time-table, schedule, and course contents.

TIME TABLE SUMMER SEMESTER 2025

Timing	Monday	Tuesday	Wednesday	Thursday	Friday	Venue
9:00 - 9:55	PHY102	PHY102	PHY102	PHY102	PHY102	AB1-2A
9:00 - 9:55	CHM102	CHM102	CHM102	CHM102	CHM102	AB1-5A
10:00 - 10:55	CHM101	CHM101	CHM101	CHM101	CHM101	LH4 (LHC)
11:00 - 11:55	MTH101 = MTH204	MTH101 = MTH204	MTH101 = MTH204	MTH101 = MTH204	MTH101 = MTH204	AB1-2A
12:00 - 12:55				PHY101	PHY101	LH4 (LHC)
	PHY201	CHM101				AB1-2B, LH4 for CHM101
13.00-13.55	HSS202	HSS202	HSS202	HSS202		AB1-2B
	MTH101 = MTH204	PHY101	PHY101	PHY101	PHY101	AB1-2A, LH4 for PHY101
14:00 - 14:55	PHY202	PHY202	PHY202	PHY202		AB1-2B
					PHY102	AB1-2A
15:00 - 15:55						AB1-2A
16:00 - 16:55	PHY201	PHY201	PHY201	PHY201	PHY201	AB1-2B
	MTH102 = MTH202	MTH102 = MTH202	MTH102 = MTH202	MTH102 = MTH202	MTH102 = MTH202	AB1-2A
17:00 - 17:55					CHM102	AB1-5A
18:00 - 18:55	MTH102 = MTH202					AB1-2A

As per the academic calendar, summer courses will commence on: 02-06-2025

Mid-sem exams: 28 & 30-06-2025

End-sem exams: 19, 21, 22, 23, & 24-07-2025

PHY101v.2: Mechanics

[Cr:3, Lc:2, Tt:1, Lb:0]

Course Outline

- Review of calculus, vectors, rotations, polar co-ordinates. Velocity and acceleration in polar co-ordinates. Newton's laws of motion. Configuration space and phase space. Notion of system Hamiltonian.
- Frames of reference. Inertial and accelerated frames. Centrifugal and Coriolis forces. Foucault's pendulum. Galilean transformations.
- Conservation laws. Conservation of energy, momentum and angular momentum. Their connection with symmetry principles.
- Central Force problem. Inverse-square law force. Derivation of orbit equation. Kepler's laws.
- Oscillations. Harmonic oscillator. Damped oscillations. Driven damped oscillations. Coupled oscillations and normal modes of motion.
- Motion of rigid bodies. Angular momentum, angular velocity, moment of inertia, product of inertia, principal axes. Euler's equations. Examples with fixed axis of rotation.
- Special theory of relativity. Relativistic kinematics. Lorentz transformations. Length contraction, time dilation. Velocity addition. Four-vectors. Doppler effect.

Recommended Reading

- C. Kittel et.al., Mechanics Volume 1 Berkeley Physics Course, 02nd edition(Special Indian Edition), Tata-McGraw Hill Ltd New Delhi (2008).
- D. Kleppner and R. Kolenkow, An Introduction to Mechanics, McGraw Hill Inc USA (1973).
- R. Resnick, D. Halliday and K. S. Krane, Physics Vol 1, 4th edition, John Wiley, (1991).
- A. P. French, Newtonian Mechanics (M.I.T. Introductory Physics Series), CBS Publishers and distributers, New Delhi (1987).

PHY102v.2: Electromagnetism

[Cr:3, Lc:2, Tt:1, Lb:0]

Course Outline

- Electrostatics: charges and fields. Charge distributions. Gauss's Law.
- The electric potential, the physical meaning of the divergence and the curl. Work and energy in electrostatics.
- Electric fields around conductors. Capacitors and capacitance. The Uniqueness Theorem. The Boundary-value problem.
- Electric fields in matter. Polarization. Bound charges. Field inside a dielectric. Linear dielectrics. Boundary value problems.
- Electric currents. Charge transport and current density. Electrical conductivity and Ohm's law. Energy dissipation.
- Fields of moving charges: From Oersted to Einstein. Magnetic forces. Electric fields measured in different frames of reference. Force on a moving charge. The Magnetic field. Vector potential. How fields transform.
- Magnetic fields in matter. Diamagnets, paramagnets and ferromagnets. Torque and forces on magnetic dipoles. Bound currents. Auxiliary field. Linear and nonlinear media. Ferromagnetism, susceptibility, and permeability.
- Electrodynamics: Electromagnetic induction and Faraday's law. Energy and momentum in electrodynamics. The Displacement Current. Maxwell's equations.

Recommended Reading

- E. M. Purcell, Electricity and Magnetism (Berkeley Physics Course Vol 2), 02nd edition, Tata-McGrawHill (2008).
- R. P. Feynman, R.B. Leighton, and M. Sands, The Feynman Lectures of Physics Vol 2, Narosa Publishing House (2008).
- D. J. Griffiths, Introduction to Electrodynamics, 03rd edition, Dorling Kindersley (2007).

PHY201v.2: Waves and optics

[Cr:3, Lc:2, Tt:1, Lb:0]

Course Outline

- Mechanical Waves. Review of oscillators and systems of coupled oscillators. Waves on a string and membrane. Waves in an elastic medium: Pressure waves and shear waves. Acoustic resonators. Speed of a wave and wave impedance, shock waves.
- Electromagnetic waves: Review of Maxwell's equations. Wave solutions to Maxwell's equations. Energy and momentum of electromagnetic radiation. Poynting theorem and conservation laws.
- Reflection and refraction of waves from interfaces. Fresnel Coefficients. Interference of light: interferometers and devices based on two-beam interference.
- Diffraction of light: Scalar wave approximation. Kirchoff integral, Kirchoff-Fresnel boundary conditions. Fraunhoffer diffraction, Babinet principle, diffraction gratings.
- Lorentz model for dispersive media. Pulse propagation in a dispersive medium.
- Coherence theory: basic ideas of coherence. Temporal coherence, bandwidth of light. Spatial coherence, basic ideas of intensity correlations.

Recommended Reading

- A. P. French, Vibrations and Waves (The M.I.T. Introductory Physics series), CBS Publishers and distributers, New Delhi (1987).
- H. J. Pain, The physics of vibration and waves, 6th edition, Wiley and Sons Ltd. New Delhi (2005).
- E. Hecht, Optics, 4th edition, Pearson Education Inc., New Delhi (2007).
- F. S. Crawford Jr., Waves (Berkeley Physics Course Vol. 3), Special Indian Ed., Tata McGraw Hill Co. New Delhi (2008).

M. V. Klein and T. E. Furtak Optics, 2nd edition, Wiley (1986).

MTH101 (old)
MTH204v.2: Symmetry

[Cr:3, Lc:2, Tt:1, Lb:0]

- Definition of symmetry in R^2 and R^3.
- Symmetries of regular planar shapes and their types, composition tables of symmetries.
- Symmetries of tetrahedron and cube, relations between symmetries.
- Axioms of symmetries, groups and subgroups.
- Permutation groups and understanding symmetry through permutation groups, permutation matrices.
- Rotation matrices and reflection matrices, matrix groups.
- Group actions, natural action of the group of symmetries.
- Platonic solids and their symmetries.

Books

1. M. A. Armstrong, *Groups and Symmetry*, Undergraduate Texts in Mathematics, SpringerVerlag, 1988.
2. M. Artin, *Algebra*, Prentice-Hall of India, New Delhi, 1994.

Mapped to old CHM101 Chemistry of elements and chemical transformations

CHM101v.2: Basic inorganic chemistry

[Cr:3, Lc:2, Tt:1, Lb:0]

Course Outline

- Periodic table and periodicity of properties (atomic & ionic radius, electronegativity, electron affinity, ionization energy). Concept of effective nuclear charge. Electronic configuration of main group elements, transition metals, lanthanides and actinides.
- Basic concepts: HSAB principle, Polarizability, MO concept (homo-diatomic and hetero-diatomic molecules including H_2, O_2, N_2, F_2, HF, NO, CO).
- Geometry of molecules, hybridization, VBT: structure and bonding.
- Transition elements and their selected complexes: Structure, bonding, properties and reaction mechanism (trans effect, inner-outer sphere mechanism). Nomenclature and isomerism of coordination compounds. Theories of bonding (VBT and CFT of octahedral, tetrahedral and square planar geometries). Electronic transitions (intra-ligand, d-d and charge transfer) and magnetic behavior. Metal-metal bonding.
- Main group elements and their selected complexes: Group-wise discussion of *s*-block and *p*-block elements covering their oxides, oxoacids, halides, and hydrides. Chemistry of boranes, borazines and phsophazenes. Some unusual properties of heavy post-transition elements and their rationalization. Pseudo-halogens, interhalogens and halogen cations.

Recommended Reading

- J. D. Lee, *Concise Inorganic Chemistry*, Indian Edition, 5th Ed, Blackwell Science Ltd, Oxford (1996).
- F. A. Cotton, G. Wilkinson, P. L. Gaus, *Basic Inorganic Chemistry*, Wiley Indian Edition, 3rd Ed, John Wiley & Sons Inc, Singapore (1995).
- G. L. Miessler, D. A. Tarr, *Inorganic Chemistry*, Indian Edition, 3rd Ed, Pearson Education, New Delhi (2007).
- J. E. Huheey, E. A. Keiter and R. L. Keiter, *Inorganic Chemistry Principles of Structure and reactivity*, 4th Edition, Addison-Wesley Publishing Company, (1993).

HSS202: Philosophy of science

[Cr:2, Lc:2, Tt:0, Lb:0]

Course Outline

- Introduction to philosophy. The questions that philosophers ask: what is the true nature of reality? what is the foundation of knowledge? what is the nature of the self? can morality and ethics be objectively defined? Brief overview of different philosophical schools of thought. Indian philosophical schools of thought. The tools of rational enquiry.
- Rationality, realism and the philosophy of nature. An examination of scientific knowledge: how is it reached, what it reveals about the world we live in and what implications it has for human life and culture.
- Introduction to classic issues in the philosophy of science. The nature of scientific explanation. Popper's critique of narrow inductivism and positivism. Hume's problem of induction. Confirmation of scientific theories. Empiricism and realism.
- Brief introduction to epistemology. The nature of scientific truth:realism, skepticism, idealism and holism. Observation and cognition.Distinction between science and metaphysics. The “unity of science” thesis. The falsifiability of a scientific hypothesis.
- Is science a search for truth or for consensus? Is science a search for causes or for satisfying explanations? Scientific revolutions:relativity, space/time and evolution. The received view and the sociology of knowledge - Kuhn's legacy.
- Topics in the philosophy of biology. Evolutionary vs teleological explanations, natural selection,random mutation. The philosophy of psychology. Bioethics.

Recommended Reading

- M. H. Salmon et. al., *Introduction to the philosophy of science*, Prentice Hall (1992).
- M. Curd and J .A. Cover, *Philosophy of science:the central issues*, W. W. Norton and Company (1998).
- D. Gilles, *Philosophy of science in the twentieth century:four central themes*, Blackwell Publishers Oxford (1993).
- J. Kourany, *Scientific knowledge: basic issues in the philosophy of science*, 02nd edition, Wadsworth Publishing (1997).
- B.C.van Fraassen, *Introduction to the philosophy of time and space*, Columbia university press (1992).

CHM102: Atoms molecules and symmetry

[Cr:3, Lc:2, Tt:1, Lb:0]

Course Outline

- Atomic structure, spectrum of hydrogen atom, Stark effect, Zeeman effect, wave-mechanical description of matter, photoelectric effect, de Broglie hypothesis, uncertainty principle, the need for quantum theory.
- Postulates of quantum mechanics, state of a system, probability amplitude, probability density, operators and observables, Hermitian operators, commutators, expectation value.
- The wave equation, Schröinger equation and its significance, particle in a 1D, 2D and 3D-box, introduction to polar and spherical coordinates, hydrogen atom, the concept of orbitals, quantum numbers, helium atom, term symbols.
- Symmetry, symmetry elements and symmetry operations, properties of reducible and irreducible representations, construction of character tables.
- Chemical bonding, symmetry and properties of orbitals, linear combination of atomic orbitals, valence-bond theory, molecular orbital theory, comparison between valence bond and molecular orbital theories, examples of homonuclear and heteronuclear systems, electronic configuration of molecules in terms of MO theory.

Recommended Reading

- D. A. McQuarrie, J. D. Simon, *Physical Chemistry: A Molecular Approach*, Indian Edition, 1st Ed, University Science Books, California (1997).
- P. Atkins, J de Paula, *Physical Chemistry*, 8th Ed, Oxford University Press, New Delhi (2006).
- I. N. Levine, *Physical Chemistry*, 5th Ed, Tata McGraw-Hill, New Delhi (2007).

PHY202v.2: Overview of mathematical methods

[Cr:2, Lc:2, Tt:0, Lb:0]

(available as IDC with same course number PHY202 who do not take physics as a pre-major)

Review of Vector calculus: Gradient, Divergence and Curl, Gauss', Stokes' and Green's theorem, Orthogonal curvilinear coordinates, Introduction to Tensor analysis: Coordinate transformation, Summation convention, Contravariant and covariant vectors, Tensors of 2nd rank, Metric tensor and line element, Kronecker delta and Levi-Civita symbol. **(4 lectures)**

Applications of Matrices and Linear Algebra in Physics

Functions of Matrices, Hermitian, Orthogonal and Unitary Matrices, Similarity Transformations, Eigenvalues and Eigenvectors, Applications of Diagonalization. **(4 lectures)**

Fourier Series and Transforms

Real and Complex forms of Fourier Series, Periodic Extensions, Parseval's Theorem, Fourier Transforms, Dirac-Delta Function and their properties, Gibbs' Phenomenon*. **(6 lectures)**

Functions of a Complex Variable

Review of Complex numbers, Analytic Functions, Contour Integrals, Laurent Series, The Residue Theorem. **(4 lectures)**

Ordinary Differential Equations

Linear first order equations, Linear second order equations, Methods of solutions, Series solution, Examples from physics problems. **(6 Lectures)**

Probability and Statistics

Sample Space of mutually exclusive outcomes of an experiment, Probability Theorems, Random variables: discrete and continuous, Mean, variance and standard deviation, Probability distributions: Binomial, Normal and Poisson distributions, Generating Functions*, Central limit theorem*, Statistics and experimental measurements. **(4 lectures)**

* *Topics that may be skipped, if required.*

References:

1. Mathematical Methods in Physical Sciences, Mary L. Boas
2. Mathematical Methods for Physicists, Arfken and Weber
3. Mathematical Methods for Physics and Engineering, Riley, Hobson, Bence
4. Mathematical Methods in Classical and Quantum Physics, Tulsi Dass, S.K. Sharma
5. Mathematical Physics: The Basics, S. D. Joglekar
6. Basic Training in Mathematics: A Fitness Program for Science Students, R. Shankar

MTH102v.2: Probability and statistics

[Cr:3, Lc:2, Tt:1, Lb:0]

- Counting (urn, coins, cards).
- Axiomatic approach to probability, conditional probability, independence of events.
- Discrete random variables, probability mass function, some standard discrete distributions and examples.

- Bivariate (discrete) distributions, marginal and conditional distributions, covariance, correlation coefficient.
- Moments, generating functions, Markov's inequality, Chebychev's inequality, sums of independent random variables, law of large numbers.
- Continuous random variables, probability density function, some standard continuous distributions and examples (with focus on properties of Gaussian distribution).
- Extension of concepts like bivariate distributions, moments, generating function etc. in the context of continuous random variables. Central limit theorem.
- A glimpse into estimation theory (maximum likelihood estimation, method of moments).
- A glimpse into hypothesis testing (null hypothesis, analysis of variance, significance).

Recommended Reading

1. K. L. Chung and F. AitSahila, *Elementary Probability Theory*, Springer (2004).
2. R. Isaac, *The Pleasures of Probability*, Springer (Undergraduate Texts in Mathematics) (1995).
3. S. Ross, *A First Course in Probability*, Pearson Education Inc. (2006).
4. V. K. Rohatgi and A. K. Md. E. Saleh, *Introduction to Probability and Statistics*, Wiley Series in Probability and Statistics (2008)
5. M. Lavine, Introduction to Statistical Thought, UMass Amherst, 2005. online version.