TECHNO INDIA UNIVERSITY
WESTBENGAL

EM 4, Sector V, Salt Lake, Kolkata-700091, West Bengal, India
Phone: +91 9836544416/17/18/19, Fax: +91 33 2357 1097

2-Year Master of Science (M.Sc.) Curriculum and Syllabus for Physics

Second Semester

Course Code	Course Title	Credit
TIU-PPH-S102	Career Advancement Skill Development	3
TIU-PPH-T102	Numerical Method & Computational Technique	3
TIU-PPH-T104	Electrodynamics	4
TIU-PPH-T106	Mathematical Methods of Physics-II	2
TIU-PPH-T108	Quantum Mechanics-II	3
TIU-PPH-T110	Solid State Physics - II	3
TIU-PPH-L102	Numerical Methods and Programming Lab	2
TIU-PPH-L112	General Physics Lab-I	3
TIU-PES-S198	Entrepreneurship Skill Development	2
	Total	**25**

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SEMESTER II

TIU-PPH-T102: NUMERICAL METHOD & COMPUTATIONAL TECHNIQUE [L-T-P-C: 2-1-0-3]

Errors: its sources, propagation and analysis;

Roots of functions: bisection, Newton-Raphson, secant method, fixed-point iteration, applications;

Linear equations: Gauss and Gauss-Jordan elimination, Gauss-Seidel, LU decomposition;

Eigenvalue Problem: power methods and its applications; Least square fitting of functions and its applications;

Interpolation: Newton's and Chebyshev polynomials; Numerical differentiation: forward, backward and centred difference formulae;

Numerical integration: Trapezoidal and Simpson's rule, Gauss-Legendre integration, applications; **Solutions of ODE:** initial value problems, Euler's method, second and fourth order Runge-Kutta methods;

Boundary value problems: finite difference method, applications.

Application using MATHEMATICA

Texts:

1. K. E. Atkinson, *Numerical Analysis,* John Wiley (Asia) (2004).
2. S. C. Chapra and R. P. Canale, *Numerical Methods for Engineers,* Tata McGraw Hill (2002).

References:

1. J. D. Hoffman, *Numerical Methods for Engineers and Scientists*, 2nd ed. CRC Press, Special Indian reprint (2010).
2. J. H. Mathews, *Numerical Methods for Mathematics, Science, and Engineering,* PrenticeHall of India (1998).
3. S. S. M. Wong, *Computational Methods in Physics,* World Scientific (1992).
4. W. H. Press, S. A. Teukolsky, W. T. Verlling and B. P. Flannery, *Numerical Recipes in C,*Cambridge (1998).

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TIU-PPH-T104: ELECTRODYNAMICS [L-T-P-C: 3-1-0-4]

Review of electrostatics and magnetostatics boundary value problems using Laplace's equation.
Maxwell's equations for time varying fields, polarization and conductivity, plane waves in dielectrics and conductors.
Wave propagation in plasmas, reflection/refraction, critical reflection.
Surface waves and medium frequency communication, wave-guides, transmission lines, dipole antenna, antenna array, Rayleigh scattering.
Postulates of special relativity, Lorentz transformations, 4-vectors, interval, 4-momentum, mass-energy equivalence, relativistic covariance of Maxwell's equations.
Lienard-Wiechert potentials, radiation from accelerated charges, applications to communication and radar.

Texts:

1. J. D. Jackson, Classical Electrodynamics, John Wiley (Asia) (1999).

References:

1. H. J. W. Muller Kirsten, Electrodynamics, World Scientific (2011).
2. E. C. Jordan and K. G. Balmain, Electromagnetic Waves and Radiating Systems, Prentice Hall (1995).
3. J. Schwinger et al., Classical Electrodynamics, Persesus Books (1998).
4. G. S. Smith, Classical Electromagnetic Radiation, Cambridge (1997).

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TIU-PPH-T106: MATHEMATICAL METHODS OF PHYSICS II [L-T- P- C: 2-1- 0-2]

Groups: Definition of groups, multiplication table, conjugate elements and classes, subgroups; direct product of groups; isomorphism & homomorphism, Permutation groups, SU(2), O(3)

Transform theory: Laplace transformation and inverse Laplace transformation; Applications of Laplace transformation; Fourier integral transform of a finite wave group; convolution theorem. Use of Fourier transformation in solving differential equations.

Tensors: General definition, contravariant, covariant and mixed tensors and their ranks. Outer product of tensors, contraction of tensors, inner product of tensors. Symmetric and antisymmetric tensors; Kronecker delta. Metric tensor, raising and lowering of indices; Cartesian tensors.

Texts:

1. G. B. Arfken, H. J. Weber and F. E. Harris, *Mathematical Methods for Physicists*, Seventh Edition, Academic Press (2012).
2. S. Andrilli & D. Hecker, *Elementary Linear Algebra*, Academic Press (2006).
3. A.W. Joshi, *Elements of Group Theory*, New Age Int. (2008).
4. A.W. Joshi, *Matrices and Tensors in Physics*, 3rd Edition, New Age Int. (2005).

References:

1. M. L. Boas, *Mathematical Methods in Physical Sciences*, John Wiley & Sons (2005).
2. S. Lang, *Introduction to Linear Algebra*, Second Edition, Springer (2012).
3. T. Lawson, *Linear Algebra*, John Wiley & Sons (1996).
4. P. Dennery & A. Krzywicki, *Mathematics for Physicists*, Dover Publications (1996).

TIU-PPH-T108: QUANTUM MECHANICS II [L-T-P-C: 3-1-0-3]

Schrodinger equation for a slowly varying potential: WKB approximation, turning points, connection formulae, derivation of Bohr-Sommerfeld quantization condition, applications of WKB;

Variational method: trial wave function, applications to simple potential problems; Time Dependent

Perturbation Theory: Sinusoidal perturbation, Fermi's Golden Rule; Special topics in radiation theory: semi-classical treatment of interaction of radiation with matter, Einstein's coefficients, spontaneous and stimulated emission and absorption, application to lasers;

Scattering Theory: Born approximation, scattering cross section, Greens functions, scattering for different kinds of potentials, applications; Relativistic quantum mechanics, Lorentz invariance, free particle Klein-Gordon and Dirac equations.

Texts:
1. B. H. Bransden and C. J. Joachain, Quantum Mechanics, Pearson Education 2nd Ed. (2004).
2. R. L. Liboff, Introductory Quantum Mechanics, Pearson Education, 4th Ed. (2003).
References:
1. P. W. Mathews and K. Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw Hill (1995).
2. F. Schwabl, Quantum Mechanics, Narosa (1998).
3. L. I. Schiff, Quantum Mechanics, McGraw Hill (1968).
4. J. J. Sakurai, Modern Quantum Mechanics, Pearson Education (2002).
5. R. Shankar, Principles of Quantum Mechanics, Springer; 2nd edition (1994).

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TIU-PPH-T110: SOLID STATE PHYSICS – II [L-T-P-C: 3-1-0-3]

Free electron theory of metals : Free electron gas model of metals, free electron gas in a one-dimensional and three dimensional box, filling up of the energy levels, Density of electron States, the Fermi energy, average kinetic energy and velocity of an electron.

Application to static and transport properties: Electronic specific heat, Pauli spin paramagnetism, Thermionic emission, the schottkey effect, field emission, the photoelectric effect. The Boltzmann transport equation, electrical conductivity, Drude Lorentz theory, Sommerfield theory, thermal conductivity, Weidemann- franz law, Hall effect.

Band theory of solids :- Wave functions in a periodic lattice and the Bloch theorem, The Kronig-Penny model , Approximate solution near a zone boundary and band gap, the tight binding approximation, cyclotron resonance, the De-Haas Van Alphben effect. Band theory of insulators and semiconductors, Intrinsic semiconductors, Band model. Extrinsic Semiconductors, impurity states and band model, measurement of band gap- the infrared absorption in band gap.

Magnetism: Dia, para, ferro, ferri and antiferromagnetic materials; Crystal field splitting, quenching of orbital angular momentum in iron group ions, cooling by isentropic demagnetization of paramagnetic materials.
Magnetic exchange interaction - Ferro, antiferro & ferrimagnetism. Pauli paramagnetism, Landau diamagnetism

Outlines of Superconductivity: Meissner effect, London equations, type-I and type-II superconductors; Ginzburg-Landau theory, outlines of BCS theory, flux quantization.

Text:

1. Introduction to Solid State Physics, C. Kittel, 8th ed; John Wiley & Sons (2005).
2. Solid State Physics, J. D. Patterson and B.C. Bailey; Springer (2007).
3. Solid State Physics, A. J. Dekker; Prentice Hall

References:

1. Solid State Physics, N. W. Ashcroft and N. D. Mermin; Harcourt Asia Pte. Ltd. (2001).
2. Solid State Physics, M. S. Rogalski and S. B. Palmer; Gordon and Breach Science Publishers (2001).

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TIU-PPH-L102: NUMERICAL METHOD & PROGRAMMING LAB

[L-T-P-C: 0-0-3-2]

Roots of functions: bisection, Newton-Raphson, secant method, fixed-point iteration, applications; **Linear equations:** Gauss and Gauss-Jordan elimination, Gauss-Seidel, LU decomposition; Eigenvalue Problem: power methods and its applications; Least square fitting of functions and its applications;

Interpolation: Newton's and Chebyshev polynomials; Numerical differentiation: forward, backward and centred difference formulae;

Numerical integration: Trapezoidal and Simpson's rule, Gauss-Legendre integration, applications; **Solutions of ODE:** initial value problems, Euler's method, second and fourth order Runge-Kutta methods;

Boundary value problems: finite difference method, applications.

Application using MATHEMATICA

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TIU-PPH-L112: GENERAL PHYSICS LABORATORY I [L-T-P-C: 0-0-6-3]

Typical Experiments:

Experiment 1: Study of magnetic susceptibility of a solid;

Experiment 2: Study of Michelson interferometer

Experiment 3: Study of Frank-Hertz experiment,

Experiment 4: Study of electrical resistivity of semiconductors,

Experiment 5: Study of magnetic hysteresis,

Experiment 6: Study of temperature dependent characteristics of *p-n* junction.

Experiment 7: Study of the dispersion relation for the mono-atomic and diatomic lattice-Comparison with theory

Experiment 8: Study of temperature variation of refractive index of a liquid using hollow prism and LASER source.

References:

1. R. A. Dunlop, Experimental Physics, Oxford University Press (1988).
2. E. Hecht, Optics, Addison-Wesley; 4^{th} Edition (2001).
3. A. Lipson, S. G. Lipson, H. Lipson, Optical Physics, Cambridge University Press; 4th (2010).
4. Laboratory Manual with details about the experiments.