Ph.D. (Physics) Program

Program Outcomes, Program Specific Outcomes, Course Outcomes

Program Outcomes	**Ph.D. (Physics) Program**
PO1.	Scientific knowledge: Apply the knowledge of physics fundamentals to the solution of specific research problems.
PO2.	Problem analysis: Identify, formulate, research literature, and analyze research related problems using basic principles of physics.
PO3.	Conduct investigations of research problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO4.	Modern tool usage: Apply appropriate techniques, resources, and modern scientific & engineering techniques to complex research related physical activities with an understanding of the limitations.
PO5.	Research Proficiency: Apply various modern techniques for research specific activities/experiments and analysis purpose
Program Specific Outcomes	**PSOs of Ph.D. (Physics) Program**
PO1.	Understand the concepts of research fundamentals and methodology
PO2.	Perform procedures/experiments as per standards
PO3.	Apply the scientist knowledge for the analysis and interpretation of the simulated/experimental outcomes
PO4	Skill of writing scientific reports and articles as per international standards

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Course Outcomes	COs of the course "PHY-601(1)-Advanced Nano Physics" Describe general understanding of nanoscience and nanotechnology, Fundamental behavior of 0-D, 1-D, 2-D, and 3-D materials, Quantum Wells, Wires, and Dots, Carbon Nano Structures and related topics. CO1: Develop an understanding of popular and scientific prospective of nanotechnology, classification of nanomaterials, density of states for 0-D, 1-D, 2-D, and 3-D materials, Quantum confinement, superlattices. CO2: Enumerate and explain structure determination by X-ray diffraction, reciprocal lattice, structure factor, size effect on X-ray diffraction, magnetoresistance etc. CO3: Explain and understand synthesis techniques for the preparation of nanoparticles; bottom up approach: sol-gel synthesis, hydrothermal growth, thin film growth (i.e. CVD, PVD). CO4: Develop an understanding sze effect on shape of materials, size effect on electronic properties- magic number, grain boundary effect, semiconductor nanoparticles; Plasmonic nanoparticles, CO5: Explain and understand some special nanomaterials: Carbon nano Structures: Fullerenes, C60, C80 SWNT and MWNT; nanocomposites: Metal-Metal nanocomposites, Polymer-Metal nanocomposites, ceramic nanocomposites.
Credits	03 Theory periods of one hour per week over a semester

Course Outcomes	COs of the course "PHY-602- Advanced Condensed Matter Physics" Describe general understanding of advancement of condensed matter physics and related problems. CO1: Linear and nonlinear dielectric properties of Materials: dielectric constants and Polarization mechanisms, linear dielectric materials etc. CO2: Enumerate and explain theory of magnetism: dia- and para-Ferro-, ferri- and anti-ferromagnetism magnetism in materials, Pauli paramagnetism, and Exchange interaction. Heisenberg Hamiltonian- mean field theory;. CO3: Explain and understand optical properties and optical transition; optical Processes and Excitons. CO4: Develop an understanding of many electron theory, Hartree-Fock theory, Second quantization formalism; Interactions of Electrons and Phonons with Photons CO5: Develop an understanding of Basic concepts in point defects, line defects, planner defects and dislocations in solids.
Credits	03 Theory and 01 Tutorial periods of one hour per week over a semester

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Course Outcomes	COs of the course "PHY-603- Advanced Quantum Mechanics" describe general understanding of special theory of relativity, covariant formulation of electrodynamics, radiation from accelerated charges, general theory of relativity and related problems. CO1: Develop an understanding of solutions of Schrödinger Equation for 1-D and 3-D square wells and potential barriers, H-atom, harmonic oscillator in matrix mechanics etc. CO2: Enumerate and explain approximation methods: Non-degenerate and degenerate perturbation theory and application to anharmonic oscillator, variational method with application to ground state of harmonic oscillator and hydrogen atom. CO3: Explain and understand time dependent perturbation: General expression for the probability of transition from one state to another, Fermi's golden rule and its application to radiative transition in atoms. CO4: Develop an understanding of relativistic quantum mechanics: The Klein-Gordon equation. The Dirac equation. Dirac matrices, spinors. CO5: Explain and understand identical Particles: Symmetric and antisymmetric wave functions: Bosons and Fermions. Summarization postulates, CO6: Explain and understand Quantum Field Theory.
Credits	03 Theory and 01 Tutorial periods of one hour per week over a semester

Course Outcomes	COs of the course "PHY-608- Renewable Energy Sources and Technologies" Describe general understanding of energy sources, solar energy, hydrogen energy, wind energy, wave energy and oceanic thermal energy conversion and related topics. CO1: Explain and enumerate production alternatives and reserves of energy sources in the world and in India; need of renewable energy sources, energy security and energy conservation, energy and its environmental impacts, distributed generation. CO2: Develop an understanding of solar thermal and solar photovoltaic technologies and their applications. CO3: Explain and understand the hydrogen production techniques, importance of hydrogen energy as per environmental concern, storage techniques and safty issues. CO4: Develop an understanding of wind energy, wave energy and OTEC and their implementation criteria.
Credits	03 Theory and 01 Tutorial periods of one hour per week over a semester

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Course Outcomes	COs of the course "PHY-604- Advanced Materials Science"Describe general understanding crystal structure of variousmaterials, chemical bonding in solids, synthesis and characterization techniques of materials and related topics. CO1: Develop an understanding of crystalline and non-crystalline materials; classification of crystals; bravais lattices; symmetry in crystals, some special crystal structure. CO2: Enumerate and explain bonding in materials; phase transitions, magnetic, dielectric materials, high Tc superconductors, nanomaterials, alloys, semiconductors, polymers, ceramics, composites, solar energy materials, imperfection in a crystal. CO3: Explain and understand single crystal growth, chemical route synthesis, thin film preparation techniques; synthesis of nanomaterials: top down and bottom up approaches of synthesis of nano-structured materials, advanced materials in 3D printing. CO4: Develop an understanding of basic principal and application of XRD, Raman spectroscopy, XPS, STM, AFM, TEM, SEM. CO5: Develop an understanding of basic principal and application of IR, UV-Visible, Dielectric spectroscopy, VSM, SQUID.
Credits	03 Theory and 01 Tutorial periods of one hour per week over a semester

Course Outcomes	COs of the course "PHY-605- Advanced Computational Physics" describe general understanding of various advances developed in Computational Physics. CO1: Develop an understanding of concepts of deterministic and stochastic simulation methods, limitations of simulational physics. CO2: Enumerate and explain Monte Carlo Method, Random walk on one, two and three dimensional lattices, self-avoiding walk, micro-canonical ensemble, canonical ensemble, classical ideal gas, ising model, grand canonical ensemble. CO3: Explain and understand Molecular Dynamics. CO4: Develop an understanding of symbolic computing systems. CO5: Explain and understand computing hardware basics: memory and CPU, components.
Credits	03 Theory and 01 Tutorial periods of one hour per week over a semester

Course Outcomes	COs of the course "PHY-606- Advanced Optoelectronics" describe general understanding of basic principles of advance optoelectronics and related devices applications. CO1: Develop an understanding of electron-hole recombination process and band gap engineering in optical materials. CO2: Enumerate and explain principle of laser actions: spontaneous and stimulated emission and absorption, the condition for the laser action. CO3: Explain and understand working of semiconductor injection laser: efficiency, stripe geometry LED materials, commercial LED materials. CO4: Develop an understanding of basic electronic devices: p-n junction their application in solar cells and light emitting diodes, optical communications, fundamental principles of photonics and light-matter interactions. CO5: Explain and understand about waveguides switches and modulators and other devices of integrated optics.
Credits	03 Theory and 01 Tutorial periods of one hour per week over a semester

Course Outcomes	COs of the course "PHY-610- Advanced Materials and Energy Devices" Describe general understanding of advanced materials and their applications including energy devices. CO1: Develop an understanding of theories and physical mechanisms of advanced materials, concept of Fermi-energy, work function and electron affinity. CO2: Enumerate and explain interaction between materials of different chemical origin; organic and inorganic species; motifs and functions, bio-functional structure, carbon based materials such a ACs, graphene, CNTs, MWNTs. CO3: Explain and understand concept of energy production and storage; Emerging trends in LEDs and optoelectronic devices; Electrochemical capacitors and supercapacitors. CO4: Develop an understanding of magneto-hydrodynamics and magnetic fluids; rechargeable batteries; solar batteries and solar charger; solar cells etc. CO5: Develop an understanding of hydrogen production techniques and storage using hybrid materials, hydride batteries and fuel cells.
Credits	03 Theory and 01 Tutorial periods of one hour per week over a semester

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Course Outcomes	COs of the course "PHY-609- Research Methodology" Describe general understanding of some basic concepts of research and its methodologies. CO1: Develop an understanding of need, importance and impact of research, types of research, research process. CO2: Learn about synopsis writing, selecting research problem; formulation of research projects; survey of literature. CO3: Develop an understanding of formulation and types of hypothesis; collection, maintenance, storage and analysis of data. CO4: Understand compilation and presentation of results, writing of manuscripts; research reports and thesis. CO5: Know about various funding agencies provides financial support for research and writing research proposal for external funding. CO6: Develop an understanding of computer and informatics including word processing, excel, power point presentation etc. CO7: Explain and understand principal and working procedure of various lab instruments. CO8: Able to writing a review article on topic of interest
Credits	03 Theory periods of one hour per week over a semester