BIRLA INSTITUTE OF TECHNOLOGY
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Metric 1.1.3

Department/Section: Academic Department

Average percentage of courses having focus on employability/entrepreneurship/skill development during the last five years

Year of offering the course	Program code	Program name	Name of the course	Course code	Year of introduction	Activities
2014-15	MS0214	IMSC (Physics)	IMP5001-ELECTRONICS	IMP5001	2011	Employability
2014-15	MS0214	IMSC (Physics)	IMP6001-MATERIALS SCIENCE & NANOTECHNOLOGY	IMP6001	2011	Employability
2014-15	MS0214	IMSC (Physics)	IMP6003-DIGITAL ELECTRONICS & COMMUNICATIONS	IMP6003	2011	Employability
2014-15	MS0214	IMSC (Physics)	GERMAN	MSH1145	2011	Employability
2014-15	MS0214	IMSC (Physics)	MATHEMATICS METHODS IN PHYSICS	SAP1001	2011	Skill development
2014-15	MS0214	IMSC (Physics)	ELECTRODYNAMICS	SAP1003	2011	Employability
2014-15	MS0214	IMSC (Physics)	CLASSICAL MECH. & RELATIVITY	SAP1005	2011	Skill development
2014-15	MS0214	IMSC (Physics)	QUANTUM MECHANICS	SAP1107	2011	Skill develop

						ment
2014-15	MS0214	IMSC (Physics)	STATISTICAL PHYSICS	SAP2007	2011	Employability
2014-15	MS0214	IMSC (Physics)	ATOMIC MOLECULAR & MODERN SEPECTROSCOPY	SAP2105	2011	Employability
2014-15	MS0214	IMSC (Physics)	CONDENSED MATTER PHYSICS	SAP2109	2011	Employability
2014-15	MS0214	IMSC (Physics)	NANOSTRUCTURES & NANOMATERIALS	SAP3011	2011	Entrepreneurship
2014-15	MS0214	IMSC (Physics)	HYSICS-II [MP]	IMP2001	2011	Skill development
2014-15	MS0214	IMSC (Physics)	SOLID STATE PHYSICS	IMP4103	2011	Entrepreneurship
2014-15	MS0214	IMSC (Physics)	HEAT & THERMODYNAMICS	IMP5003	2011	Skill development
2014-15	MS0214	IMSC (Physics)	OPTOELECTRONICS	IMP5005	2011	Employability
2014-15	MS0214	IMSC (Physics)	INTRO. TO QUANTUM MECHANICS	IMP5007	2011	Skill development
2014-15	MS0214	IMSC (Physics)	INTRODUCTION TO PLASMA PHYSICS	IMP6005	2011	Employability
2014-15	MS0214	IMSC (Physics)	INTRODUCTION TO NULCEAR PHYSICS	IMP6007	2011	Employability
2014-15	MT0114	M.TECH (NanoTechnology)	NANOPHOTONICS	TNT2003	2011	Employability
2014-15	MS0114	MSC (Physics)	ELECTRONICS & INSTRUMENTATION	SAP2101	2011	Employability

2014-15	MS0114	MSC (Physics)	QUANTUM ELECTRONICS	SAP2203	2011	Employability
2014-15	MS0114	MSC (Physics)	MATERIAL SCIENCE	IMP6001	2011	Employability
2014-15	MS0114	MSC (Physics)	FIBER OPTICS & INTEGRATED OPTICS	SAP3109	2011	Employability
2014-15	MS0114	MSC (Physics)	NUCLEAR PHYSICS & ENGINEERING	SAP3201	2011	Employability
2014-15	MS0114	MSC (Physics)	PLASMA PHYSICS	SAP3203	2011	Employability
2015-16	MS0214	IMSC (Physics)	ELECTRONICS	IMP5001	2011	Entrepreneurship
2015-16	MS0214	IMSC (Physics)	MATERIALS SCIENCE & NANOTECHNOLOGY	IMP6001	2011	Employability
2015-16	MS0214	IMSC (Physics)	DIGITAL ELECTRONICS & COMMUNICATIONS	IMP6003	2011	Employability
2015-16	MS0214	IMSC (Physics)	MODERN COMPUTATIONAL TECHNIQUES & PROGRAMMING	IMP7002	2015	Employability
2015-16	MS0214	IMSC (Physics)	GERMAN	MSH1145	2015	Skill development
2015-16	MS0214	IMSC (Physics)	MATHEMATICS METHODS IN PHYSICS	SAP1001	2011	Skill development
2015-16	MS0214	IMSC (Physics)	ELECTRODYNAMICS	SAP1003	2011	Employability
2015-16	MS0214	IMSC (Physics)	CLASSICAL MECH. & RELATIVITY	SAP1005	2011	Skill development
2015-16	MS0214	IMSC (Physics)	QUANTUM MECHANICS	SAP1107	2011	Skill develop

						ment
2015-16	MS0214	IMSC (Physics)	ELECTRONICS DEVICES AND CIRCUITS	SAP2101	2015	Skill develop ment
2015-16	MS0214	IMSC (Physics)	STATISTICAL PHYSICS [M-BL]	SAP2007	2011	Employa bility
2015-16	MS0214	IMSC (Physics)	ADVANCED QUANTUM MECHANICS	SAP2011	2015	Skill develop ment
2015-16	MS0214	IMSC (Physics)	LASER PHYSICS AND APPLICATIONS	SAP2013	2015	Employa bility
2015-16	MS0214	IMSC (Physics)	ATOMIC MOLECULAR & MODERN SEPECTROSCOPY	SAP2105	2011	Employa bility
2015-16	MS0214	IMSC (Physics)	CONDENSED MATTER PHYSICS	SAP2109	2011	Employa bility
2015-16	MS0214	IMSC (Physics)	ADVANCED ELECTRODYNAMICS	SAP3007	2015	Employa bility
2015-16	MS0214	IMSC (Physics)	PLASMA PHYSICS	SAP3203	2015	Employa bility
2015-16	MS0214	IMSC (Physics)	NANOSTRUCTURES & NANOMATERIALS	SAP3011	2011	Entrepre neurship
2015-16	MS0214	IMSC (Physics)	MICROWAVE ELECTRONICS	SAP3013	2015	Skill develop ment
2015-16	MS0214	IMSC (Physics)	FIBER AND INTEGRATED OPTICS	SAP3017	2015	Employa bility
2015-16	MS0214	IMSC (Physics)	ADVANCED EXPERIMENTAL TECHNIQUES	SAP3115	2015	Skill develop ment
2015-16	MS0214	IMSC (Physics)	NUCLEAR AND PARTICLE PHYSICS	SAP3301	2015	Employa bility

2015-16	MS0214	IMSC (Physics)	THEORY OF PLASMAS	SAP4001	2015	Employa bility
2015-16	MS0214	IMSC (Physics)	PLASMA BEAMS AND APPLICATIONS	SAP4003	2015	Skill develop ment
2015-16	MS0214	IMSC (Physics)	PLASMA PROCESSING OF MATERIALS	SAP4005	2015	Skill develop ment
2015-16	MS0214	IMSC (Physics)	THIN FILM AND VACUUM TECHNOLOGY	SAP4007	2015	Employa bility
2015-16	MS0214	IMSC (Physics)	PHYSICS OF SOLID STATE DEVICES	SAP4009	2015	Skill develop ment
2015-16	MS0214	IMSC (Physics)	ADVANCED MATERIALS SCIENCE	SAP4011	2015	Skill develop ment
2015-16	MS0214	IMSC (Physics)	NONCONVENTIONAL ENERGY MATERIALS	SAP4013	2015	Entrepre neurship
2015-16	MS0214	IMSC (Physics)	PHYSICS OF THIN FILMS	SAP4015	2015	Employa bility
2015-16	MS0214	IMSC (Physics)	MICROPROCESSORS AND MICROCONTROLLERS	SAP4019	2015	Employa bility
2015-16	MS0214	IMSC (Physics)	INSTRUMENTATION AND CONTROL	SAP4021	2015	Skill develop ment
2015-16	MS0214	IMSC (Physics)	INTEGRATED ELECTRONICS	SAP4023	2015	Employa bility
2015-16	MS0214	IMSC (Physics)	QUANTUM & NONLINEAR OPTICS	SAP4027	2015	Employa bility
2015-16	MS0214	IMSC (Physics)	INTRODUCTION TO NANOPHOTONICS	SAP4029	2015	Employa bility
2015-16	MS0214	IMSC	PHOTONIC AND	SAP4031	2015	Employa

		(Physics)	OPTOELECTRONIC DEVICES			bility
2015-16	MS0214	IMSC (Physics)	HOLOGRAPHY AND APPLICATIONS	SAP4033	2015	Employability
2015-16	MS0214	IMSC (Physics)	PHYSICS-II [MP]	IMP2001	2011	Skill development
2015-16	MS0214	IMSC (Physics)	SOLID STATE PHYSICS	IMP4003	2011	Entrepreneurship
2015-16	MS0214	IMSC (Physics)	HEAT & THERMODYNAMICS	IMP5003	2011	Skill development
2015-16	MS0214	IMSC (Physics)	OPTOELECTRONICS	IMP5005	2011	Employability
2015-16	MS0214	IMSC (Physics)	INTRO. TO QUANTAUM MECHANICS	IMP5007	2011	Skill development
2015-16	MS0214	IMSC (Physics)	INTRODUCTION TO PLASMA PHYSICS	IMP6005	2011	Employability
2015-16	MS0214	IMSC (Physics)	INTRODUCTION TO NULCEAR PHYSICS	IMP6007	2011	Employability
2015-16	MT0105	IMSC (Physics)	BOUNDARY LAYER METEOROLOGY & AIR POLLUTION	IPA2005	2015	Employability
2015-16	MT0114	M.TECH (NanoTechnology)	NANOPHOTONICS	TNT2003	2011	Employability
2015-16	MS0114	MSC (Physics)	ELECTRONICS & INSTRUMENTATION	SAP2101	2011	Employability
2015-16	MS0114	MSC (Physics)	QUANTUM ELECTRONICS	SAP2203	2011	Employability
2015-16	MS0114	MSC (Physics)	MATERIAL SCIENCE	SAP6101	2011	Employability

2015-16	MS0114	MSC (Physics)	FIBER OPTICS & INTEGRATED OPTICS	SAP3109	2011	Employability
2015-16	MS0114	MSC (Physics)	NUCLEAR PHYSICS & ENGINEERING	SAP3201	2011	Employability
2015-16	MS0114	MSC (Physics)	PLASMA PHYSICS	SAP3203	2011	Employability
2015-16	MS0214	IMSC (Physics)	ELECTRONIC DEVICES AND CIRCUITS	SAP2001	2011	Employability
2016-17	MS0214	IMSC (Physics)	ELECTRONICS	IMP5001	2011	Entrepreneurship
2016-17	MS0214	IMSC (Physics)	MATERIALS SCIENCE & NANOTECHNOLOGY	IMP6001	2011	Employability
2016-17	MS0214	IMSC (Physics)	DIGITAL ELECTRONICS & COMMUNICATIONS	IMP6003	2011	Employability
2016-17	MS0214	IMSC (Physics)	MODERN COMPUTATIONAL TECHNIQUES & PROGRAMMING	IMP7002	2015	Employability
2016-17	MS0214	IMSC (Physics)	GERMAN	MSH1145	2011	Employability
2016-17	MS0214	IMSC (Physics)	MATHEMATICS METHODS IN PHYSICS	SAP1001	2011	Skill development
2016-17	MS0214	IMSC (Physics)	ELECTRODYNAMICS	SAP1003	2011	Employability
2016-17	MS0214	IMSC (Physics)	CLASSICAL MECH. & RELATIVITY	SAP1005	2011	Skill development
2016-17	MS0214	IMSC (Physics)	QUANTUM MECHANICS	SAP1107	2011	Skill development
2016-17	MS0214	IMSC (Physics)	ELECTRONICS DEVICES AND CIRCUITS	SAP2101	2015	Skill develop

						ment
2016-17	MS0214	IMSC (Physics)	STATISTICAL PHYSICS [M-BL]	SAP2007	2011	Employability
2016-17	MS0214	IMSC (Physics)	ADVANCED QUANTUM MECHANICS	SAP2011	2015	
2016-17	MS0214	IMSC (Physics)	LASER PHYSICS AND APPLICATIONS	SAP2013	2015	Employability
2016-17	MS0214	IMSC (Physics)	ATOMIC MOLECULAR & MODERN SEPECTROSCOPY	SAP2105	2015	Employability
2016-17	MS0214	IMSC (Physics)	CONDENSED MATTER PHYSICS	SAP2109	2011	Employability
2016-17	MS0214	IMSC (Physics)	ADVANCED ELECTRODYNAMICS	SAP3007	2015	Employability
2016-17	MS0214	IMSC (Physics)	PLASMA PHYSICS	SAP3203	2015	Employability
2016-17	MS0214	IMSC (Physics)	NANOSTRUCTURES & NANOMATERIALS	SAP3011	2011	Entrepreneurship
2016-17	MS0214	IMSC (Physics)	MICROWAVE ELECTRONICS	SAP3013	2015	Skill development
2016-17	MS0214	IMSC (Physics)	FIBER AND INTEGRATED OPTICS	SAP3017	2015	Employability
2016-17	MS0214	IMSC (Physics)	ADVANCED EXPERIMENTAL TECHNIQUES	SAP3115	2015	Skill development
2016-17	MS0214	IMSC (Physics)	NUCLEAR AND PARTICLE PHYSICS	SAP3301	2015	Employability
2016-17	MS0214	IMSC (Physics)	THEORY OF PLASMAS	SAP4001	2015	Employability
2016-17	MS0214	IMSC (Physics)	PLASMA BEAMS AND APPLICATIONS	SAP4003	2015	Skill develop

						ment
2016-17	MS0214	IMSC (Physics)	PLASMA PROCESSING OF MATERIALS	SAP4005	2015	Skill development
2016-17	MS0214	IMSC (Physics)	THIN FILM AND VACUUM TECHNOLOGY	SAP4007	2015	Employability
2016-17	MS0214	IMSC (Physics)	PHYSICS OF SOLID STATE DEVICES	SAP4009	2015	Skill development
2016-17	MS0214	IMSC (Physics)	ADVANCED MATERIALS SCIENCE	SAP4011	2015	Skill development
2016-17	MS0214	IMSC (Physics)	NONCONVENTIONAL ENERGY MATERIALS	SAP4013	2015	Entrepreneurship
2016-17	MS0214	IMSC (Physics)	PHYSICS OF THIN FILMS	SAP4015	2015	Employability
2016-17	MS0214	IMSC (Physics)	OPTICAL COMMUNICATIONS	SAP4017		
2016-17	MS0214	IMSC (Physics)	MICROPROCESSORS AND MICROCONTROLLERS	SAP4019	2015	Employability
2016-17	MS0214	IMSC (Physics)	INSTRUMENTATION AND CONTROL	SAP4021	2015	Skill development
2016-17	MS0214	IMSC (Physics)	INTEGRATED ELECTRONICS	SAP4023	2015	Employability
2016-17	MS0214	IMSC (Physics)	QUANTUM & NONLINEAR OPTICS	SAP4027	2015	Employability
2016-17	MS0214	IMSC (Physics)	INTRODUCTION TO NANOPHOTONICS	SAP4029	2015	Employability
2016-17	MS0214	IMSC (Physics)	PHOTONIC AND OPTOELECTRONIC DEVICES	SAP4031	2015	Employability

2016-17	MS0214	IMSC (Physics)	HOLOGRAPHY AND APPLICATIONS	SAP4033	2015	Employability
2016-17	MS0214	IMSC (Physics)	PHYSICS-II [MP]	IMP2001	2011	Skill development
2016-17	MS0214	IMSC (Physics)	SOLID STATE PHYSICS	IMP4103	2011	Entrepreneurship
2016-17	MS0214	IMSC (Physics)	INTRODUCTION TO PLASMA PHYSICS	IMP6005	2011	Employability
2016-17	MS0214	IMSC (Physics)	INTRODUCTION TO NULCEAR PHYSICS	IMP6007	2011	Employability
2016-17	MT0114	M.TECH (NanoTechnology)	NANOPHOTONICS	TNT2003	2011	Employability
2016-17	MS0114	MSC (Physics)	ELECTRONICS & INSTRUMENTATION	SAP2101	2011	Employability
2016-17	MS0114	MSC (Physics)	QUANTUM ELECTRONICS	SAP2203	2011	Employability
2016-17	MS0114	MSC (Physics)	MATERIAL SCIENCE	SAP3005	2011	Employability
2016-17	MS0114	MSC (Physics)	FIBER OPTICS & INTEGRATED OPTICS	SAP3109	2011	Employability
2016-17	MS0114	MSC (Physics)	NUCLEAR PHYSICS & ENGINEERING	SAP3201	2011	Employability
2016-17	MS0114	MSC (Physics)	PLASMA PHYSICS	SAP3203	2011	Employability
2016-17	MS0214	IMSC (Physics)	ELECTRONIC DEVICES AND CIRCUITS	SAP2001	2011	Employability
2017-18	MS0214	IMSC (Physics)	ELECTRONICS	IMP5001	2015	Entrepreneurship
2017-18	MS0214	IMSC	MATERIALS SCIENCE &	IMP6001	2011	Employa

		(Physics)	NANOTECHNOLOGY			bility
2017-18	MS0214	IMSC (Physics)	DIGITAL ELECTRONICS & COMMUNICATIONS	IMP6003	2011	Employa bility
2017-18	MS0214	IMSC (Physics)	MODERN COMPUTATIONAL TECHNIQUES & PROGRAMMING	IMP7002	2015	Employa bility
2017-18	MS0214	IMSC (Physics)	GERMAN	MSH114 5	2011	Employa bility
2017-18	MS0214	IMSC (Physics)	MATHEMATICS METHODS IN PHYSICS	SAP1001	2011	Skill develop ment
2017-18	MS0214	IMSC (Physics)	ELECTRODYNAMICS	SAP1003	2011	Employa bility
2017-18	MS0214	IMSC (Physics)	CLASSICAL MECH. & RELATIVITY	SAP1005	2011	Skill develop ment
2017-18	MS0214	IMSC (Physics)	QUANTUM MECHANICS	SAP1107	2011	Skill develop ment
2017-18	MS0214	IMSC (Physics)	ELECTRONICS DEVICES AND CIRCUITS	SAP2101	2015	Skill develop ment
2017-18	MS0214	IMSC (Physics)	STATISTICAL PHYSICS [M-BL]	SAP2007	2011	Employa bility
2017-18	MS0214	IMSC (Physics)	ADVANCED QUANTUM MECHANICS	SAP2011		
2017-18	MS0214	IMSC (Physics)	LASER PHYSICS AND APPLICATIONS	SAP2013	2015	Employa bility
2017-18	MS0214	IMSC (Physics)	ATOMIC MOLECULAR & MODERN SEPECTROSCOPY	SAP2105	2011	Employa bility
2017-18	MS0214	IMSC (Physics)	CONDENSED MATTER PHYSICS	SAP2109	2011	Employa bility

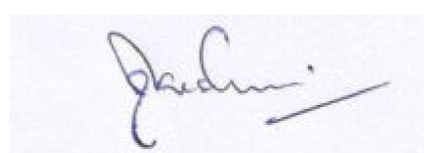
2017-18	MS0214	IMSC (Physics)	ADVANCED ELECTRODYNAMICS	SAP3007	2015	Employability
2017-18	MS0214	IMSC (Physics)	PLASMA PHYSICS	SAP3203	2015	Employability
2017-18	MS0214	IMSC (Physics)	NANOSTRUCTURES & NANOMATERIALS	SAP3011	2011	Entrepreneurship
2017-18	MS0214	IMSC (Physics)	MICROWAVE ELECTRONICS	SAP3013	2015	Skill development
2017-18	MS0214	IMSC (Physics)	FIBER AND INTEGRATED OPTICS	SAP3017	2015	Employability
2017-18	MS0214	IMSC (Physics)	ADVANCED EXPERIMENTAL TECHNIQUES	SAP3115	2015	Skill development
2017-18	MS0214	IMSC (Physics)	NUCLEAR AND PARTICLE PHYSICS	SAP3301	2015	Employability
2017-18	MS0214	IMSC (Physics)	THEORY OF PLASMAS	SAP4001	2015	Employability
2017-18	MS0214	IMSC (Physics)	PLASMA BEAMS AND APPLICATIONS	SAP4003	2015	Skill development
2017-18	MS0214	IMSC (Physics)	PLASMA PROCESSING OF MATERIALS	SAP4005	2015	Skill development
2017-18	MS0214	IMSC (Physics)	THIN FILM AND VACUUM TECHNOLOGY	SAP4007	2015	Employability
2017-18	MS0214	IMSC (Physics)	PHYSICS OF SOLID STATE DEVICES	SAP4009	2015	Skill development
2017-18	MS0214	IMSC (Physics)	ADVANCED MATERIALS SCIENCE	SAP4011	2015	Skill development

2017-18	MS0214	IMSC (Physics)	NONCONVENTIONAL ENERGY MATERIALS	SAP4013	2015	Entrepreneurship
2017-18	MS0214	IMSC (Physics)	PHYSICS OF THIN FILMS	SAP4015	2015	Employability
2017-18	MS0214	IMSC (Physics)	MICROPROCESSORS AND MICROCONTROLLERS	SAP4019	2015	Employability
2017-18	MS0214	IMSC (Physics)	INSTRUMENTATION AND CONTROL	SAP4021	2015	Skill development
2017-18	MS0214	IMSC (Physics)	INTEGRATED ELECTRONICS	SAP4023	2015	Employability
2017-18	MS0214	IMSC (Physics)	QUANTUM & NONLINEAR OPTICS	SAP4027	2015	Employability
2017-18	MS0214	IMSC (Physics)	INTRODUCTION TO NANOPHOTONICS	SAP4029	2015	Employability
2017-18	MS0214	IMSC (Physics)	PHOTONIC AND OPTOELECTRONIC DEVICES	SAP4031	2015	Employability
2017-18	MS0214	IMSC (Physics)	HOLOGRAPHY AND APPLICATIONS	SAP4033	2015	Employability
2017-18	MS0214	IMSC (Physics)	PHYSICS-II [MP]	IMP2001	2015	Skill development
2017-18	MS0215	IMSC (Physics)	SOLID STATE PHYSICS	IMP4103	2011	Entrepreneurship
2017-18	MS0216	IMSC (Physics)	HEAT & THERMODYNAMICS	IMP5003	2011	Skill development
2017-18	MS0217	IMSC (Physics)	OPTOELECTRONICS	IMP5005	2011	Employability
2017-18	MS0218	IMSC (Physics)	INTRO. TO QUANTAUM MECHANICS	IMP5007	2011	Skill development

2017-18	MS0219	IMSC (Physics)	INTRODUCTION TO PLASMA PHYSICS	IMP6005	2011	Employability
2017-18	MS0220	IMSC (Physics)	INTRODUCTION TO NULCEAR PHYSICS	IMP6007	2011	Employability
2017-18	MT0114	M.TECH (NanoTechnology)	TNT2003 NANOPHOTONICSSECURITY [MK]	TNT2003	2011	Employability
2017-18	MS0114	MSC (Physics)	ELECTRONICS & INSTRUMENTATION	SAP2101	2011	Employability
2017-18	MS0114	MSC (Physics)	QUANTUM ELECTRONICS	SAP2203	2011	Employability
2017-18	MS0114	MSC (Physics)	MATERIAL SCIENCE	SAP3005	2011	Employability
2017-18	MS0114	MSC (Physics)	FIBER OPTICS & INTEGRATED OPTICS	SAP3109	2011	Employability
2017-18	MS0114	MSC (Physics)	NUCLEAR PHYSICS & ENGINEERING	SAP3201	2011	Employability
2017-18	MS0114	MSC (Physics)	PLASMA PHYSICS	SAP3203	2011	Employability
2017-18	MS0214	IMSC (Physics)	ELECTRONIC DEVICES AND CIRCUITS	SAP2001	2011	Employability
2018-19	MS0214	IMSC (Physics)	ELECTRONICS	IMP5001	2015	Entrepreneurship
2018-19	MS0214	IMSC (Physics)	DIGITAL ELECTRONICS& COMMUNICATIONS	IMP6003	2011	Employability
2018-19	MS0214	IMSC (Physics)	ELECTRICITY & MAGNETISM	PH102	2018	Skill develpment
2018-19	MS0214	IMSC (Physics)	MATHEMATICAL PHYSICS- 1	PH105	2018	Skill develpment

2018-19	MS0214	IMSC (Physics)	WAVES AND OPTICS	PH106	2018	Skill develpm ent
2018-19	MS0214	IMSC (Physics)	MATHEMATICSMETHODS IN PHYSICS	SAP1001	2015	Skill develop ment
2018-19	MS0214	IMSC (Physics)	ELECTRODYNAMICS	SAP1003	2011	Employa bility
2018-19	MS0214	IMSC (Physics)	CLASSICAL MECH. & RELATIVITY	SAP1005	2011	Skill develop ment
2018-19	MS0214	IMSC (Physics)	QUANTUM MECHANICS	SAP1107	2011	Skill develop ment
2018-19	MS0214	IMSC (Physics)	STATISTICAL PHYSICS[M-BL]	SAP2007	2011	Employa bility
2018-19	MS0214	IMSC (Physics)	ATOMIC MOLECULAR& MODERN SEPECTROSCOPY	SAP2105	2015	Employa bility
2018-19	MS0214	IMSC (Physics)	CONDENSED MATTER PHYSICS	SAP2109	2011	Employa bility
2018-19	MS0214	IMSC (Physics)	NANOSTRUCTURES & NANOMATERIALS	SAP3011	2011	Entrepre neurship
2018-19	MS0214	IMSC (Physics)	PHYSICS-IV (MODERN OPTICS)	IMP4001	2015	Employa bility
2018-19	MS0214	IMSC (Physics)	SOLID STATE PHYSICS	IMP4103	2011	Entrepre neurship
2018-19	MS0214	IMSC (Physics)	HEAT & THERMODYNAMICS	IMP5003	2011	Skill develop ment
2018-19	MS0214	IMSC (Physics)	OPTOELECTRONICS	IMP5005	2011	Employa bility
2018-19	MS0214	IMSC	INTRO. TO QUANTAUM	IMP5007	2011	Skill

		(Physics)	MECHANICS			develop ment
2018-19	MS0214	IMSC (Physics)	MATERIALS SCIENCE& NANOTECHNOLOGY	IMP6001	2011	Employa bility
2018-19	MS0214	IMSC (Physics)	INTRODUCTION TO PLASMAPHYSICS	IMP6005	2011	Employa bility
2018-19	MS0214	IMSC (Physics)	INTRODUCTION TO NULCEARPHYSICS	IMP6007	2011	Employa bility
2018-19	MS0114	MSC (Physics)	CONSTITUTION OF INDIA	MT204	2018	Employa bility
2018-19	MS0114	MSC (Physics)	ELECTRONICS& INSTRUMENTATION	SAP2101	2011	Employa bility
2018-19	MS0114	MSC (Physics)	QUANTUM ELECTRONICS	SAP2203	2011	Employa bility
2018-19	MS0114	MSC (Physics)	MATERIAL SCIENCE	SAP3005	2011	Employa bility
2018-19	MS0114	MSC (Physics)	FIBER OPTICS& INTEGRATED OPTICS	SAP3109	2011	Employa bility
2018-19	MS0114	MSC (Physics)	NUCLEAR PHYSICS& ENGINEERING	SAP3201	2011	Employa bility
2018-19	MS0114	MSC (Physics)	PLASMA PHYSICS	SAP3203	2011	Employa bility



Head of Department

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ISP 4003 Solid State Physics (3-1-0-4)

Crystal structure: Lattice, Basis, Translational vectors, Primitive unit cell, Symmetry operations, Bravais lattices, SC, BCC and FCC structures, Packing fraction, Miller indices, Lattice planes and directions, Reciprocal lattice; Bragg's law and Bragg's Diffraction condition in direct and reciprocal lattice, Ewald's construction, Debye Scherer method, Analysis of cubic structure by powder method. [7]

Crystal bonding: Different types of bonding- ionic, covalent, metallic, van der Waals and hydrogen bonding; cohesive energy. [3]

Lattice Vibrations: Vibration modes of continuous medium; concept of Phonons; Lattice specific heat; Classical theory, Einstein's theory and Debye's theory of specific heat. [4]

Free Electron Theory: Classical free electron theory (Drude model) and its draw back; Quantum theory of free electrons: Schrodinger's wave equations and its applications in particle in box; Physical significance of wave function; Fermi energy, Fermi level, Fermi-Dirac distribution function and effect of temperature; Hall Effect, Origin of energy gap, Energy bands in Solids, Distinction between metal, semiconductor and insulator [7]

Semiconductors Introduction to Metal, Semiconductors and insulator; Types of semiconductors: intrinsic and extrinsic semiconductors; junction devices (diode, transistors, LED,). [4]

Dielectrics: Concepts of dielectrics, Dipole moment; Basic concepts and types of polarization, A.C. effects, Ferro-electricity, Piezo electricity, Ferro and piezo electric materials. [4]

Magnetism: Electron spin and magnetic moment; Origin of magnetism; Types of Magnetism: Dia-, para-, ferro-, ferri-, and antiferromagnetism; Langevin theory of Dia- and paramagnetism, Curie's law; Magnetic domains & hysteresis, Magnetic materials, Magnetic storage devices, Memory materials [4]

Superconductivity: Introduction, effect of magnetic field, Meissner effect, Isotope effect, Penetration depth (London Equations). [3]

Text books:

1. Introduction to Solid State Physics:C. Kittel, Wiley Eastern ltd., New Delhi - 1988.

2. A. J. Dekker: Solid state Physics

Reference books:

1. Solid State Electronics Engineering Materials, S. O. Pillai, Wiley Eastern ltd. New Delhi, 1992.

2. Solid State Physics: Asheroft & Mermin

This course has direct bearing on entrepreneurship

Module I: Network theorems [4]

Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer theorem

Module II: Devices [4]

Types, structure, characteristics and operation of p-n junction diode, Zener diode, LED, BJT, FET

Module III: Amplifiers [9]

Transistor configurations, biasing; small signal BJT amplifiers: h-parameters (CE only), RC coupled amplifier, frequency response, amplifier cascade, emitter-follower and Darlington configurations; Power amplifiers: class A, B (Push-pull). Feedback in amplifiers: negative and positive feedback.

Module IV: Oscillators [3]

Barkhausen criterion for sustained oscillation; RC phase shift, Hartley, Colpitts and crystal oscillator.

Module V: Communication principles [6]

Elementary theory of amplitude modulation, DSB, SSB and VSB; envelope and synchronous detection of AM signals, principle of superheterodyning; FM and PM, and demodulation of FM signals using slope detector and PLL.

Module VI: Operational amplifiers [4]

Op-amp, its properties, differential amplifiers, inverting and non-inverting amplifiers, adder, integrator and differentiator.

Module VII: Power Supplies [5]

Half and full wave rectifiers, efficiency and ripple factor; filters (C, L, pi), Regulated power supply using Zener diode.

Recommended books:

1. Integrated Electronics. Millman & Halkias, Tata-McGraw Hill Edition
2. Engineering Electronics, J. D. Ryder, McGraw Hill Book Company
3. Electronics Fundamentals 7/e, T. L. Floyd, Pearson International Edition

This topic has direct bearing on employability

IMP 5003 Heat and Thermodynamics (3-0-0-3)

Module I: [4]

Concept of heat and temperature, Measurement of temperature, thermometers and thermocouple (SS). Kinetic theory of gases; equation of state of a perfect gas; significance of temperature, derivation of the gas laws, mean free path.

Module II: [6]

Maxwell's law for the distribution of velocities and its verification; mean speed, root mean square speed and most probable speed, degrees of freedom, equipartition of energy, application to specific heats; Transport properties: viscosity and thermal conductivity of a gas; Diffusion in gases

Module III: [5]

Conduction of heat: conductivity and diffusivity; Fourier equation for the propagation of heat and its steady state solution for rectilinear flow of heat; Measurement of thermal conductivity for good and bad conductors.

Module IV: [4]

Basic concepts of thermodynamics: macroscopic and microscopic points of view of thermodynamics, Thermodynamic systems and thermodynamic equilibrium, Quasistatic process;

Module V: [6]

Laws of thermodynamics: The first law of thermodynamics, isothermal and adiabatic changes in perfect and real gases. Reversible and irreversible processes; The second law of thermodynamics; Carnot cycle and the Kelvin temperature scale; Clausius theorem; Entropy and its physical interpretation.

Module VI: [4]

Thermodynamic functions: Helmholtz free energy, Specific heat, Gibb's free energy and enthalpy functions.

Module VII: [6]

Radiation: Concept of radiation, emissive and absorptive power of different bodies, black body radiation, Kirchhoff's law, pressure of radiation, the Stefan-Boltzmann law and its experimental verification. Nernst heat theorem and the third law of thermodynamics.

Textbooks:

1. Heat & Thermodynamics: M. W. Zemansky (McGraw-Hill, International Editions)
2. Heat and Thermodynamics, Brij Lal and N. Subrahmanyam (S Chand and Co. Ltd)

Reference:

1. A treatise on heat: M. N. Saha, B. N. Srivastava (Indian Press 1958)

This course has direct bearing on skill development

IMP 5005 Optoelectronics (3-0-0-3)

Module I: Overview of Optical Fibers [5]

Introduction to optical fibers, types of fibers, fiber parameters, attenuation, dispersion, fabrication and application.

Module II: Theory of Optical Waveguides [6]

Planar, rectangular, Channel and strip loaded waveguides; symmetric and asymmetric waveguide. Modes in waveguide structures, cut off conditions Anisotropic waveguides, guided and radiation modes.

Module III: Optical Sources [5]

Light -Emitting Diodes and laser diodes, Fiber lasers. Power launching and coupling techniques. Source of Power coupling. Fiber to Fiber joints and splitting techniques.

Module IV: Photo Detector [5]

Photo Detectors, PIN Photodiodes and Avalanche photodiode.

Module V: Optical Amplifiers [4]

Semiconductor optical amplifier, mechanisms and rate equations, EDFA, amplification.

Module VI: Fiber Optics Sensors [5]

Concept of sensors, transmissive, reflective, micro bending displacement sensor, Temperature sensor, Pressure sensors, Flow sensor, liquid Level sensor, Magnetic and Electric field sensors. Principle of interferometric sensors

Module VII: Elements of Optical communications [5]

Couplers, connectors, splices, multiplexers, circulators, splices, isolators, sources and detectors.

Books:

1. Optical Electronics; A.K. Ghatak and K. Thayagarajan
2. Optoelectronics: Amon Yariv
3. Fundamental of fiber optics in telecommunication and sensor systems, B.P. Pal, New Age International (P) limited

This course has direct bearing on employability

IMP 5007 Introduction to Quantum Mechanics (3-1-0-4)

Module I: [5]
Inadequacy of classical physics, black body radiation, origin of quantum theory, photoelectric effect, Compton effect, de Broglie's hypothesis, wave-particle duality, Davisson Germer experiment.

Module II: [5]
Concept of wave function, probability density and normalization. Free particle wave function, Gaussian wave packet, delta-function representation, Propagation of wave packets, concept of phase and group velocity, spread of wave packet.

Module III: [5]
Heisenberg uncertainty principle, uncertainty product, consequences of uncertainty relation, examples, natural line-width of spectral lines.

Module IV: [4]
Operators and expectation value. Probability currents and their relation with the flux in beam of particles, Ehrenfest's theorem.

Module V: [6]
Schrödinger wave equation, stationary states, eigen functions, degeneracy, bound states in infinite and finite square potential wells, penetration through a potential barrier, alpha decay.

Module VI: [5]
Linear harmonic oscillator, classical and quantum probability densities, eigenvalue and wave functions, Energy eigenfunction in position space. Numerical problems.

Module VII: [5]
Angular momentum operators, eigenvalues and eigenfunctions, various commutation relations, spin angular momentum, Pauli Exclusion Principle.

Textbooks:

1. Introduction to Quantum Mechanics: B. H. Bransden & C. J. Joachain (English Language Book Society/ Longman).
2. Quantum Mechanics: Theory and Applications; S. Lokanathan and A. Ghatak

This course has direct bearing on skill development

IMP 6001 Materials Science and Nanotechnology (3-1-0-4)

Module I: Imperfections and strengthening mechanisms in solids [5]

Introduction to crystallography, types of imperfections, point defects, edge dislocations, screw dislocations, Burger's vector, dislocation density, surface defects, grains, grain boundary.

Module II: Elastic deformation [5]

Elastic deformation, Hooke's law, stress - strain behavior of mild steel, atomic view of elasticity, anelasticity, elastic moduli, plastic deformation, slip, slip systems, resolved shear stress, Frenkel's calculation of theoretical shear strength,

Module III: Plastic deformation [5]

Plastic deformation of single crystals and polycrystalline materials, strain hardening, annealing, recovery, recrystallization, grain growth, Introduction to fracture, fatigue, creep

Module IV: Ceramics and Glasses [5]

Traditional ceramics, general properties, types, applications. Advanced ceramics, properties and applications, Glasses, general properties, types, applications,

Module V: Polymers and Composites [5]

Traditional polymers, classification, properties, applications, Advanced polymers, for optical, electrical and electronic applications. General properties, types, applications of composites Fibre reinforced composites, various types of fibres - plastic, glass, carbon, etc, influence of fibre length & orientation

Module VI: Introduction to nanotechnology [5]

Basic concepts of nanotechnology, Nanomaterials (Nanoparticles, nanoclusters, quantum dots). Nanoscale, Effect of Nano scale on Material, Properties: Thermal, Mechanical, Electrical, Magnetic and Optical Properties.

Module VII: Synthesis of nanomaterials [5]

Introduction to Nanomaterials Fabrication Techniques: Top-Down Process (Ball Milling, Lithography, Sputtering techniques), Bottom-Up Process (Chemical routes).

Textbooks:

1. W. D. Callister, Materials Science and Engineering: An Introduction, John Wiley, 6th Edition, 2003.
2. W. F. Smith, Principles of Materials Science and Engineering, McGraw Hill International, 1986.
3. Introduction to Nanotechnology, Charles P. Poole, Jr., Frank J. Owens, John Wiley & Sons, 2013.

References:

1. The Structure and Properties of Materials, Wiley Eastern
   Vol. –I, Moffatt, Pearsall and Wulff
   Vol. –III , Hayden , Moffatt and Wulff
2. Physical Properties of Materials, M. C. Lovell, A. J. Avery, M. W. Vernon, ELBS.

This course has direct bearing on employability

ISP 6003 ` Digital Electronics & Communications (3-1-0-4)

Digital Electronics: **(15 classes)**

Introduction to various logic families; Combinational Circuits, adders, subtracters, multiplexers, demultiplexers, encoders, decoders; Sequential circuits, flip-flops, RS, JK, Master Slaves, T and D Flip-Flops, controlled registers, shift registers, synchronous and asynchronous counters, controlled counters, up/down counters, ring counter Memories ROM, PROM, EROM, EEPROM, RAM static and dynamic,

8-BIT microprocessor: (15 classes)

8085 Architecture and Memory interfacing, interfacing I/O devices, Instruction set, Addressing Modes, Assembly language programming, counters and time delays, interrupts, timing diagram, Microprocessor applications; Serial and parallel I/O (8251 and 8255); Programmable interrupt controller (8259), keyboard display controller (8279).

Communication: (10 classes)

Introduction to communication systems, amplitude modulation, radio transmitter and receiver, angle modulation, pulse width modulation

Textbooks:

Digital Electronics, by Malvino

This course has direct bearing on employability

IMP 6005 Introduction to Plasma Physics (3-0-0-3)

Module I: [8]

Basics of vacuum technology, gas flow at low pressures, conductance, throughput and pumping speed, vacuum pumps, vacuum gauges, vacuum accessories, components and vacuum systems.

Module II: [5]

Introduction and brief history of plasma physics, concept of temperature, plasma as the fourth state of matter, types of plasma, plasma parameter, collective behaviour, quasi-neutrality, plasma frequency, plasma sheath, Debye shielding, criteria for existence of plasma.

Module III: [5]

Single particle dynamics; charged particle motion in electric field, magnetic field and in combined electric and magnetic field, basics of ExB drift, drift of guiding center, gradient drift, curvature drift and magnetic mirror.

Module IV: [7]

Plasma production: breakdown of gases, I-V characteristic of electrical discharge, Paschen curve, Plasma devices and machines; glow discharge, dc and rf sputtering, vacuum arcs, stabilized atmospheric arc plasma.

Module V: [4]

Basic plasma diagnostics: electric probes (single and double), optical emission spectroscopy (basic idea).

Module VI: [2]

Plasma Applications: Controlled thermo-nuclear fusion, Tokamaks, Space & Astrophysical plasmas.

Module VII: [4]

Industrial applications of plasma: MHD energy conversion, solid sate plasma, gas lasers, plasma displays, plasma lighting, isotope separation, plasmas for sterilization, plasma in semiconductor industry, plasma welding, cutting, drilling, etching, spheroidization and waste disposal.

Reference Books

1. Introduction to Plasma Physics and Controlled Fusion, Francis F. Chen, Plenum Press, 1984
2. Fundamentals of plasma physics, J. A. Bittencourt, Springer-Verlag New York Inc., 2004
3. The Fourth state of matter- Introduction to plasma science, S. Eliezer and Y. Eliezer, IoP Publishing Ltd., 2001
4. Elementary plasma physics, L.A. Arzimovich, Blaisdell Publishing Company, 1965
5. Plasmas – The fourth state of Matter, D. A. Frank-Kamenetskii, Macmillan Press, 1972

This course has direct bearing on employability

IMP 6007 Introduction to Nuclear Physics (3-0-0-3)

Module I: Properties of Atomic Nuclei

Nuclear size and its determination (electron scattering method), nuclear mass and mass spectroscopy (Aston's mass spectrograph), binding energy , mass defect & packing fraction, nuclear force, Yukawa's theory.

Module II: Radioactivity

Types of atomic nuclei (isotopes, isotones, isobars), laws of radioactivity decay, half-life of radioactive nuclide, average life of an atom, successive radioactive transformation, radioactive equilibrium, applications, tracers, radioactive dating

Module III: Nuclear Models

Fermi gas Model, liquid drop Model, (Weizsacker semi-empirical mass formula, calculations for some nuclei, determination of coefficients, transitions between odd A isobars, transitions between even A isobars, odd-even effects), magic numbers and basic concepts of shell Model

Module IV: Nuclear Reactions

Types of nuclear reactions, conservation laws, Q-value equation, exoergic and endoergic reactions, theory of the compound nucleus, reactions induced by protons, deuterons, α-particles, neutrons, fission, etc

Module V: Nuclear Energy

Fissionable and fissile materials, Fission reactors, breeding, Fusion processes in stars, conditions for controlled thermonuclear reactions, Lawson criteria

Module VI: Nuclear Detectors

Ionization chamber, proportional counter, Geiger-Muller counter, scintillation counter, semiconductor counter,

Module VII: Accelerators

Motion of charged particles in electric and magnetic fields, dynamics of relativistic particles, Van de Graaf generator, tandem van de Graaff, Betatron, Cyclotron

Books Recommended:

1. Nuclear Physics- B. Cohen
2. Nuclear Physics-D C Tayal
3. Elements of Nuclear Physics-Pandey & Yadav
4. Nuclear Physics- I. Kaplan
5. Physics of Particle Accelerator-Kalus Wille

This course has direct bearing on employability

Semester- VII

SAP 1001 Mathematical Methods in Physics (3-0-0-3)

Matrix Algebra: Definition, Algebra of matrices, Special matrices, Eigen-values and Eigen-vectors, LU-Decomposition, Solution of Linear system by LU-Decomposition. **(4)**

Complex variables: Analytic functions, Cauchy-Riemann conditions, Cauchy's Integral theorem and Integral formula, Laurent expansion, Singularities, Evaluation of residues, Residue theorem. **(5)**

Second order differential equations: Partial differential equations of theoretical physics, separation of variables – ordinary differential equations, singular points, series solutions – Frobenius' method, **(4)**

Special Functions: Gamma and Beta functions, Relation between Gamma and Beta functions, Duplication formula, Error function, Bessel's Functions of different kinds, Integral representations of Bessel's Functions, Orthogonality of Bessel's Functions, Modified Bessel's Functions, Legendre Polynomials, Recurrence relations, Rodrigue's formula, Orthogonality of Legendre Polynomials, Associated Legendre Function, Hypergeometric Functions and its integral representation. **(12)**

Fourier Series: General Properties, Advantage and uses of Fourier series, Applications of Fourier series. **(4)**

Integral Transform: Laplace Transform, Inversion, Convolution Theorem, Applications of Laplace Transform; Fourier Transform, Inversion, Fourier Sine and Cosine transform, Convolution Theorem, Fourier transforms of derivatives. Applications of Fourier Transform. **(6)**

Text books

1. Hans J. Weber George B. Arfken, *Mathematical Methods for Physicists*, (2005), Academic Press.
2. L. A. Pipes, *Applied Mathematics for Engineering and Physics* (1958) McGraw-Hill.

References:

1. Charlie Harper, *Introduction to Mathematical Physics* (2003), Prentice-Hall India.
2. Erwin Kreyszig, *Advanced Engineering Mathematics* (1999), Wiley.
3. N. P. Bali, A. Saxena and N.C. S. W. Iyengar, *A Text Book of Engineering Mathematics* (1996), Laxmi Pushiations (P) Ltd.

This course has direct bearing on skill development

SAP 1003 Electrodynamics (3-0-0-3)

Electrostatics: The concept of a scalar potential. Poisson's and Laplace's equations for scalar potential. Green's theorem, Electrostatic field energy density. Solutions of Laplace's equation in rectangular, spherical and cylindrical coordinates using the method of separation of variables. Multipole expansion of potential due to a localized charge distribution. Dipole and quadrupole fields. Interaction energy of dipole and quadrupole in an external field. Electrostatics in matter; Polarization and electric displacement vector. Electric field at the boundary of an interface. Clausius - Mossotti equation.

(13)

Magnetostattics, Time Varying Fields and Maxwell's Equations: Foundations of Magnetostatiscs, Scalar and Vector potentials, Magnetic moment of a current distribution. Macroscopic magnetostatics, Magnetization. M and H vectors, Maxwell's displacement current. Maxwell's equations. Vector and scalar potential. Lorentz and Coulomb gauge. Conservation of energy and momentum of a system of charged particles and electromagnetic fields. Field energy and field momentum.

(13)

Solutions of Maxwell's Equations and Radiation: Plane waves in dielectrics medium. Polarization, reflection and refraction at a plane interface between dielectrics, Fresnel's equations. Phase velocity and group velocity, spreading of a pulse propagating in a dispersive medium, propagation in a conductor, skin depth. Wave guides and cavity resonator. Radiation due to localized oscillatory source, near and far zones, radiated power due to an electric dipole, magnetic pole, example of a centre - fed linear antenna as an electric dipole radiator. Retarded green's function. Lienard-Wichert potentials and fields for a point charge. Larmor's formula for power radiated by a slowly moving accelerated charge. Thomson scattering, Rayleigh scattering and application to nanoparticles.

(14)

Text Book: *Classical Electrodynamics,* J. D. Jackson

References

1. *Introdiuction to Electromagnetic Fields and Waves*, D. R. Corson and P. Lorrain
2. *Introduction to electromagnetics,* D. J. Griffiths
3. *Electromagnetic Theory,* J. A. Statton, McGraw Hill

This course has direct bearing on employability

SAP 1005: Classical Mechanics and Relativity (3-0-0-3)

Constrained Motion: Constraints, Classification of Constraints, Principal of Virtual Work, D'Alembert's principal and its applications (**3)**

Lagrangian formulation: Generalized coordinates, Langrange's equations of motion, properties of kinetic energy function, theorem on total energy, generalized momenta, cyclic-coordinates, integrals of motion, Jacobi integrals and energy conservation, Concept of symmetry, invariance under Galilean transformation, velocity dependent potential. **(8)**

Hamilton's formulation: Hamilton's function and Hamilton's equation of motion, configuration space, phase space and state space, Lagrangian and Hamiltonian of relativistic particles and light rays. **(5)**

Canonical Transformations: Generating function, Conditions for canonical transformation and problem. **(5)**

Poisson Brackets: Definition, Identities, Poisson theorem, Jacobi-Poisson theorem, Jacobi identity, (statement only), invariance of PB under canonical transformation. **(4)**

Rotational Motion: Rotating frames of reference, inertial forces in rotating frames, Larmour precision, electromagnetic analogy of inertial forces, effects of Coriolis force, Focoult's pendulum. **5)**

Central Force: Two body central force problem, stability of orbits, condition for closure, integrable power laws, Kepler's problems, orbits of artificial satellites, Virial theorem. **(5)**

Relativity: Special theory of relativity, Lorentz's transformation, covariant four –dimensional formulations, force and energy equations in relativistic mechanics **(5)**

Text Book: Classical Mechanics by H.Goldstein, Pearson Education Asia.

References:

1. Classical Dynamics of Particles and Systems by Marion and Thomtron, Third Edition, Horoloma Book Jovanovich College Publisher.

2. Classical Mechanics by P.V.Panat, Narosa Publishing Home,, New Delhi.

3. Classical Mechanics by N.C.Rana and P.S.Joag, Tata Mc-Graw Hill Publishing Company Limited, New Delhi.

4. Introduction to Classical Mechanics by R.G.Takawale and P.S.Puranik, Tata Mc-Graw Hill Publishing Company Limited, New Delhi.

This course has direct bearing on skill development

SAP 1007 Quantum Mechanics (3-1-0-4)

Introduction to quantum mechanics: Schrödinger wave equation, interpretation of wave function, probability current density. Solutions:one dimensional square well and barrier,. Linear harmonic oscillator, Heisenberg and quantum mechanical treatments. Spherically symmetric potential in three dimensions, hydrogen atom.
(9)

Scattering theory and WKB approximation method: Scattering cross sections and coefficients, scattering by spherically symmetric potentials, scattering by a coulomb field. Born approximations, WKB approximations, boundary conditions in the quasi classical case,
(9)

Angular momentum, spin and identical particles: Angular momentum, various commutation relations, eigenvalues and eigenfunctions of the angular momentum, spin, spin operators, Pauli's spin matrices, spinors, the principle of in distinguishaility of identical particles, Pauli's exclusion principle,
(8)

Perturbation theory: Perturbation independent of time, first and second order, the effect of the electric field on the energy levels of an atom (Stark effect), perturbations depending on time, first order transitions, constant perturbation, fermi golden rule, interaction of an atom with electromagnetic radiation, the Einstein's A & B coefficients.
(7)

Relativistic wave equations: Klein-Gordon equation for a free particle and particle under the influence of an electromagnetic potential, Dirac's relativistic Hamiltonian, Dirac's relativistic wave equation, significance of negative energy states,
(7)

Text Book: Quantum theory by L.I.Schiff. (Tata McGraw, New Delhi)

References:

1. Quantum Mechanics by L. D. Landau and E. M.Lifshitz (Pergamon, Berlin)
2. Introduction to Quantum Mechanics; D.J.Griffith
3. Quantum Mechanics by A.K.Ghatak and Loknathan.
4. A Modern Approach to Quantum Mechanics by J.S. Townsend, Viva Books, 2010
5. Quantum Mechanics, B.C. Reed, Viva Books, 2010

This course has direct bearing on skill development

SAP 2007 Statistical Physics (3-0-0-3)

Formalism of Equilibrium Statistical Mechanics: Concept of phase space, Liouville's theorem, basic postulates of statistical mechanics, ensembles: microcanonical, canonical, grand canonical, and isobaric, connection to thermodynamics, fluctuations, applications of various ensembles, equation of state for a non-ideal gas, Van der Waals' equation of state, Meyer cluster expansion, virial coefficients. **(8)**

Quantum Statistics: Formalism of Fermi-Dirac and Bose-Einstein statistics. Applications of the formalism to:

(a) Ideal Bose gas, Debye theory of specific heat, properties of black-body radiation, Bose-Einstein condensation, degeneracy, BEC in a harmonic potential.

(b) Ideal Fermi gas, properties of simple metals, Pauli paramagnetism, electronic specific heat, white dwarf stars. **(8)**

Phase Transitions and Critical Phenomena: Thermodynamics of phase transitions, metastable states, Van der Waals' equation of state, coexistence of phases, Landau theory, critical phenomena at second-order phase transitions, spatial and temporal fluctuations, scaling hypothesis, critical exponents, universality classes. **(8)**

Ising Model: Ising model, mean-field theory, exact solution in one dimension, renormalization in one dimension. **(8)**

Nonequilibrium Systems: Systems out of equilibrium, kinetic theory of a gas, approach to equilibrium and the H-theorem, Boltzmann equation and its application to transport problems, master equation and irreversibility, simple examples, ergodic theorem. Brownian motion, Langevin equation, fluctuation-dissipation theorem, Einstein relation, Fokker-Planck equation.

(8)

Text Book: Statistical Physics, Landau and Lifshitz, Pergamon Press

References:

Statistical Physics, R. K. Patharia, Pergamon Press

Statistical Physics, Kerson Huang, John Wiley and Sons

Statistical Physics, S. K. Ma, World Scientific Publishing, Singapore

This course has direct bearing on employability

ISP 7002 Modern Computational Techniques & Programming (1-0-3-3)

Theory & Lab work using Matlab and Maple software for solving problems of following topics:

1. **Approximation Methods and Errors:** Accuracy and precision, Truncation and round-off errors. (5)

2. **Roots of Equations**: Bracketing Methods (false position, bisection), Iteration Methods (Newton-Raphson and secant). (5)

3. **Systems of linear algebraic equations:** Gauss elimination, matrix inversion and LU decomposition methods. (5)

4. **Curve fitting and Interpolation :** Least squares regression, Linear, multiple linear and nonlinear regressions, Cubic spline. Newton's divided difference and Lagrange interpolating polynomials. (7)

5. **Numerical differentiation and integration:** Divided difference method for differentiation, Newton-Cotes formula, Trapezoidal and Simpson's rules, Romberg and Gauss quadrature methods. (5)

6. **Ordinary differential equations:** Euler's method and its modifications, Runge-Kutta methods, Boundary value and Eigen value problems. (5)

7. **Partial differential equations:** Finite difference equations, Elliptic equations, Laplace's equation and solutions, Parabolic equations, Solution of the heat conduction equation. Finite element method: General approach, Application to 1-dimensional and 2-dimensional problems. (8)

REFERENCES:

1. Numerical Mathematical Analysis, J.B. Scarborough, John Hopkins (1966).
2. Introductory Methods of Numerical Analysis, S.S. Sastry, Prentice Hall of India (1983)
3. Numerical Methods for Engineering, S.C. Chopra and R.C. Canale, McGraw-Hill (1989).
4. Numerical Methods for Scientists and Engineers, Prentice Hall of India (1988).
5. Electromagnetics and Calculation of Fields, Nathan P-Ida and J.P.A. Bastos, Springer-Verlag (1992).

This course has direct bearing on employability

Semester- VIII

SAP 2101 Electronics and Instrumentation (3-1-0-4)

Module I: Electronic Devices [4]

Varactor diode, photo-diode, Schottky diode, solar cell, Principle of Operation and I-V Characteristics of FET, MOSFET.

Module II: Integrated Analog Electronics [7]

Basics of operational amplifiers, voltage gain, input and output impedance of inverting amplifier, non-inverting amplifier; phase inverter, scale changer, integrator, differentiator. voltage multiplier, limiter, clipper, clamper and peak-to-peak detector, difference amplifier, instrumentation amplifier, active filters (low-pass, high-pass, band-pass, band-reject/ notch), RC phase shift and Wein bridge oscillators.

Module III: Advanced applications of op-amps [7]

Comparators, schmitt trigger, multivibrators, AMV and MMV using 555 timer, waveform generation, power supply circuits, analog computation using op-amps. D/A converters, binary weighted, ladder type, A/D converters, simultaneous, counter type, successive approximation type, dual slope converter.

Module IV: Digital Electronics [5]

Introduction to various logic families; Combinational Circuits, adders, subtracters, multiplexers, demultiplexers, encoders, decoders, Sequential circuits, flip-flops, RS, JK, Master Slaves, T and D Flip-Flops, controlled registers, shift registers, synchronous and asynchronous counters, controlled counters, up/down counters, ring counter Memories ROM, PROM, RAM

Module V: Introduction of measurements and measurement systems [2]

Measurement basics: range, resolution, linearity, hysteresis, reproducibility and drift, calibration, accuracy and precision. Errors and noise in measurements, basic noise reduction techniques.

Module VI: Electronic Instruments [7]

Classification and principles of operation analog electronic voltmeter, DC voltmeter, advantages of digital over analog processing. Digital voltmeter and frequency meter, Kelvin Double Bridge, Maxwell's Bridge; Signal conditioning.

Module VII: Transducers [4]

Definition, classification, principle of analog transducer: resistive (strain gauge, thermistor and RTD), capacitive, piezoelectric, thermocouple and LVDT, Actuators: pneumatic cylinder, relay, solenoid.

Textbooks:

1. Electronic Devices: Solid State Electronic Devices – B. G. Streetman, PHI, Physics of Semiconductor Devices – S. M. Sze.
2. Electronics Circuits & Systems: Integrated Electronics - Millman & Halkias, McGraw Hill,
3. Operational Amplifiers and Linear Integrated Circuits - R. F. Coughlin, F. F. Driscoll, PHI.,
4. Operational Amplifiers and Linear Integrated Circuits - R. A. Gayakwad, PHI.
5. Digital Electronics: Digital Electronics – Malvino and Leach, TMH.
6. Instrumentation: Electrical and Electronic Measurements and Instrumentation - A. K. Sawhney,
7. Electronic Instrumentation - H. S. Kalsi, Modern Electronic Instrumentation & Measurement Techniques - Helfrick & Cooper

References:

1. Electronic Devices and Circuits – T.F. Bogart Jr., J.S.Beasley and G.Rico, Pearson Education, 6th edition,2004.
2. Electronics Fundamentals and Applications, J. D. Ryder, Prentice Hall of India , New Delhi , 1987.
3. Electrical and Electronic Measurements and Instrumentation, Sawhney, Dhanpatrai and Sons, New Delhi, 1982.

This course has direct bearing on employability

SAP 2203 Quantum Electronics (3-0-0-3)

Module I: Beam Optics [5]

Paraxial theory, Gaussian beam transmission through optical components, Hermite –Gaussian beams, Laguerre-Gaussian and Bessel beams.

Module II: Optical Resonator (cavity) [5]

Theory of resonator, ABCD matrix, Stable and unstable resonator, Longitudinal and transverse mode of the cavity.

Module III: Electro-optics and magneto-optics [5]

Light propagation in anisotropic media. Theory of electro-optic, magneto-optic and acousto-optic effects and devices.

Module IV: Laser principle and properties [5]

Coherence, monochromaticity, divergence .Principle of laser: Absorption and Emission of light, Population inversion, Gain oscillation, Gain saturation, Threshold, Rate – equation, 3 and 4 level systems.

Module V: Types of lasers [5]

Continuous wave, Pulsed, Q- switched and Mode locked laser. Different lasers Systems: Design (in brief) and functioning of different lasers - Ruby Laser, Nd: YAG laser He-Ne laser, Co2 laser, Argon ion laser, Excimer laser, Semiconductor laser, Fiber laser.

Module VI: Laser safety and Applications [5]

Alignment, Targeting, Tracking, Dimension gauging, Velocity Measurement, Surface quality measurement, Contour mapping, Profile detection, Determination and measurement of atmospheric pollution. Holographic non destructive testing (NDT).

Module VII: [5]

Interaction of atom with electromagnetic field, Rabi oscillation, linear absorption and amplification-Beer's Law. Introduction to non-linearity of matter towards its optical properties. Brief introductions to harmonic generation and parametric processes. Nonlinear material (Brief discussion).

Textbook:

1. Elements of Photonics: K. Izuka
2. Laser Fundamentals: William T. Silfvast, Cambridge University Press (1998)

References:

1. K. Shimoda, Introduction to laser Physics, Springer Verlag, Berlin (1984)
2. Laser Electronics: J.T.Verdeyen, 3rd Ed, Prentice Hall (1994)
3. Laser Physics, M. Sargent III, M. O. Scully and W. E. Lamb, Jr.

This course has direct bearing on employability

SAP 2105: Atomic, Molecular and Modern Spectroscopy (3-0-0-3)

1. Atomic Physics: Quantum states of an electron in an atom; Electron spin; Stern-Gerlach experiment; Spectrum of Hydrogen, helium and alkali atoms; Relativistic corrections for energy levels of hydrogen; Hyperfine structure and isotopic shift; Spectral terms of two electron atoms, terms for equivalent electrons, L-S and J-J coupling schemes, Singlet-Triplet separation for interaction energy of L-S coupling. Lande Interval rule, Zeeman, Paschen Back & Stark effect; width of spectral lines

2. Molecular Spectroscopy: Rotational, vibrational and electronic spectra of diatomic molecules; Frank – Condon principle and selection rules, Raman Effect, Rotational Raman spectra. Vibrational Raman spectra. Stokes and anti-Stokes lines and their Intensity difference, Rule of mutual exclusion, Importance of neutral hydrogen atom, Molecular hydrogen, Fluorescence and Phosphorescence

3. NMR Spectroscopy: Nuclear spin, nuclear resonance, saturation, chemical shift, de shielding, spin-spin interaction, coupling constant J, basic ideas about instrumentation of NMR, applications.

4. Mass Spectroscopy: Ion production, fragmentation, ion analysis, ion abundance, mass spectroscopy, instrumentation and application.

5. Mossbauer Spectroscopy: Spectral parameters and spectrum display, Isomer shift, quadruple splitting, hyperfine interaction and applications

Suggested Books:

1. "Introduction to Atomic Spectra", H.E. White, McGraw-Hill
2. “Atomic Physics”, G. P. Harnwell & W.E. Stephens, McGraw-Hills Book Company, Inc.
3. “Fundamentals of Molecular Spectroscopy” C. N. Banwell & E. M. McCash,

4. “Modern Spectroscopy”, J. M. Hollas, John Wiley
5. “Preparation of Molecular Physics” A. Beisen, McGraw-Hill.
6. The Feynman Lectures on Physics by R. B. Feynman, R. B. Leighton, M. Sands, Narosa Publishing House

This course has direct bearing on employability

SAP 2009 Condensed Matter Physics (3-0-0-3)

Crystal Structure: Crystalline and amorphous solids, unit cell, reciprocal lattice, lattice planes and Directions, HCP structure, diamond structure, various types of crystal defects, Burger vector (5)

Thermal Properties of Materials: Phonons, heat capacity, Thermal expansion and conductivity Density of states in 1D and 3D, Vibration of lattice - mono- and di-atomic chains. 5

Electrical Properties of Materials: Density of energy states and Fermi energy, Electrical conductivity from Quantum Mechanics consideration, Electron Scattering and sources of resistance in metals, Electron-Scattering Mechanism and variation of resistivity with temp, Band theory of solids, and origin of energy gap, Bloch functions, Kronig Penny model, periodic & nonperiodic potential, Hall Effect & Hall coefficient. 8

Semiconductors: General properties and band structure, carrier statistics, impurities, intrinsic and extrinsic semiconductors, p-n junctions, equilibrium fields and densities in junctions, drift and diffusion currents, Hall Effect & Hall coefficient, Generation and recombination of carriers, Theory of p-n junction. 8

Magnetic Properties of Materials: Classification of magnetic materials, Quantum theory of para & ferromagnetism. Weiss theory of paramagnetism, Crystal field splitting, Magnetic ordering, Magnetization, Hysteresis, theory of ferromagnetism, Weiss Molecular theory, temperature dependence of spontaneous magnetization, Ferromagnetism domains, Bloch wall, Antiferromagnetism, Ferrimagnetism. 8

Superconductivity: type-I and type-II superconductors, Meissner effect, Concept of energy gap, Optical properties of SC, London equation, BCS theory, Giaver and Josephson tunneling. 4

Dielectrics and Ferroelectrics: polarization, A.C effects, Clausius-Mossotti relation, ferro electric hysteresis loop, antiferroelectricity, piezo-electricity. 4

References

1. C. Kittel: Introduction to Solid State Physics, Wiley Eastern Ltd., New Delhi - 1988.

2. S. O. Pillai: Solid State Electronics Engineering Materials,Wiley Eastern Ltd. New Delhi, 1992.

3. A. J. Dekker: Solid State Physics, Macmillan, 1962

4. Asheroft & Mermim: Solid State Physics

This course has direct bearing on employability

SAP 3109 Fiber Optics and Integrated Optics (3-0-0-3)

Module I: Overview of Optical Fibers [5]

Structure of optical fibers. Step-index and graded index fibers; light propagation in optical fibers. Single mode, multimode and W-profile fibers. Ray Optics representation, numerical aperture and acceptance angle.

Module II: Attenuation and Dispersion [5]

Attenuation in optical fibers - Absorption - Scattering losses - Radiative losses.Dispersion effects, Material dispersion - Combined effect of material and multipath dispersion - RMS pulse widths and frequency response - Model Birefringence

Module III: Wave Propagation in Step-index Fibers [5]

Modes in an ideal step-index fiber, Time dispersion - Material Dispersion and Waveguide dispersion in single-mode fibers.

Module IV: Wave Propagation in Graded-index Fibers [5]

Modes in graded index fibers. No. of propagating modes. Inter Model and Intra Model dispersion in graded-index Fibers. Mode coupling.

Module V: Fabrication processes [5]

Different fiber fabrication methods- chemical vapor deposition method, axial vapor deposition, plasma enhanced modified CVD.

Module VI: Photonic Crystal Fibers [5]

guiding principle, index guiding and band gap guiding. Types of fibers, dispersion, birefringence, polarization and nonlinear property. Device application.

Module VII: Theory of Optical Waveguides [5]

Planar, rectangular, Channel and strip loaded waveguides; symmetric and asymmetric waveguide. Step-index and graded index waveguides, Electro-optic and acousto-optic waveguide devices. Modulators, Waveguide Couplers and integrated optics devices.

Textbook:

1. Introduction to Optical fibers: A.K. Ghatak and K. Thayagarajan
2. Optoelectronics: AmonYariv

References:

1. Optical Fiber Communication Systems by Gerd Keiser.
2. Optical Communication Systems by John Gowar.

This course has direct bearing on employability

Semester IX

SAP 3201 Nuclear Physics and Engineering (3-0-0-3)

Module I: Nuclear Models

Liquid drop Model, semi-empirical mass formula, transitions between odd A isobars, transitions between even A isobars, odd-even effects & magic numbers, shell Model

Module II: Two nucleon problem

Ground state of deuteron, excited state of deuteron, nature of nuclear forces, spin-dependence of nuclear force tensor forces, meson theory of nuclear force

Module III: Scattering

Neutron-proton scattering at low energies, cross-section, scattering cross-section, scattering length, proton-proton scattering at low energies,

Module IV: Interaction of radiation with matter

Interaction of charged particles with matter, stopping power of heavy charged particles, energy loss of heavy ions and electrons, Cerenkov radiation, absorption of gamma rays, photoelectric effect, Compton effect and pair production

Module V: Accelerators & Detectors

Electron source, ion source, linear accelerator, synchrotron, introduction to advance accelerator (LHC) Ionization chamber, scintillation counter, semiconductor counter, Cerenkov detectors

Module VI: Elementary particles

Classification of elementary particles, particles and anti particles, fundamental interactions (response of particles to strong, electromagnetic and weak interactions), elementary particles quantum numbers, conservation laws and symmetry, the CPT theorem

Books Recommended:

1. Nuclear Theory- Roy and Nigam
2. Nuclear Physics-D C Tayal
3. Nuclear Physics : D. Halliday
4. Nuclear Physics: I. Kaplan
5. Physics of Particle Accelerators:-Kalus Wille
6. Elementary Particles: I S Hughes

This course has direct bearing on employability

SAP 3203 Plasma Physics (3-1-0-4)

Module I: Introduction to Plasma [6]

The fourth state of matter, collective behaviour, charge neutrality, space and time scales, Concept of plasma temperature, Debye length, plasma frequency, plasma parameters and criteria for plasma state. Debye Shielding, Plasma sheath, Plasmas in nature and laboratory

Module II: Basic Processes in plasmas [8]

Collisions in plasmas, Ionization and the Saha equation, LTE and equilibrium Models, Recombination, Concepts of diffusion, mobility and electrical conductivity, Ambipolar diffusion, Effect of magnetic field on the mobility, diffusion of plasma in presence of magnetic field.

Module III: Plasma Theory [8]

Motion of charged particles in electric and magnetic fields, Concepts of elementary kinetic theory of plasmas, Boltzmann and Vlasov equation, Fluid theory of plasma, single & multi fluid approximations, generalized Ohm's law, MHD equations

Module IV: Plasma Oscillations and waves [4]

Langmuir oscillations, ion waves, electromagnetic waves along and perpendicular to B_o, Alfven waves.

Module V: Plasma production [6]

Electrical discharges, Electrical Breakdown in gases, glow discharge, self-sustained discharges, Paschen curve, high frequency electrical discharge in gases, electrode less discharge, Capacitively and inductively coupled plasmas, Electrical arcs.

Module VI: Plasma diagnostics [4]

Langmuir probe, Spectroscopic diagnostics.

Module VII: Plasma Applications [4]

Controlled thermonuclear fusion, tokamak, MHD generator, plasma display, industrial applications of plasmas, hazardous waste disposal.

Textbooks:

1. Introduction to Plasma Physics and Controlled Fusion, Francis F. Chen , Springer; 2nd ed. 1984. latest edition. 2006.
2. Fundamentals of plasma physics, J. A. Bittencourt, 3rd Edition Springer-Verlag New York Inc., 2004
3. The Physics of Plasmas, T. J. M. Boyd and J. J. Sanderson, Cambridge University Press, 2003
4. Cold Plasma in Materials Fabrication from Fundamentals to Applications, A. Grill, (IEEE Press, New Jersey, 1994)
5. Reactions under Plasma conditions Vol. I and II, Venugopalan

This course has direct bearing on employability

SAP 3015 Advanced Experimental Techniques (3-0-0-3)

X-ray Diffraction Methods: (8)
Classification of crystal system, Bragg's law and Laue conditions, Powder methods, crystal size analysis, Rietvold method of structural analysis, X-ray fluorescence spectroscopy, applications of emission spectra for compounds and alloys, Applications of absorption spectra for solid solutions and transitional metal compounds, Neutron spectroscopy. X-Ray Reflectivity

Spectroscopy (6)
Atomic absorption spectrophotometer and its application to environmental analysis, UV-visible spectroscopy and its application, IR-spectroscopy and its application, AES, XPS, Introduction to RBS, SIMS, and its applications. Raman Spectroscopy (UV and Vis)

NMR, EPR spectroscopy (7)
Principles of magnetic resonance, Instrumentation and specimen preparation techniques, chemical shift, spectral analysis, basic principles of ESR. Some applications to simple solids and liquids. An Introduction to Mossbauer spectroscopy.

Microscopy & Optical Microscopy (4)
Optical microscopy, metallurgical microscope, TEM, SEM and AFM, specimen preparation, instrumentation and applications, Electron Energy Loss Spectroscopy, Nano indenter and NanoTribometer

Thermochemical analysis (4)
Thermoanalytical techniques, Instrumentation and applications of TGA, DTA, DSC.

Electrochemical Techniques (6)
Electrochemical Instrumentation, Coulometry, polarography, cyclic voltametry, application to oxidation-reduction reaction, pulse technique and stripping voltametry.

Vacuum Technology & Thin film Deposition Technique (6)
Application to Vacuum Technology, Types of vacuum pumps, different technique of thin film deposition CVD, PVD, MBE, MOCVD.

Mass spectrophotometic technique, TLC, HPLC, GC-MS etc. (4)

Text Book:
Mossbauer Effect: An Introduction to Inorganic and Geo Chemist by G. M. Banchroft, McGraw Hill, 1973

References:
1. Spectroscopy, Vol. I, II and III, ed. By Straughan and Walker, John Wiley.
2. Analytical Chemistry by G. D. Christian, 6th edition, John Wiley & Sons.
3. Analytical Chemistry by D. Kealey & P. J. Haines, Viva Books Pvt. Ltd.

This course has direct bearing on skill development

SAP **3011** **Nanostructures and Nanomaterials** **(3-0-0-3)**

Module-I
Introduction to Nanotechnology & Nanomaterials, Nanoscale, Effect of Nano scale on Material Properties: Thermal, Mechanical, Electrical, Magnetic and Optical Properties. 10

Module-II
New Behaviour: Size confinement, Interfacial Phenomena, Surface to Volume Ratio, Surface Tension, Quantum Mechanics (Importance of Nanomaterials & its effect on Bulk Properties, Nanomaterials. 07

Module-III
Nanostructured Materials: Properties and Applications of Nanocrystals, Nanoparticles (Emphasis on Surface to Volume Ratio, Surface Tension, Surface Energy), Nanowires, Nanotubes, Oxide Nanostructures, Nanorods, Biomolecules, Nanostructured Polymers, Nanostructured Coatings & Nanocatalist. 10

Module-IV
Introduction to Nanomaterials Fabrication Techniques: Top-Down Process, Bottom-Up Process & Self Assembly. 04

Module-V
Introduction to Nanomaterials Characterization Methods: AFM, Scanning Probe Microscopy, Nanoindentation, Raman Spectroscopy, XPS & FTIR. 06

Module-VI
Applications of Nanomaterials: Structural and Functional Applications, Electronics Applications & Biological Applications. 03

Text Book: C. P. Poole Jr. and F J Ownes, Introduction to Nanotechnology, Wiley (2003).

Reference:
D. Tomanek and R. J. Enbody, Science and Applications of Nanotubes, Kluwer (2003).
Davies, Introduction to semiconductor Devices, Wiley (2002).

This course has direct bearing on entrepreneurship

TNT 2003 Nanophotonics (3-0-0-3)

Foundations for Nanophotonics: Photons and electrons: similarities and differences, freespace propagation. Confinement of photons and electrons. Propagation through a classically forbidden zone: tunneling. Localization under a periodic potential: Band gap. Cooperative effects for photons and electrons. Nanoscale optical interactions, axial and lateral nanoscopic localization. Nanoscale confinement of electronic interactions: Quantun confinement effects, nanoscale interaction dynamics.

Quantum Confined Materials: Inorganic semiconductors, quantum wells, quantum wired, quantum dots, quantum rings. Manifestation of quantum confinement: Optical properties nonlinear optical properties. Quantum confined stark effect. Dielectric confinement effect, superlattices. Quantum confined structures as Lasing media.

Photonic Crystals: Basics Concepts, Features of Photonic Crystals, wave propagation, photonic bansgaps, light guiding. Theoretical Modeling of Photonic Crystals. Methods of Fabrication. Photonic Crystal Optical Circuitry. Nonlinear Photonic Crystals. Photonic Crystals and Optical Communications. **A**pplication to high efficiency emitters, miniaturized photonic circuits and dispersion engineering. Photonic Crystal Sensors.

Microstructure Fibers: Photonic crystal fiber, photonic band gap fibers (PBG), band gap guiding, single mode and multi mode, dispersion engineering, nonlinearity engineering, devices using crystal fibers.

Plasmonics: Metallic nanoparticles, nanorods and nanoshells, local field enhancement. Collective modes in nanoparticle arrays, particle chains and arrays. suface plasmons, plasmon waveguides. Applications of Metallic Nanostructures.

Nanophotonic Devices : Resonant cavity quantum well lasers and light-emitting diodes, fundamentals of Cavity QED, strong and weak coupling regime, Purcell factor, Spontaneous emission control, Application of microcavities, including low threshold lasers, resonant cavity LED. Microcavity-based single photon sources.

Books:

1. Nanophotonics, Paras N Ptrasad, John Wiley & Sons (2004)
2. Photonic Crystals: Towards Nanoscale Photonic Devices; Jean Michel Lourtioz, Springer ; ISBN 354024431X
3. Fundamentals of Photonic Crystal Fibers; Fredric Zolla- Imperial College Press. ISBN 1860945074
4. Photonic Crystals; John D Joannopoulos, Princeton University Press; ISBN 0691037442
5. Photonic Crystals: Modelling Flow of Light; John D Joannopoulos , R.D. Meade and J.N.Winn, Princeton University Press (1995)

This course has direct bearing on employability

IMP 2001 Physics II - Basic Electromagnetic Theory (3-0-0-3)

Module I: Fields [5]

Vector and scalar fields, physical and mathematical concepts of gradient, divergence and curl, Gauss's theorem and Stokes' theorem.

Module II: Electrostatics I [5]

Coulomb's law, Gauss's law in integral and differential form, electric potential and relation with E, electrostatic energy density,

Module III: Electrostatics II [5]

Dielectrics, Relation between E, D and P vectors, dielectric susceptibility, boundary conditions on E and D.

Module IV: Magnetism I [5]

Motion of charged particles in electric and magnetic fields, Biot-Savart law, Ampere's law in integral and differential form, applications, Hall effect.

Module V: Magnetism II [7]

Types of magnetism – diamagnetism, paramagnetism and ferromagnetism, Weiss field, domains, magnetic permeability and susceptibility, Relation between B, H and M vectors, boundary conditions on B and H, hysteresis.

Module VI: Electromagnetic theory I [4]

Faraday's law of electromagnetic induction in integral and differential form, Inductance, magnetic energy density, continuity equation for charge, displacement current,

Module VII: Electromagnetic theory II [4]

Maxwell's equations in free space, electromagnetic wave equation for plane waves in dielectric medium and free space, relation between E, B and k, Poynting vector, radiation pressure.

Textbooks:

1. Fundamental of Physics: Halliday, Resnick & Walker (6th Edition)
2. Engineering Electromagnetics: William Hayt, John Buck, McGraw-Hill Company (7th Edition)

Reference books:

1. Introduction to Electrodynamics: David J Griffiths, 3rd Ed.
2. Electricity and Magnetism: J. D. Jackson

This course has direct bearing on skill development

IMSc Physics -IV Semester

IMP 4103 Solid State Physics

[3-0-0-3]

Module I: Crystal structure: [5]
Bravais space lattices, basis, lattice vectors, crystal systems, primitive cell, unit cell, packing fraction, SC, FCC, BCC, HCP systems, relation between density and lattice constant, Miller indices, lattice planes and directions, relation between interplanar spacing and lattice constants, X-ray diffraction, Bragg's law

Module II: Crystal bonding: [5]
Types of bonding in solids, nature of ionic, covalent, metallic, van der Waals, and hydrogen bonding (qualitative), mixed bonding, properties of materials with these bonds, concept of cohesive energy. Madelung constant, evaluation of Madelung constant for NaCl structure.

Module III: Electrical properties of solids: [5]
Free Electron Theory of metals, drift velocity, microscopic form of Ohm's law, conductivity, mobility of charge carriers, Hall effect & Hall coefficient, Band theory (qualitative), resistivity, variation with temperature, thermoelectricity, thermocouples, applications

Module IV: Semiconductors: [5]
General properties, band structure, intrinsic and extrinsic semiconductors, Fermi level, carrier concentration, carrier statistics, electrical conductivity, mobility of charge carriers, effect of temperature on carrier concentration, metal semiconductor junction properties.

Module V: Dielectrics: [5]
General concepts and properties, applications, dielectric constant, permittivity, losses, dielectric breakdown, measurements, dipole moment, types of polarization, polar molecules, Langevin's theory of orientational polarizability, Clausius–Mossotti equ ation, Ferroelectric behaviour

Module VI: Magnetism: [5]
Classification of magnetic materials, qualitative concepts of diamagnetism and paramagnetism, ferromagnetism, hysteresis, domains, Weiss theory, Curie law, anti-ferromagnetism, ferrimagnetism, ferrites, atomic theory of magnetism, origin of permanent magnetic moments

Module VII: Superconductivity: [5]
Historical, general concepts and properties, critical temperature, Meissner effect, critical field, Type-I and Type-II superconductors, introduction to high TC superconductors, applications.

Text books:
1. Introduction to Solid State Physics: C. Kittel, Wiley Eastern ltd., New Delhi - 1988.
2. Solid state Physics: A. J. Dekker, Macmillan, Ed. 2011.

Reference books:
1. Solid state Physics: M.A.Wahab, Narosa
2. Elementary Solid State Physics: M Ali Omar, Pearson

This course has a direct bearing on entrepreneurship

IMP 5001 Fundamentals of Electronics [3-1-0-4]

Module I: Network theorems **[5]**
Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum Power Transfer theorem

Module II: Devices **[6]**
Types, structure, characteristics and operation of p-n junction diode, Zener diode, LED, BJT, FET, UJT, SCR

Module III: Amplifiers **[11]**
Transistor configurations, biasing; small signal BJT amplifiers: h-parameters (CE only), RC coupled amplifier, frequency response, amplifier cascade, emitter-follower and Darlington configurations; Power amplifiers: class A, B (Push-pull). Feedback in amplifiers: negative and positive feedback.

Module IV: Oscillators **[5]**
Barkhausen criterion for sustained oscillation; RC phase shift, Hartley, Colpitts and crystal oscillator.

Module V: Communication principles **[10]**
Elementary theory of amplitude modulation, DSB, SSB and VSB; envelope and synchronous detection of AM signals, principle of superheterodyning; FM and PM, and demodulation of FM signals using slope detector and PLL.

Module VI: Operational amplifiers **[5]**
Op-amp, its properties, differential amplifiers, inverting and non-inverting amplifiers, adder, integrator and differentiator

Module VII: Power Supplies **[8]**
Half and full wave rectifiers, efficiency and ripple factor; filters (C, L, pi), Regulated power supply using Zener diode, series pass regulator and series pass regulator with op-amp feedback.

Text books:

1. Electronics Fundamentals 7/e, T. L. Floyd, Pearson International Edition
2. Engineering Electronics, J. D. Ryder, McGraw Hill Book Company

This course has a direct bearing on entrepreneurship

IMSc Physics -V Semester

IMP 5103 Heat and Thermodynamics [3-0-0-3]

Module I: Concept of heat and temperature, Conduction of heat, Measurement of temperature, thermometers and thermocouple, Kinetic theory of gases; Basic assumptions of kinetic theory, Ideal gas approximation, deduction of perfect gas laws. **[6]**

Module II: Maxwell's law for the distribution of velocities and its verification; mean speed, root mean square speed and most probable speed, degrees of freedom, equipartition of energy, application to specific heats; Transport properties: viscosity and thermal conductivity of a gas; Diffusion in gases. Real gases, Andrew's curves, Equation of state, Virial coefficients, Van der Waals equation, Critical constants. **[6]**

Module III: Thermal conductivity and diffusivity; Fourier equation for the propagation of heat and its steady state solution for rectilinear flow of heat; cylindrical flow of heat; various experiments for measurement of thermal conductivity for good and bad conductors. **[6]**

Module IV:
Basic concepts of thermodynamics: macroscopic and microscopic points of view of thermodynamics, Thermodynamic systems and thermodynamic equilibrium, Thermodynamic state of a system and Zeroth law of Thermodynamics, Thermodynamic Equilibrium, Adiabatic and isothermal changes, Work done during isothermal changes, Adiabatic relations for perfect gas, Work done during adiabatic change, Indicator Diagram. **[5]**

Module V:
Laws of thermodynamics: The first law of thermodynamics, Reversible and irreversible processes; Conversion of Heat into Work and its converse, Carnot's Cycle and Carnot's Heat Engine and its efficiency, Second law of Thermodynamics, Concept of Entropy, T-dS Equation, Clausius-Clapeyron Latent heat equations, Nernst heat theorem and the third law of thermodynamics. **[6]**

Module VI:
Thermodynamic functions: Internal energy, Helmholtz free energy, Specific heat, Gibb's free energy and enthalpy functions. **[5]**

Module VII:
Radiation: Concept of radiation, emissive and absorptive power of different bodies, black body radiation, Kirchhoff's law, pressure of radiation, the Stefan-Boltzmann law, Wien's displacement law, Rayleigh-Jean's law, Planck's quantum theory o f radiation. **[6]**

Text books:
1. Heat & Thermodynamics: M. W. Zemansky (McGraw-Hill, International Editions)
2. Heat and Thermodynamics, Brij Lal and N. Subrahmanyam (S Chand and Co. Ltd)

Reference:
1. A treatise on heat: M. N. Saha, B. N. Srivastava (Indian Press 1958)

This course has a direct bearing on skill development

IMSc Physics -V Semester

IMP 5107 Introduction to Quantum Mechanics

[3-1-0-4]

Module I: Inadequacy of classical physics, black body radiation, Planck's law of radiation, origin of quantum theory, Specific heat of solids, Debye's theory, Photoelectric effect, Einstein's equation, Compton effect, de Broglie's hypothesis, wave-particle duality, Bohr's theory of Hydrogen atom, Franck-Hertz experiment. Bohr's correspondence principle, Davisson Germer experiment, Thomson's experiment. **[8]**

Module II: Concept of wave function, probability density and normalization. Free particle wave function, Dirac delta–function representation, Gaus sian wave packet, Propagation of wave packets, concept of phase and group velocity, spread of wave packet. **[6]**

Module III: Heisenberg uncertainty principle, Derivation of uncertainty relation using Schwartz inequality, consequences of uncertainty relation, examples, natural line-width of spectral lines. **[5]**

Module IV: Operator formalism in Quantum mechanics, Expectation value, Probability currents and their relation with the flux in beam of particles. **[5]**

Module V: Schrödinger time-independent and time-dependent equ ations, concept of stationary states, eigen functions, degeneracy, One dimensional potential problems: particle in a box, bound states in infinite square potential well, penetration through a potential barrier, alpha decay. **[6]**

Module VI: Linear harmonic oscillator (qualitative), classical and quantum probability densities, eigen values and wave functions, Energy eigen functions in position space. **[5]**

Module VII: Angular momentum operators, eigen values and eigen functions, various commutation relations, spin angular momentum, Pauli's Exclusion Principle (qualitative). **[5]**

Textbooks:

1. Introduction to Quantum Mechanics: B. H. Bransden & C. J. Joachain (English Language Book Society/Longman).
2. Quantum Mechanics: Theory and Applications; S. Lokanathan and A. Ghatak

This course has a direct bearing on skill development

IMSc Physics -VI Semester

IMP 6101 Materials Science and Nanotechnology

[3-0-0-3]

Module I: Imperfections and strengthening mechanisms in solids [6]
Introduction to crystallography, types of imperfections, point defects, edge dislocations, screw dislocations, Burger's vector, dislocation density, surface defects, grains, grain boundary.

Module II: Elastic deformation [6]
Elastic deformation, Hooke's law, stress - strain behavior of mild steel, atomic view of elasticity, anelasticity, elastic moduli, plastic deformation, slip, slip systems, resolved shear stress, Frenkel's calculation of theoretical shear strength,

Module III: Plastic deformation [6]
Plastic deformation of single crystals and polycrystalline materials, strain hardening, annealing, recovery, recrystallization, grain growth, Introduction to fracture, fatigue, creep

Module IV: Ceramics and Glasses [6]
Traditional ceramics, general properties, types, applications. Advanced ceramics, properties and applications, Glasses, general properties, types, applications,

Module V: Polymers and Composites [6]
Traditional polymers, classification, properties, applications, Advanced polymers, for optical, electrical and electronic applications. General properties, types, applications of composites Fibre reinforced composites, various types of fibres - plastic, glass, carbon, etc, influence of fibre length & orientation

Module VI: Introduction to nanotechnology [5]
Basic concepts of nanotechnology, Nanomaterials (Nanoparticles, nanoclusters, quantum dots). Nanoscale, Effect of Nano scale on Material, Properties: Thermal, Mechanical, Electrical, Magnetic and Optical Properties.

Module VII: Synthesis of nanomaterials [5]
Introduction to Nanomaterials Fabrication Techniques: Top-Down Process (Ball Milling, Lithography, Sputtering techniques), Bottom-Up Process (Chemical routes).

Textbooks:
1. W. D. Callister, Materials Science and Engineering: An Introduction, John Wiley, 6th Edition, 2003.
2. W. F. Smith, Principles of Materials Science and Engineering, McGraw Hill International, 1986.
3. Introduction to Nanotechnology, Charles P. Poole, Jr., Frank J. Owens, John Wiley & Sons, 2013.

References:
1. The Structure and Properties of Materials, Wiley Eastern
Vol. –I, Moffatt, Pearsall and Wulff
Vol. –III, Hayden, Moffatt and Wulff
2. Physical Properties of Materials, M. C. Lovell, A. J. Avery, M. W. Vernon, ELBS.

This course has direct bearing on employability

IMP 6003 Digital Electronics [3-1-0-4]

Module I: Fundamentals [6]
Difference between analog and digital circuits, binary numbers, binary to decimal conversion, AND, OR and NOT gates (realization using diodes and transistor). Boolean algebra, Boolean equations of logic circuits, De Morgan theorem, NOR and NAND gates; Introduction to various logic families.

Module II: Combinational logic [5]
Boolean Theorems, minterm, maxterm, sum of products, products of sum, method of realizing a circuit for a given truth table, minimization using Karnaugh map (elementary ideas).

Module III: Combinational Circuits [5]
Adders, subtracters, encoders, decoders, multiplexers, demultiplexers.

Module IV: Sequential circuits [12]
Flip-flops, RS, JK, Master Slaves, T and D flip-Flops, controlled registers, shift registers, synchronous and asynchronous counters, controlled counters, up/down counters, ring counter.

Module V: Timing circuits [4]
Applications of logic gates in timing circuits, op-amp and its applications in timing circuits, Schmitt trigger, 555 timer.

Module VI: Memories [6]
ROM, RAM, PROM, EROM, EEPROM, static and dynamic RAM.

Module VII: Data converters [12]
Digital to Analog Conversion, R-2R ladder type DAC, Weighted resistor type DAC, Switched current source type DAC, Switched capacitor type DAC, Analog to Digital Conversion, Counter type A/D converter, Flashtype A/D converter, Dual slope A/D converter, Successive approximation ADC.

Recommended books:
1. Digital Electronics, Malvino & Leach, McGraw-Hill Book Company
2. Digital Design, 4/e, Morris Mano, Pearson
3. Digital Fundamentals 9/e, Thomas L. Floyd, Pearson
4. Digital Computer Electronics, Albert Paul Malvino, McGraw-Hill Book Company
5. Modern Digital Electronics 4/e, R. P. Jain, Tata McGraw-Hill Education

This course has a direct bearing on employability

IMSc Physics -VI Semester

MSH 1143 Foreign Language (French-I)

[3-0-0-3]

Module I:
Langue Française, Le pronom personnel, Articles définis et indéfinis, Verbes au présent,
Se présenter et présenter quelqu'un (salutations formelles et informelles)

Module II:
Nationalités, professions, nombres, les heures, lesjours de la semaine, les mois de l'année,
Négation,
Demander et donner des infos personnelles

Module III:
Articles partitifs, expression de la quantité, Leschiffres, Formule de politesse

Module IV:
Adjectifs démonstratifs, Adjectifs qualificatifs (mas/fém., pluriel etc.) et possessifs
Utilisation de « est-ce que ? » et « qu'est-ce que c'est ? » quel, quelle etc.

Module V:
Parler de goûts et des préférences et leurs degrés,Trois formes d'interrogation, L'impératif

Module VI:
Le présent, futur proche, passé récent, Décrire uneprsonne ou un lieu, Ecrire une carte postale, e-mail

Module VII:
Le passe composé, le futur, Parler de ses activitésquotidiennes, Décrire la ville, des amis, des parents
etc.

Suggested Reading

1. Jumelage - Niveau-1, Manjiri Khandekar & Roopa Luktuke, Saraswati House Pvt. Ltd. New-Delhi
2. Le Nouveau sans Frontières-1, Philippe Dominique, Jacky Girardet, Michel Verdelhan & Michel
Verdelhan, CLE International, Paris
3. Alter Ego-1, Annie Berthet, Catherine Hugot, Véronique M. Kizirian, Béatrix Sampsons & Monique Waendendries, Hachette, Paris
4. Campus- 1, Jacky Girardet & Jacques Pécheur, CLEinternational, Paris
5. Libre Echange- 1, Janine Courtillon, Geneviève-Dominique de Salins & Christine Guyot-Clément, Didier, Paris
6. 450 Exercices de phonétique, Lucile Charliac, Jean Thierry, Bernard Loreil & Annie Claude, CLE International,
Paris
7. Echo - A1, Jacky Girardet & Jacques Pécheur, CLEInternational, Paris

This course has direct bearing on employability

IMSc Physics -VI Semester

MSH 1145 Foreign Language (German-I)

[3-0-0-3]

Module I:
Sich begrüssen, sich vorstellen, sich verabschieden und Woher kommen Sie? Ländernamen, Nationalitätsbezeichnung, Das Verb: Präsens – (sei n, heissen), Personalpronomen: ich und Sie, Verb + Adjektiv, Das Nomen: Singular und Plural, Zahlen von 1 – 10. Antworten mit Ja / Nein

Module II:
Das Alphabet, buchstabieren, Das Verb: haben, schliessen, machen, Fragepronomen, Zahlen von 1- 100, Personalpronomen du, er und sie und es, Das Demonstrativpronomen „das", Unterschied zwischen Uhr – Stunde, Negativartikel, Der Artikel: bestimmter und unbestimmter Artikel.

Module III:
Reisende im Gespräch, Das Verb: Präsens **-** (fahren, lesen, nehmen usw.), Vorsilbe und Verb (trennbare Verben), Wortstellung von trennbaren Verben, Präpos itionen, Tage – Monate. Erklärung von drei **sie/Sie,** Der Akkusativ, „es gibt/gibt es" **.**

Module IV:
Ein Freunde besucht, über Familie sprechen, Das Nom en: Dativergänzung, Der Dativ und der Akkusativ, Das Fragepronomen: Wem?, Possessiv-Pronomen, Präpos itionen mit dem Dativ und mit dem Akkusativ, Wortstellung, Das Zeitadverb.

Module V:
Rat geben, Geburtstag feiern, Telefongespräch, Die Uhrzeiten, Modalverben **-** (wollen, müssen, können), Wortstellung bei Modalverben, Das Personalpronomen bei Akkusativ- und Dativergänzungen und deren Wortstellung.

Module VI:
Die Wohnung beschreiben, Ein Zimmer vermieten, Richtungsangaben, Das Demonstrativpronomen: dies, wohen? – wo? – wohin? Präpostionen mit dem Akkusati v oder Dativ, Zahlen von 100 – 1000, Jahreszahlen, Das Verb: dürfen – sollen.

Module VII:
Im Supermarkt, Konjugation von möchten, Der Genetiv , Das Präteritum: sein und haben, Reflexivpronomen, Das Perfekt.

Suggested Readings
1. Deutschsprachlehre für Ausländer, Heinz Griesbac h, Dora Schulz, Max Hueber Verlag.
2. Lagune: Kursbuch: Deutsch als Fremdsprache - A1-I + II, Hartmut Aufderstrasse, Jutta Müller, Thomas Storz, Hueber Verlag.
3. Tangram Aktuell – A1-I + II, Roza Maria Dallapia zza, Eduard von Jan, Til Schönherr, Hueber Verlag.

This course has direct bearing on employability

I.M.Sc Physics-VII-Semester / M.Sc Physics -I Semester

SAP 1107 Quantum Mechanics

[3-0-0-3]

Module I & II: Schrödinger wave equation, interpretation of wave f unction, probability current density. Ehrenfests theorem, one dimensional finite square well and barrier. Linear vector space, Dirac Bra-Ket notations. Determination of eigen-values and eigen-functions using matrix representations. Coordinate and momentum representation. Uncertainty principle. **[10]**

Module III: Linear harmonic oscillator, Heisenberg and quantum mechanical treatments. Asymptotic behavior, energy levels, correspondence with classical theory. Spherically symmetric potential in three dimensions, hydrogen atom, wave functions, eigenvalues, degeneracy etc. **[9]**

Module IV & V: Theory of angular momentum, symmetry, invariance and conservation laws, relation between rotation and angular momentum. Commutation rules, eigenvalues and eigen functions of the angular momentum. Stern-Gerlach experiment, spin, spin operators, Pauli's spin matrices. Spin states of two spin-1/2 particles. Addition of angular momenta, Clebsch-Gordon coefficients. Principle of indistinguishablity of identical particles, Pauli's exclusion principle. **[12]**

Module VI: Scattering Theory, differential and total scattering cross-section laws, partial wave analysis and application to simple cases; Integral form of scattering equation, Born approximation validity and simple applications. **[5]**

Module VII: WKB approximation, solution near a turning point, connection formula, tunneling through barrier. boundary conditions in the quasi classical case. **[4]**

Book:

1. Quantum Mechanics by L. I. Schiff. (Tata McGraw Hill, New Delhi)

References:

1. Quantum Mechanics by L. D. Landau and E. M. Lifshitz (Pergamon, Berlin)
2. Quantum Mechanics by A. K. Ghatak and S. Lokanathan (McMillan India)
3. A Textbook of Quantum Mechanics by P. T. Mathews (Tata McGraw Hill)

This course has direct bearing on skill development

I.M.Sc Physics-VII-Semester / M.Sc Physics -I Semester

IMP 7002 Modern Computational Techniques & Programming

[1-0-3-3]

Theory & Lab work using Matlab and Maple software for solving problems of following topics:

Module I: Approximation Methods and Errors [4]
Accuracy and precision, Truncation and round-off errors.

Module II: Roots of Equations [4]
Bracketing Methods (false position, bisection), Iteration Methods (Newton-Raphson and secant).

Module III: Systems of linear algebraic equations [4]
Gauss elimination, matrix inversion and LU decomposition methods.

Module IV: Curve fitting and Interpolation [6]
Least squares regression, Linear, multiple linear and nonlinear regressions, Cubic spline. Newton's divided difference and Lagrange interpolating polynomials.

Module V: Numerical differentiation and integration [5]
Divided difference method for differentiation, Newton-Cotes formula, Trapezoidal and Simpson's rules, Romberg and Gauss quadrature methods.

Module VI: Ordinary differential equations [5]
Euler's method and its modifications, Runge-Kutta methods, Boundary value and Eigen value problems.

Module VII: Partial differential equations [7]
Finite difference equations, Elliptic equations, Laplace's equation and solutions, Parabolic equations, Solution of the heat conduction equation. Finite element method: General approach, Application to 1- dimensional and 2-dimensional problems.

References:

1. Introductory Methods of Numerical Analysis, S.S. Sastry, Prentice Hall of India (1983)
2. Numerical Methods for Engineering, S.C. Chopra and R.C. Canale, McGraw-Hill (1989).
3. Numerical Methods for Scientists and Engineers, Prentice Hall of India (1988).

This course has a direct bearing on employability

I.M.Sc Physics-VIII-Semester/M.Sc Physics -II Semester

SAP 2109 Condensed Matter Physics

[3-0-0-3]

Module I&II: Crystal Structure [10]
Revision of concepts, crystal structure, simple crystals, Miller indices, lattice planes, Bragg's law (SS), structure determination, Laue's method, powder crystal method, rotating crystal method, electron diffraction, neutron diffraction, reciprocal lattice, Ewald's construction, symmetry operations. Structure determination using Laue, powder crystal and rotating crystal methods.

Module III: Lattice vibrations [6]
Classical and Einstein theory of specific heat(self study), Debye theory of specific heat, the density of states in 1D and 3D, elastic waves, concept of phonons, vibration of lattice- mono and diatomic chains.

Module IV: Energy band theory [6]
Classical free electron theory and failure. Wave
mechanical treatment of electron in a box, electrons in a periodic potential, Bloch's theorem, Kronig-Penney Model, crystal potential, periodic and nonperiodic potential, Brillouin zones, energy band structure in conductors, semiconductors, insulators, Fermi-Dirac distribution, Fermi energy density of states, Fermi surface, effective mass.

Module V: Magnetism [6]
Classification of magnetic materials, Langevin's theory of paramagnetism, ferromagnetism, hysteresis, ferromagnetic domains, antiferromagnetism, ferrimagnetism, ferrites, Curie's law, magnetic ordering, Weiss theory of paramagnetism, quantum theory of para & ferromagnetism, paramagnetic resonances, ferromagnetic resonance

Module VI: Dielectrics and ferroelectrics [6]
Different types of polarization and polarizability (SS) Clausius-Mossotti relation, dielectric constant, dielectric breakdown, dielectric losses, ferroelectric, piezoelectric, pyroelectric behavior. Frequency dependence of dielectric properties, temperature dependence, ferroelectric-paraelectric phase transitions.

Module VII: Superconductivity [6]
Meissner effect, type-I and type-II superconductors (SS). London equation, penetration depth, superconducting transitions, optical properties, Cooper pair, BCS theory (Qualitative), coherence length, electron-phonon interaction, flux quantization, Josephson junction, high Tc superconductors.

References

1. Introduction to Solid State Physics: C. Kittel, Wiley Eastern Ltd., New Delhi - 1988.
2. Solid State Electronics Engineering Materials, S. O. Pillai, Wiley Eastern ltd. New Delhi, 1992.
3. Solid State Physics: Ashcroft & Mermin
4. Solid State Physics: A. J. Dekker, Macmillan, new Ed, 2011

This course has direct bearing on employability

I.M.Sc Physics-VIII-Semester/M.Sc Physics -II Semester

SAP 2011 Advanced Quantum Mechanics

[3-0-0-3]

Module I & II: Perturbation theory, time-independent perturbation theory (non-degenerate and degenerate) and applications. Stark effect and other simple cases. Relativistic perturbation to hydrogen atom. Energy levels of hydrogen including fine structure, Lamb shift and hyperfine splitting. Zeeman effect (normal and anomalous) time, first and second order, the effect of the electric field on the energy levels of an atom (Stark effect). **[12]**

Module III: Quantum mechanics of molecules, Born-Oppenheimer approximation **[6]**

Module IV & V: Time-dependent perturbations , first order transitions, Semi- classical theory of interaction of atoms with field. Quantization of radiation field. Hamiltonian of field and atom, Fermi golden rule, the Einstein's A & B coefficients. **[8]**

Module VI: Atom field interaction, density matrix equation, closed and open two level atoms, Rabi oscillations. **[6]**

Module VII: Relativistic wave equations: Klein-Gordon equation for a free particle and particle under the influence of an electromagnetic potential, Dirac's relativistic Hamiltonian, Dirac's relativistic wave equation, positive and negative energy states, significance of negative energy states. **[8]**

Book:

1. Quantum Mechanics by L. I. Schiff. (Tata McGraw Hill, New Delhi)

References:

1. Quantum Mechanics by L. D. Landau and E. M. Lifshitz (Pergamon, Berlin)
3. Quantum Mechanics by A. K. Ghatak and S. Lokanathan (McMillan India)
4. A Textbook of Quantum Mechanics by P. T. Mathews (Tata McGraw Hill)

This course has direct bearing on skill development

I.M.Sc Physics-VIII-Semester/M.Sc Physics -II Semester

SAP 2013 Laser Physics and Applications

[3-0-0-3]

Module I & II: Properties of laser, coherence, monochromaticity, divergence. Principle of laser: Absorption and Emission of light, Population inversion, gain oscillation, gain saturation, threshold, rate equation, 3 and 4 level systems, laser line shape, hole burning, Lamb dip, output power. **[12]**

Module III: Theory of resonator, ABCD matrix, Stable and unstable resonator, longitudinal and transverse mode of the cavity. **[6]**

Module IV: Continuous wave, Pulsed, Q- switched and Mode locked lasers. **[6]**

Module V: Different type of lasers, design (in brief) and functioning of different lasers - Ruby laser, Nd: YAG laser, He-Ne laser, CO_2 laser, Argon ion laser, Dye laser, Excimer laser. Free electron laser. **[8]**

Module VI & VII: Measurement with laser, alignment, targeting, tracking, velocity measurement, surface quality measurement, Measurement of distance (interferometric, pulse echo, Beam modulation), laser gyroscope, Holographic non destructive testing (NDT). Application in communication. Material Processing: cutting, welding, drilling and surface treatment. Medical Applications. **[8]**

Book:

1. O. Svelto; Principles of Lasers, Springer (2004)
2. Laser Fundamentsls: William T. Silfvast, Cambridge University Press (1998)
3. K. Shimoda, Introduction to laser Physics, Springer Verlag, Berlin (1984)
4. Laser Electronics: J.T.Verdeyen, 3rd Ed, Prentice Hall (1994)
5. Laser Applications in Surface Science and Technology; H.G.Rubahn; John Wiley & Sons (1999)
6. Optical Methods in Engineering Metrology: Ed D.C.Williams; Chapman & Hall

This course has direct bearing on entrepreneurship

I.M.Sc Physics-IX-Semester/M.Sc Physics -III Semester

SAP 3301 Nuclear and Particle Physics

[3-0-0-3]

Module I: Nuclear Models

Nuclear Models Liquid drop Model, semi-empirical mass formula, transitions between odd A isobars, transitions between even A isobars, odd-even effects & magic numbers, shell Model , collective model.

Module II: Two nucleon problem

The Deuteron, ground state of deuteron, nature of nuclear forces, excited state of deuteron, spin-dependence of nuclear force, meson theory of nuclear force

Module III: Scattering

Cross-section, differential cross-section, scattering cross-section, nucleon-nucleon scattering, proton-proton and neutron-neutron scattering at low energies.

Module IV: Interaction of radiation with matter

Interaction of charged particles with matter, stopping power of heavy charged particles, energy loss of electrons, absorption of gamma rays, photoelectric effect, Compton effect and pair production

Module V: Elementary particles I

Mesons, leptons, baryons, antiparticles, neutrinos, antineutrino and strange particles

Module VI: Elementary particles II

Eightfold way, Baryon octet and meson octet, Quark model, Baryon Decuplet, meson nonlet, Intermediate vector boson, strong, electromagnetic and weak interactions, standard Model, lepton classification and quark classification.

Books Recommended:

1. Nuclear Theory- Roy and Nigam
2. Introductory Nuclear Physics- Kenneth S. Krane
3. Nuclear Physics : D. Halliday
4. Elements of Nuclear Physics :Pandya and Yadav
4. Introduction to Elementary Particles: David Griffiths

I.M.Sc Physics-IX-Semester / M.Sc Physics -III Semester

SAP 3007 Advanced Electrodynamics

[3-0-0-3]

Module 1 & 2: Waveguides, Resonant Cavities, and Optical Fibers

Transmission line parameters-transmission line equations-input impedance, SWR and power-the Smith chart-some application of transmission lines. Cylindrical Cavities and Waveguides, Waveguides, TE and TM modes in a Rectangular Waveguide, Energy Flow and Attenuation in Waveguides, Perturbation of Boundary Conditions, Resonant Cavities, Power Losses in a Cavity; Q of a Cavity, Earth and Ionosphere as a Resonant Cavity: Schumann Resonances. **[10]**

Module 3: Radiating Systems, Multipole Fields and Radiation **[6]**

Fields and Radiation of a Localized Oscillating Source, Multipole Expansion for Localized Source, Spherical Wave Solutions of the Scalar Wave Equation, Multipole Expansion of the Electromagnetic Fields, Angular Distribution of Multipole Radiation

Module 4: Special Theory of Relativity **[6]**

Matrix representation of Lorentz transformations, infinitesimal generators, Thomas precession, invariance of electric charge; covariance of electrodynamics, transformation of electromagnetic fields, relativistic equation of motion for spin in uniform or slowly varying external fields

Module 5: Dynamics of Relativistic Particles and Electromagnetic Fields **[6]**

Lagrangian and Hamiltonian for a Relativistic Charged Particle in External Electromagnetic Fields Motion in a Uniform, Static Magnetic Field, Motion in Combined, Uniform, Static Electric and Magnetic Fields, Particle Drifts in Nonuniform, Static Magnetic Fields,

Module 6: Collisions and Energy Loss **[6]**

Energy transfer in Coulomb collision between heavy incident particle and free electron; energy loss in hard and soft Collisions; Total Energy Loss Cherenkov Radiation

Module 7: Bremsstrahlung, Method of Virtual Quanta **[6]**

Radiation Emitted During Collisions, Bremsstrahlung in Coulomb Collisions, Screening Effects; Relativistic Radiative Energy Loss, Weizsacker-Williams Method of Virtual Quanta, Bremsstrahlung as the Scattering of Virtual Quanta

Textbook and References:

1. Electromagnetic Theory - Stratton
2. Electromagnetic Theory – J. A. Kong; John Wiley and Sons, 1986
3. Classical Electricity and Magnetism – Phillips and Panofsky, Addison Wesley
4. Introduction to Electrodynamics – D. J. Griffiths; John Wiley and Sons, 1986
5. Engineering Electromagnetics - William H. Hayt
6. Elements of engineering electromagnetics - Narayana Rao, PHI
7. Electromagnetic Waves and Radiating Systems – E. C. Jordan and K. G. Balmain, Prentice Hall, Inc.

This course has direct bearing on employability

I.M.Sc Physics-IX-Semester / M.Sc Physics -III Semester

SAP 3115: Advanced Experimental Techniques

[3-0-0-3]

Module I: X-ray Diffraction Methods:
Classification of crystal system, Bragg's law and Laue conditions, Powder methods, crystal size analysis, Rietvold method of structural analysis, X-ray fluorescence spectroscopy, applications of emission spectra for compounds and alloys, Applications of absorption spectra for solid solutions and transitional metal compounds, Neutron spectroscopy. X-Ray Reflectivity. **[5]**

Module II: Microscopy
Optical microscopy, metallurgical microscope, TEM, SEM and AFM, specimen preparation, instrumentation and applications, Low Energy electron Spectroscopy. **[5]**

Module III: Spectroscopy
Atomic absorption spectrophotometer and its application to environmental analysis, UV-visible spectroscopy and its application, IR-spectroscopy and its application, AES, XPS, Introduction to RBS, SIMS, and its applications. **[8]**

Module IV: ESR and Mossbauer spectroscopy
Basic principles of ESR, Instrumentations and applications, Principle of Mossbauer spectroscopy, Isomer shift, Quadruple splitting and hyperfine interaction, applications-in determination of phases and diffusion studies. **[7]**

Module V: Thermochemical analysis
Thermo analytical techniques, Instrumentation and applications of TGA, DTA, DSC. **[5]**

Module VI: Electrochemical Techniques
Electrochemical Instrumentation, Coulometry, polarography, cyclic voltametry, application to oxidation-reduction reaction, Principle of Corrosion, types and prevention. **[10]**

Module VII: Vacuum Technology & Thin film Deposition Technique
Application to Vacuum Technology, Types of vacuum pumps, different technique of thin film deposition CVD, PVD, MBE, MOCVD. **[10]**

References:

1.. Surface Analysis – The Principal Techniques, Ed ited by J. C. Vickerman, John Willey & Sons
2. Spectroscopy, Vol. I, II and III, ed. By Straughan and Walker, John Wiley.
3. Instrumental Methods of Chemical Analysis By G. W. Ewing, Mcgraw –Hill Book Company
4. Vacuum Science and Technology by V.V. Rao, T.B. Gosh, K.L. Chopra, Allied Publishers, 17-Oct-1998

This course has a direct bearing on employability

I.M.Sc Physics-IX-Semester / M.Sc Physics -III Semester

SAP 3013: Microwave Electronics

[3-1-0-4]

Module 1: Transmission lines and Waveguides (12 Classes) Introduction of Microwaves and their applications. Types of Transmission lines, Characterization in terms of primary and secondary constants, Characteristic impedance, General wave equation, Loss less propagation, Propagation constant, Wave reflection at discontinuities, Voltage standing wave ratio, Transmission line of finite length, The Smith Chart, Smith Chart calculations for lossy lines, Impedance matching by Quarter wave transformer, Single and double stub matching. Rectangular Waveguides: TE and TM wave solutions, Field patterns, Wave impedance and Power flow.

Module 2: Microwave Sources (7 Classes) Microwave Linear-Beam (O type) and Crossed-Field tubes (M type), Limitations of conventional tubes at microwave frequencies, Klystron, Multicavity Klystron Amplifiers, Reflex Klystrons, Helix Travelling-wave tubes, magnetron Oscillators. Tunnel diode, TED - Gunn diode, Avalanche transit time devices IMPATT (also TRAPAT) and parametric devices,

Module 3: Stripline and microstrip lines (6 Classes) Dominant mode of propagation, Field patterns, Characteristic impedance, Basic design formulas and characteristics. Parallel coupled striplines and microstrip lines- Even- and odd- mode excitations. Slot lines and Coplanar lines. Advantages over waveguides

Module 4: Microwave Network Analysis (5 Classes) Impedance and Admittance matrices, Scattering matrix, Parameters of reciprocal and Loss less networks, ABCD Matrix, Scattering matrices of typical two-port, three-port and four-port networks, Conversion between two-port network matrices.

Module 5: Microwave Passive Components (8 Classes) Waveguide Components: E-plane and H-plane Tees, Magic Tee, Shorting plunger, Directional couplers, and Attenuator. Stripline and Microstrip line Components: Open and shorted ends. Half wave resonator, Lumped elements (inductors, capacitors and resistors) in microstrip. Ring resonator, 3-dB branchline coupler, backward wave coupler, Wilkinson power dividers and rat-race hybrid ring. Low pass and band pass filters.

Module 6: Microwave Measurements (6 Classes) Detection of microwaves, Microwave power measurement, Impedance measurement, Measurement of reflection loss (VSWR), and transmission loss in components. Passive and active circuit measurement & characterization using network analyser, spectrum analyser and noise figuremeter

Module 7: Microwave Integrated Circuit Technology (6 Classes) Substrates for Microwave Integrated Circuits (MICs) and their properties. Hybrid technology – Photolithographic process, deposited and discrete lumped components. Microwave Monolithic Integrated Circuit (MMIC) technology- Substrates, MMIC process, comparison with hybrid integrated circuit technology (MIC technology).

RECOMMENDED BOOKS:

1. Electromagnetic Waves and Radiating Systems – E.C. Jordan & K.G. Balmain, Prentice Hall, Inc.
2. Microwave Devices and Circuits - S. Y. LIAO, PHI
3. Introduction to Microwave Theory and Measurements – L. A. Lance, TMH
4. Transmission lines and Networks – Walter C. Johnson , McGraw Hill, New Delhi
5. Networks Lines and Fields – John D. Ryder
6. Microwave Engineering: Passive Circuits - Peter A. Razi, Prentice Hall of India Pvt. Ltd, New Delhi.
7. Waveguides – H.R.L. Lamont, Methuen and Company Lim ited, London
8. Foundations for Microwave Engineering – Robert E. C ollin, McGraw Hill Book Company, New Delhi
9. Microwave Engineering – Annapurna Das, TMH, New Del hi

This course has direct bearing on employability

I.M.Sc Physics-IX-Semester / M.Sc Physics -III Semester

SAP. 3017 Fiber and Integrated Optics

[3-1-0-4]

Module I: Principle of light propagation in fibers, step-index and graded index fibers; single mode, multimode and W-profile fibers. Ray optics representation, meridional and skew rays. Numerical aperture and acceptance angle. Dispersion, combined effects of material and other dispersions - RMS pulse widths and frequency response, birefringence. Attenuation in optical fibers. **[12]**

Module II: Wave propagation in step-index fibers, modes in an ideal step-index fiber - weakly guiding solutions. Material dispersion and waveguide dispersion in single-mode fibers. [**6]**

Module III: Wave propagation in graded-index fibers, modes in graded index fibers, approximate solutions and number of modes. Equivalence of WKB approximation and ray model. Inter and intramodal dispersion in graded-index fibers. Mode coupling. **[6]**

Module IV&V: Theory of optical waveguides, planar, rectangular, symmetric and asymmetric waveguides, channel and strip loaded waveguides. Anisotropic and segmented waveguides. Step-index and graded index waveguides, guided and radiation modes. Arrayed waveguide devices. Fabrication of integrated optical waveguides and devices. **[12]**

Module VI: Wave guide couplers, transverse couplers, grating couplers, tapered couplers, prism couplers, fiber to waveguide couplers. Multilayer planar waveguide couplers, dual channel directional couplers, Butt coupled ridge waveguides, Branching waveguide couplers. Directional couplers, optical switch; phase and amplitude modulators, filters, etc. Y-junction, power splitters. **[6]**

Module VII: Fiber optics sensors, intensity modulation, phase modulation sensors, fiber Bragg grating sensors. Measurement of current, pressure, strain, temperature, refractive index, liquid level etc. Time domain and frequency domain dispersion measurement. [**8]**

References:

1. Introduction to Fiber Optics: A.K. Ghatak and K. Thayagarajan, Cambridge University press.
2.Integrated Optics: Theory and Technology; R. G. Hunsperger; Springer (2002)
3. Optical Fiber Sensors, John Dakin and Brain Culshaw, Arctech House Inc.
4.Essentials of optoelectronics, Alan Rogers, 1st Ed., Chapman & Hall.
5.Semiconductor Optoelectronics Devices, P. Bhattacharya, PHI.
6. Optoelectronics and Photonics, principles and practices S. O. Kasap, Prentice Hall

This course has direct bearing on employability

SAP 4001 Theory of Plasmas

[3-1-0--4]

Module I: Introduction to Plasma
The fourth state of matter, collective behaviour, charge neutrality, space and time scales, Concept of plasma temperature, Debye length, plasma frequency, plasma parameters and criteria for plasma state. Debye Shielding, Plasma sheath, Plasmas in nature and laboratory

Module II: Basic Processes in plasmas
Collisions in plasmas, Ionization and the Saha equation, LTE and equilibrium Models, Recombination, Concepts of diffusion, mobility and electrical conductivity, Ambipolar diffusion, Effect of magnetic field on the mobility, diffusion of plasma in presence of magnetic field.

Module III: Plasma Theory
Motion of charged particles in electric and magnetic fields, Concepts of elementary kinetic theory of plasmas, Boltzmann and Vlasov equation, Fluid theory of plasma, single & multi fluid approximations, generalized Ohm's law, MHD equations

Module IV: Plasma Oscillations and waves
Langmuir oscillations, ion waves, electromagnetic waves along and perpendicular to Bo, Alfven waves.

Module V: Plasma production
Electrical discharges, Electrical Breakdown in gases, glow discharge, self-sustained discharges, Paschen curve, high frequency electrical discharge in gases, electrode less discharge, capacitively and inductively coupled plasmas, Electrical arcs.

Module VI: Plasma diagnostics
Langmuir probe, Spectroscopic diagnostics.

Module VII: Plasma Applications
Controlled thermonuclear fusion, tokamak, MHD generator, plasma display, industrial applications of plasmas, hazardous waste disposal.

Textbooks:

1. Introduction to Plasma Physics and Controlled Fusion, Francis F. Chen , Springer; 2nd ed. 1984. Latest edition. 2006.
2. Fundamentals of plasma physics, J. A. Bittencourt, 3rd Edition Springer-Verlag New York Inc., 2004
3. The Physics of Plasmas, T. J. M. Boyd and J. J. Sanderson, Cambridge University Press, 2003
4. Cold Plasma in Materials Fabrication from Fundamentals to Applications, A. Grill, (IEEE Press, New Jersey, 1994)
5. Reactions under Plasma conditions Vol. I and II, Venugopalan

This course has direct bearing on skill development

SAP 4003 Plasma Beams and Applications

[3-1-0--4]

Module-I : Fundamentals of Plasma Physics and Plasma Chemistry
Plasma-the fourth state of matter, Plasma Parameters, Debye length, Plasma oscillations & frequency, Plasma Sheath, Interaction of electromagnetic wave with plasma, Concept about plasma equilibrium, Industrial Plasmas, Cold and thermal plasma, Plasma Chemistry, Homogeneous and Heterogeneous reaction, Reaction rate coefficients, Plasma Surface interaction

Module-II: Plasma dynamics and Fluid mechanics of plasmas
Fluid mechanics of plasmas, Concepts of MHD equations

Module-III: Plasma models and Radiation transport
Concepts about Local Thermal Equilibrium (LTE), PLTE, Corona and CR models of plasma

Module-IV: Plasma Production Techniques
DC discharges, Glow discharge, Normal and abnormal glow discharges, Arc discharge, Arc stabilization, Transferred and non transferred arcs Cathode and anode fall, Arc Column, RF discharge, Capacitively and inductively coupled plasmas, Microwave discharge, ECR Plasmas

Module-V: Plasma Diagnostic Techniques
Measurements of Plasma parameters, Electrical probes, Single and double Langmuir probe, Magnetic probe, Calorimetric measurements, Enthalpy Probes, Spectroscopic method

Module-VI: Applications
Plasma treatment of textiles, Underwater cutting by plasma torches, Ion implamentation, Re- entry plasma simulation and aerospace material testing, Plasma propulsion, devices, Plasma as light source, Flat panel displays

REFERENCES:

1. Principles of plasma discharges and materials processing, M. A. Lieberman and A. J. Lichtenberg, (John Wiley and Sons, 2005)
2. Plasma Physics and Engineering, A. Friedman and L. A. Kennedy, (Taylor and Francis, New York, 2004)
3. Cold Plasma in Materials Fabrication from Fundamentals to Applications, A. Grill, (IEEE Press, New Jersey, 1994)
4. Thermal Plasmas- Fundamentals and Applications, M. I. Boulos, P. Fauchais and E. Pfender, (Plenum Press, New York and London, 1994)
5. Plasma Technology, B. Gross, B. Greyz and K. Miklossy, (Iliffe Books Ltd., London, 1968).
6. Industrial plasma engineering: Vol. 1 & 2, J. R. Roth, (IOP, 1995 & 2001)
7. Handbook of Plasma Processing Technology: Fundamental, Etching, Deposition and Surface Interactions, S. M. Rossnagel, J. J. Cuomo, W. D. Westwood, (Noyes Publications, 1990)

This course has direct bearing on employability

SAP 4005 Plasma Processing of Materials

[3-1-0--4]

Module-I: Plasma statistics and Thermodynamics
Plasmas and thermodynamic equilibrium, Thermodynamics of ideal gases, Dissociation and ionization equilibrium in Gas mixtures, Statistics and thermodynamics of equilibrium and non-equilibrium plasma, Determination of plasma composition, Thermodynamic and transport properties of plasma

Module-II: Design principles of plasma reactors
Design principles and construction of plasma torches and thermal plasma reactors, Efficiency of plasma torches in converting electrical energy in to thermal energy, Designing aspects of low pressure plasma reactors

Module-III: Plasma Production Techniques
Coronal discharges. Photo plasmas, Shock wave generated plasma, Atmospheric pressure glow discharges, Dielectric barrier discharges

Module-IV: Plasma Diagnostic Techniques
Laser based diagnostics, Microwave and Laser interferometer, Laser induced fluorescence, Thomson scattering, Absorption spectroscopy

Module-V: Plasma Etching and Spraying
Anisotropic etching, plasma cleaning, surfactants removal, plasma ashing, plasma Polymerization, Non transferred plasma torches, powder feeder, optimization of spraying processes, spherodization.

Module-VI: Plasma sputtering and PECVD
Thin film coatings, magnetron sputtering, RF PECVD, MW PECVD, plasma nitriding

Module-VII: Atmospheric Plasma Processing
Arc plasmas, Plasma torches, plasma waste processing, Synthesis of materials and metallurgy in arc plasmas, Plasma cutting and Welding

REFERENCES:

1. Principles of plasma discharges and materials processing, M. A. Lieberman and A. J. Lichtenberg, (John Wiley and Sons, 2005)
2. Plasma Physics and Engineering, A. Friedman and L. A. Kennedy, (Taylor and Francis, New York, 2004)
3. Cold Plasma in Materials Fabrication from Fundamentals to Applications, A. Grill, (IEEE Press, New Jersey, 1994)
4. Thermal Plasmas- Fundamentals and Applications, M. I. Boulos, P. Fauchais and E. Pfender, (Plenum Press, New York and London, 1994)
5. Plasma Technology, B. Gross, B. Greyz and K. Miklossy, (Iliffe Books Ltd., London, 1968).
6. Industrial plasma engineering: Vol. 1 & 2, J. R. Roth, (IOP, 1995 & 2001)
7. Handbook of Advanced Plasma Processing Techniques, Eds. R.J. Shul and S.J. Pearton,

This course has direct bearing on skill deveopment

SAP 4007 Thin Film and Vacuum Technology

[3-1-0--4]

Module-I
Thermodynamics and Thin Film growth

Module-II
Vacuum Technology: Gas Laws, Kinetic Theory of Gases, Conductance and Throughput, Gas Sources in a Vacuum Chamber, Vacuum Pumps.

Module-III
Physical Vapor Deposition: Sputtering (Plasma Physics (DC Diode), rf Plasmas, Magnetic Fields in Plasmas, Sputtering Mechanisms), Evaporation.

Module-IV
Chemical Vapor Deposition: Mechanisms, Materials, Chemistries, Systems.

Module-V
Etching: Wet Chemical Etching (Mechanisms, Materials and Chemistries), Dry Plasma Etching/Reactive Ion Etching (Mechanisms, Materials and Chemistries).

Module-VI
FILM Formation and Structure: Capillarity Theory, Atomistic Nucleation processes, Cluster Coalescence, Grain Structure of Films.

Module-VII
Thin Film Characterization: Structural, Chemical

Textbook:
1. R. K. Waits, Thin Film Deposition and Patterning, American Vacuum Society, 1998.

References:
1. M. Ohring, The Materials Science of Thin Films, Academic Press, Boston, 1991.
2. Ludmila Eckertova, Physics of Thin Films, 2nd Plenum Press New York, 1986
3. Kasturi L. Chopra, Thin Film Phenomena (McGraw-Hill, 1969)

This course has direct bearing on employability

SAP 4009 Physics of Solid State Devices

[3-1-0-4]

Module I:
Carrier transport phenomena in solids: carrier drift and diffusion process, transport in crystalline and amorphous semiconductors, high field properties of semiconductors, organic semiconductors.

Module II:
p-n junction devices: Minority and majority carrier injection, Depletion layer, I-V characteristics, heterojunctions and superlattices, Metal-semiconductor junctions, Schottky and Ohmic contacts.

Module III:
Three terminal devices: bipolar junction transistor (BJT), junction field effect transistor (JFET), metal oxide field effect transistor (MOSFET) metal semiconductor field effect transistor (MESFET).

Module IV & V:
Integrated circuits: Introduction of analog lC's, digital lC's, Monolithic lC's, Hybrid lC's. Materials for IC fabrication (Si and GaAs), Crystal growth and wafer preparation, Epitaxy, Vapour phase epitaxy (VPE), Molecular beam epitaxy (BME), MOCVD Oxidation, diffusion, Ion implantation, Optical lithography, electron beam lithography, etching processes.

Module VI:
Single electron devices: Energy states of jailed electron, Quantum point contact, Coulomb blockade, Resonant tunneling transistor, Single electron transistor (SET).

Module VII:
Microwave semiconductor devices: Tunnel diode, IMPATT, Gunn effect and Gunn diode.

Text Books:
1. Streetman, B.G. and Banerjee, S., Solid State Electronic Devices, 6th Edition, (Prentice-Hall, 2005).
2. Grove, A.S., Physics and Technology of Semiconductor Devices, (John Wiley, 1971).

Reference Book(s)
1. Sze, S.M. and Kwok, K.Ng., Physics of Semiconductor Devices, 3rd Edition, (Wiley-Interscience, 2006).

2. Quinn, J.J. and Yi, K-S., Solid State Physics: Principles and Modern Applications, 1st Edition (Springer, 2009).

This course has direct bearing on skill development

SAP 4011 Advanced Materials Science **[3-1-0--4]**

Modules I, II & III

Metals, Alloys, Ceramics, Polymers and Composites: Phase rules Fe-C phase diagram, steels, cold, hot working of metals, recovery, recrystallization and grain growth, Structure, properties, processing and applications of ceramics. Classification of polymers, polymerization, structure, properties, additives, products, processing and applications. Quasicrystals, Conducting Polymers; Properties and applications composites. [18]

Modules IV and V

Advanced Materials: Smart materials, ferroelectric, piezoelectric, biomaterials (some basic information), superalloys, aerospace materials, shape memory alloys, optoelectronic materials, Materials for photodiode, light emitting diode (LED), Photovoltaic/Solar cell. [16]

Modules VI and VII:

Nanostructured Materials: Nanomaterials classification (Gleiter's Classification)–properly changes done to size effects, synthesis of nanomaterials, ball milling, Liquid state processing - Sol-gel process, Vapour state processing –CVD, MBE, Aerosol processing, Quantum dot, wire and well, fullerene and tubules, formation and characterization of fullerenes and tubules, single wall and multiwall carbon tubules, electronic properties of tubules, applications: optical lithography, MOCVD, super hard coating. [16]

Text books:

1. Materials Science and Engineering, An Introduction, 5th Edition, William D. Callister Jr., John Wiley & Sons, Inc., New York, 1999, with CD-ROM.
2. Principles of Materials Science and Engineering, W. F. Smith, McGraw Hill International, 1986. (WFS)
3. Introduction to nanotechnology, Charles P. Poole, Jr. and Frank J. Owens; Wiley student edition (reprint-2009).

Reference books:

1. Structure and properties of engineering materials, fifth edition, Henkel and Pense, McGraw Hill, 2002
2. Biomaterials Science, An Introduction to Materials in Medicine , Edited by B.D. Ratner, A.S. Hoffman, F.J. Sckoen, and J.E.L Emons, Academic Press, second edition, 2004

This course has direct bearing on skill development

SAP 4013 Nonconventional Energy Materials

[3-1-0-4]

Module 1: Current Status of Energy Sources: Energy sources and their availability, conventional sources of energy: Fossil fuel, Hydraulic energy, Nuclear energy: nuclear fission, nuclear fusion, Environmental impact of conventional sources of energy, Need for sustainable energy sources, Non-conventional energy sources, Current status of renewable energy sources. **[6]**

Module 2: P-N Junction Solar Cells: P-N Junction: space charge region, energy band diagram, carrier movements and current densities, carrier concentration profile; P-N junction in non-equilibrium condition, I-V Relation, P-N Junction under Illumination, Generation of photovoltage, Light generated current, I-V equation of solar cells. **[6]**

Module 3: Design of Solar Cells and its characterization : Solar Cell Characteristics and Cell parameters: Short circuit current, open circuit voltage, fill factor, efficiency; losses in solar cells, Solar Cell Design: design for high I_{sc}, design for high V_{oc}, design for high FF; Solar spectrum at the Earth's surface, Solar simulator: I-V Measurement, quantum efficiency (QE) Measurement, minority carrier lifetime and diffusion length measurement. **[7]**

Module 4: Wafer-Based Solar Cell Technology: Development of Si solar cells, Processes of solar cell fabrication: saw damage removal and surface texturing, P-N Junction formation, ARC and surface passivation, metal contacts—pattern defining and de position. Thin Film Solar Cell Technologies: Advantages of thin film technologies, materials for thin film technologies, thin film deposition techniques, thin films solar cell structures, thin film crystalline, microcrystalline, polycrystalline, and amorphous Si solar cells. **[10]**

Module 5: Emerging Solar Cell Technologies
Organic Solar Cells: working principle, material properties, solar cell structure; Dye-sensitized Solar Cell (DSC): working principle, materials and their Properties; GaAs solar cells, Thermo-photovoltaics, multijunction solar cells. **[7]**

Module 6: Nonconventional Energy Sources: Wind Energy: Classification of wind mills, advantages and disadvantage of wind energy; Bio Energy: Bio gas and its compositions, process of bio gas, generation – wet process, dry process, utilization and benefits of biogas technology. **[7]**

Module 7: Other Nonconventional Energy Sources: Tidal Power: Introduction, classification of tidal power plants, factors affecting the suitability of the site for tidal power plant, advantages and disadvantages of tidal power plants. Fuel Cells: Introduction, working of fuel cell, types of fuel cells, advantages of fuel cell technology. Solar Thermal: Solar collectors, solar cookers, solar water heater. **[7]**

Text/Reference Books:
1. Solar cells: Operating principles, technology and system applications by Martin A Green, Prentice Hall Inc, Englewood Cliffs, NJ, USA, 1981.
2. Semiconductor for solar cells, H J Moller, Artech House Inc, MA, USA, 1993.
3. Solis state electronic device, Ben G Streetman, Prentice Hall of India Pvt Ltd., New Delhi 1995.
4. Direct energy conversion, M.A. Kettani, Addision Wesley Reading, 1970.
5. Hand book of Batteries and fuel cells, Linden, Mc Graw Hill, 1984.

This course has direct bearing on entrepreneurship

SAP 4015 Physics of Thin Films

[3-1-0-4]

Module 1: Basic Thermodynamics of Thin Films [8]

Solid surface, interphase surface, Surface energies: Binding energy and Interatomic Potential energy, latent heat, surface tension, Liquid surface energy measurement by capillary effect, by zero creep; magnitude of surface energy, General concept, jump frequency and diffusion flux, Fick's First law, Non - linear diffusion, Fick's second law, calculation of diffusion coefficient, interdiffusion and diffusion in thin films,

Module 2: Vacuum Science & Technology: [6]

Kinetic theory of gases, gas transport and pumping, Conductance, vacuum pumps and measurement gauges.

Module 3: Mechanisms of Film Formation [8]

Stages of thin film formation: Nucleation, Adsorption, Surface diffusion, capillarity theory of nucleation, statistical theory of nucleation, growth and coalescence of islands, grain structure and microstructure of thin films, diffusion during film growth, polycrystalline and amorphous films.

Module 4 & 5: Methods of Preparation of Thin Films: [15]

Physical vapour deposition: Vacuum evaporation-Hertz- Knudsen equation, evaporation from a source and film thickness uniformity, Glow discharge and plasmas-Plasma structure, DC, RF and microwave excitation; Sputtering processes-Mechanism and sputtering yield, Sputtering of alloys; magnetron sputtering, Reactive sputtering; vacuum arc: cathodic and anodic vacuum arc deposition.

Chemical vapour deposition: Thermodynamics of CVD, gas transport, growth kinetics, Plasma chemistry, plasma etching mechanisms; etch rate and selectivity, orientation dependent etching; PECVD

Module 6: Epitaxy: [7]

Epitaxy: Structural aspects of epitaxy, homo- and hetero-epitaxy, lattice misfit and imperfections; epitaxy of compound semiconductor, theories of epitaxy, Role of interfacial layer, Artificial semiconductors, Band-gap engineering, Super lattice structures, Epitaxial film growth and characterization

Module 7: Characterization of thin films: [6]

Deposition rate, Film thickness and uniformity, Structural properties: Crystallographic properties, defects, residual stresses, adhesion, hardness, ductility, electrical properties, magnetic properties; optical properties.

Text books:

1. The Material Science of Thin Films by Milton Ohring, Academic Press, Inc., 1992.
2. Handbook of Thin Films by Maissel and Glang
3. Thin Film Phenomena by K. L. Chopra

Reference books:

1. Coating Technology Handbook by D. Satas, A. A. Tracton, Marcel Dekkar Inc. USA.
2. Arc Plasma Technology in Material Science, P. A. Gerdeman and N. L. Hecht, Springer Verlag, 1972.

This course has direct bearing on employability

SAP 4019: Microprocessors and Microcontrollers

[3-1-0-4]

Module 1 [9] 8086 Architecture; Introduction to 8085 Microprocessor, 8086 Architecture-Functional diagram. Register Organization, Memory Segmentation. Programming Mode!. Memory addresses. Physical memory organization. Architecture of 8086, signal descriptions of 8086- common function signals. Minimum and Maximum mode signals. Timing diagrams. Interrupts of 8086.

Module 2 **[7]**
Instruction Set and Assembly Language Programming of 8086: Instruction formats, addressing modes, instruction set, assembler directives, macros, simple programs involving logical, branch and call instructions, sorting, evaluating arithmetic expressions, string manipulations.

Module 3 **[8]**
I/O Interface: 8255 PPI various modes of operation and interfacing to 8086. Interfacing keyboard, display, stepper motor interfacing, D/A and A/D converter. Memory interfacing to 8086, Interrupt structure of 8086, Vector interrupt table, Interrupt service routine, Introduction to DOS and BIOS interrupts, Interfacing Interrupt Controller 8259 DMA Controller 8257 to 8086.

Module 4 **[6]**
Communication Interface: Serial communication standards, Serial data transfer schemes. 8251 USART architecture and interfacing, RS-232, IEEE-4-88, Prototyping and trouble shooting

Module 5 **[6]**
Introduction to Microcontrollers: Overview of 8051 microcontroller. Architecture. I/O Ports. Memory organization, addressing modes and instruction set of 8051, simple program

Module 6 **[7]**
8051 Real Time Control: Interrupts, timer/ Counter and serial communication, programming Timer Interrupts, programming external hardware interrupts, programming the serial communication interrupts, programming 8051 timers and counters.

Module 7 **[7]**
The AVR RISC microcontroller architecture: Introduction, AVR Family architecture, Register File, The ALU. Memory access and Instruction execution. I/O memory. EEPROM. I/O ports. Timers. UART. Interrupt Structure

TEXT BOOKS:

1. D. V. Hall. Micro processors and Interfacing, TMGH. 2'1 edition 2006.
2. Kenneth. J. Ayala. The 8051 microcontroller , 3rd edition, Cengage learning, 2010

REFERENCE BOOKS:

1. Advanced Microprocessors and Peripherals - A. K. Ray and K.M. Bhurchandani, TMH, 2nd edition 2006.
2. The 8051 Microcontrollers, Architecture and programming and Applications -K.Uma Rao, Andhe Pallavi,,Pearson, 2009.
3. Micro Computer System 8086/8088 Family Architecture. Programming and Design - By Liu and GA Gibson, PHI, 2nd Ed.,
4. Microcontrollers and application, Ajay. V. Deshmukh, TMGH. 2005

This course has direct bearing on employability

SAP 4021: Instrumentation and Control

[3-1-0-4]

Module 1 and 2: Sensors (15)

Measurement basics: range, resolution, linearity, hysteresis, reproducibility and drift, calibration, accuracy and precision. Sensor Systems, characteristics, Instrument Selection, Measurement Issues and Criteria, Acceleration, Shock and Vibration Sensors, Interfacing and Designs, Capacitive and Inductive Displacement Sensors, Magnetic Field Sensors, Flow and Level Sensors, Load Sensors, Strain gauges, Humidity Sensors, Accelerometers, Photosensors, Thermal Infrared Detectors, Contact and Non-contact Position sensors, Motion Sensors, Piezoresistive and Piezoelectric Pressure Sensors, Sensors for Mechanical Shock, Temperature Sensors (contact and non-contact)

Module 3 & 4: Signal conditioning (15)

Types of signal conditioning, Amplification, Isolation, Filtering, Linearization, Classes of signal conditioning, Sensor Signal Conditioning, Conditioning Bridge Circuits, D/A and A/D converters for signal conditioning, Signal Conditioning for high impedance sensors

Grounded and floating signal sources, single-ended and differential measurement, measuring grounded signal sources, ground loops, signal circuit isolation, measuring ungrounded signal sources, system isolation techniques, errors, noise and interference in measurements, types of noise, noise minimization techniques

Module 5: Actuators (4)

Correction and regulating elements used in control systems, pneumatic, hydraulic and electric correction elements.

Module 6 & 7: Control System (16)

Open loop and closed loop (feedback) systems and stability analysis of these systems, Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of linear time invariant (LTI) control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral- Derivative (PID) control. State variable representation and solution of state equation of LTI control systems.

References:

1. Electronic Instrumentation - H. S. Kalsi, Tata McGraw-Hill Education, 2010
2. Electronic Instrumentation - W. Bolton
3. Instrumentation: Electrical and Electronic Measurements and Instrumentation - A. K. Sawhney,
4. Modern Electronic Instrumentation & Measurement Techniques - Helfrick & Cooper

This course has direct bearing on skill development

SAP 4023: Integrated Electronics

[3-1-0-4]

Logic Families **(5 Classes)**

Diode Transistor Logic, High Threshold Logic, Transistor-transistor Logic, Resistor-transistor Logic, Direct Coupled Transistor Logic, Comparison of Logic families

Integrated Chip Technology **(20 Classes)**

Overview of semiconductor industry, Stages of Manufacturing, Process and product trends, Crystal growth, Basic wafer fabrication operations, process yields, semiconductor material preparation, yield measurement, contamination sources, clean room construction, substrates, diffusion, oxidation and photolithography, doping and depositions, implantation, rapid thermal processing, metallization. patterning process, Photoresists, physical properties of photoresists, Storage and control of photoresists, photo masking process, Hard bake, develop inspect, Dry etching Wet etching, resist stripping, Doping and depositions: Diffusion process steps, deposition, Drive-in oxidation, Ion implantation, CVD basics, CVD process steps, Low pressure CVD systems, Plasma enhanced CVD systems, Vapour phase epitoxy, molecular beam epitaxy. Design rules and Scaling, BICMOS ICs: Choice of transistor types, pnp transistors, Resistors, capacitors, Packaging: Chip characteristics, package functions, package operations

Nanoelectronic devices **(25 Classes)**

Effect of shrinking the p-n junction and bipolar transistor; field-effect transistors, MOSFETs, Introduction, CMOS scaling, the nanoscale MOSFET, vertical MOSFETs, electrical characteristics of sub-100 nm MOS transistors, limits to scaling, system integration limits (interconnect issues etc.), heterostructure and heterojunction devices, ballistic transport and high-electron-mobility devices, HEMT, Carbon Nanotube Transistor, single electron effects, Coulomb blockade. Single Electron Transistor, Resonant Tunneling Diode, Resonant Tunneling Transistor, applications in high frequency and digital electronic circuits and comparison with competitive devices, direct and indirect band gap semiconductors, QWLED, QWLaser, Quantum Cascade Laser

Integrated Micromachining Technologies for Transducer Fabrication, Applications of Functional Thin Films and Nanostructures in Gas Sensing, Chemical Sensors, Applications of Functional Thin Films for Mechanical sensing, Sensing Infrared signals by Functional Films

Textbooks and Reference Books:

1. Herbert Taub, Donald L. Schilling, Digital Integrated Electronics, McGraw-Hill, 1977
2. S.M. Sze, Ed, Modern Semiconductor Device Physics, Wiley, New York
3. S.M. Sze and K.K. Ng, Physics of Semiconductor Devices, 3rd Ed, Wiley, Hoboken.
4. S. Wolf and R.N. Tauber, Silicon Processing, vol. 1, (Lattice Press)
5. S.Wolf and R. N. Tauber, Silicon Processing for the VLSI Era. (Lattice Press, 2000)
6. Streetman, B.G. Solid State Electronic Devices, Prentice Hall, Fifth Edition, 2000
7. R. D. Doering and Y. Nishi, Handbook of Semiconductor Manufacturing Technology, CRC Press, Boca Raton.
8. W. R. Fahrner (Editor), Nanotechnology and Nanoelectronics, Materials, Devices, Measurement Techniques
9. Anis Zribi, Jeffrey Fortin (Editors), Functional Thin Films and Nanostructures for Sensors Synthesis, Physics, and Applications

This course has direct bearing on employability

SAP 4027 Quantum and Nonlinear Optics

[3-1-0-4]

Module I & II: Nonlinear Optical Phenomena: Introduction to nonlinear optics, description of nonlinear optical interaction, phenomenological theory of nonlinearity, nonlinear optical susceptibilities. Sum and difference frequency generation, second harmonic generation, coupled wave equation. Manley-Rowe relations, phase matching of SHG, quasi phasematching, electric field induced SHG (EIFISH), optical parametric amplification, third harmonic generation, two-photon absorption. Stimulated Raman scattering and stimulated Brillouin scattering. **[12]**

Module III: Two level atoms: nonlinear optics in two level approximations, density matrix equation, closed and open two level atoms, steady state response in monochromatic field, Rabi oscillations, dressed atomic state, optical wave mixing in two level systems. **[10]**

Module IV: Intensity dependent phenomena: intensity dependent refractive index, self-focusing, self phase modulation,spectral broadening, optical continuum generation by short optical pulse. Optical phase conjugation, application of OPC in signal processing. Self induced transparency, spatial and temporal solitons, solitons in Kerr media, photorefractive and quadratic solitons, optical vortices. Pulse compression. **[10]**

Module V: Bistability: optical bistability, Steady state bistability, absoptive bistability, Dispersive bistability, Optical switching. **[6]**

Module VI: Ultra fast Phenomena: ultrafast pulse generation with and without mode locking, range gating with Ultra short pulse, four dimensional imaging. femto second laser Gyroscope, Soliton pulses. Transient NLO effects, Bloch vectors, Rabi oscillations, photon echo, self induced transparency, optical nutation, free induction decay. [6]

Module VII: Nonlinear guided wave optical devices: nonlinear planar waveguide, nonlinear channel waveguide, nonlinear directional coupler, nonlinear mode sorter, nonlinear Mach-Zehnder interferometer and logic gate, Nonlinear loop mirror. [6]

Book:

1. Fundamentals of Nonlinear Optics; P.E.Powers, CRC Press Francis and Taylor (2011)
2. Principles of Nonlinear Optics; Y.R.Shen
3. Nonlinear Optics: Robert Boyd, Academic press
4. Physics of Nonlinar Optics: Guang- Sheng –He and So ng-Hao Lin; World scientific.
5. Two Level Resonances in Atoms; Allen and J.H. Emberly, John Wiley.

This course has direct bearing on employability

SAP 4029 Introduction to Nanophotonics

[3-1-0-4]

Module I & II: Foundations for Nanophotonics: similarities and differences of photons and electrons and their confinement. Propagation through a classically forbidden zone: tunneling. Localization under a periodic potential: Band gap. Cooperative effects for photons and electrons. Nanoscale optical interactions, axial and lateral nanoscopic localization, scanning near-field optical microscopy. Nanoscale confinement of electronic interactions: Quantun confinement effects, nanoscale interaction dynamics, nanoscale electronic energy transfer. Cooperative emissions. **[12]**

Module III: Quantum wells, quantum wired, quantum dots, quantum rings and superlatices. Quantum confinement, density of states, optical properties. Quantum confined stark effect. Dielectric confinement effect,. Core-shell quantum dots and quantum-dot-quantum wells. Quantum confined structures as lasing media. Organic quantum-confined structures. [8]

Module IV: Photonic Crystals: basics concepts, features of photonic crystals, wave propagation, photonic band-gaps, light guiding. Theoretical modeling of photonic crystals. Methods of fabrication. Photonic crystal optical circuitry. Nonlinear photonic crystals. **A**pplications of photonic crystals. [6].

Module V: Microstructure fibers: photonic crystal fiber(PCF), photonic band gap fibers (PBG), band gap guiding, single mode and multi mode, dispersion engineering, nonlinearity engineering, PCF devices. [6]

Module VI: Plasmonics: Metallic nanoparticles, nanorods and nanoshells, local field enhancement. Collective modes in nanoparticle arrays, particle chains and arrays. suface plasmons, plasmon waveguides. Applications of metallic Nanostructures. [8]

Module VII: Nanophotonic Devices: Quantum well lasers: resonant cavity quantum well lasers and light-emitting diodes, Fundamentals of Cavity QED, strong and weak coupling regime, Purcell factor, Spontaneous emission control, Application of microcavities, including low threshold lasers, resonant cavity LED. Microcavity-based single photon sources. [10]

Book:

1. Nanophotonics, Paras N Ptrasad, John Wiley & Sons (2004)
2. Fundamentals of Photonic Crystal Fibers; Fredric Zolla- Imperial College Press.
3. Photonic Crystals; John D Joannopoulos, Princeton University Press.
4. Photonic Crystals: Modelling Flow of Light; John D Joannopoulos , R.D. Meade and J.N.Winn, Prenceton University Press (1995)

This course has direct bearing on employability

SAP 4031 Photonic and Optoelectronic Devices

[3-1-0-4]

Module I: Optical processes in semiconductors: Electron-hole pair formation and recombination, Direct and indirect bandgap semiconductors, optoelectronic materials, compound semiconductors, absorption in semiconductors, Stark effects, Absorption and emission spectra, Stokes shift in optical transitions, exciton recombination. [8]

Module II & III: Optical sources: Light emitting diodes, surface and edge emitting configuration. Injection laser diodes, gain and index guided lasers, vertical cavity lasers, DFB lasers, Quantum well lasers, Laser rate equations, Laser modes, Q-switching, Mode locking. [12]

Module IV: Optical modulators and switches: Electro-optic modulator, Magneto-optic modulator, Acousto- optic modulator. Electro-absorption modulators, Mach-Zehnder Electrorefraction (Electrooptic) modulators, Lithium Niobate light modulators, optical switches. [8]

Module V: Optical Detectors: PIN and avalanche photodiodes, Photoconductors, Phototransistors, noise in photodetector. Solar cells (spectral response, conversion efficiency), Charge couple devices, Characteristics and applications. [10]

Module VI: Optical computing: Digital optical computing: Nonlinear devices, optical bistable devices, SEED devices, Optical phase conjugate devices, integrated devices, spatial light modulators(SLM). [10]

Module VII: Photonic switching and interconnects: Kerr gates, Nonlinear Directional couplers, Nonlinear optical loop mirror (NOLM), Soliton logic gates, Free-space optical interconnects, wave-guide interconnects. [10]

Books:

1. Essentials of optoelectronics, Alan Rogers, 1st Ed., Chapman & Hall.
2. Introduction to Fiber Optics, Ghatak & Thyagarajan, Cambridge University press.
3. Semiconductor Optoelectronics Devices, P. Bhattacharya, PHI.
4. Optoelectronics and Photonics, principles and practices S. O. Kasap, Prentice Hall
5. Photonic switching and Interconnects; Abdellatif Marrakchi, Marcel Dekker, Inc.
6. Optical Computing, an Introduction, Mohammad A. Karim and Abdul A. S. Awwal, John Wileyy & Sons Inc.

This course has direct bearing on employability

SAP 4033 Holography and Applications

[3-1-0-4]

Module-I: Basics of Holography: In line Hologram, off axis hologram, Fourier Hologram, Lenses Fourier Hologram, Image Hologram, Fraunhofer Hologram. Holographic interferometry, double exposure hologram, real-time holography, digital holography, holographic camera. [8]

Module-II: Theory of Hologram: Coupled wave theory, Thin Hologram, Volume Hologram, Transmission Hologram, Reflection Hologram, Anomalous Effect. [8].

Module-III&IV:Recording Medium: Microscopic Characteristics, Modulation transfer function, Diffraction efficiencies, Image Resolution, Nonlinearities, S/N ratio, Silver halide emulsion, Dichromated gelatin, Photoresist, Photochrometics, Photothermoplastics, photorefractive crystals. [13]

Module-V&VI:Applications: Microscopy, interferometry, NDT of engineering objects, particle sizing, holographic particle image velocimetry; imaging through aberrated media, phase amplification by holography; Optical testing; Information storage. [13]

Module-VII: Holographic Optical Elements(HOE): multifunction, holographic lenses, holographic mirror, holographic beam splitters, polarizing, diffuser, interconnects, couplers, scanners; Optical data processing, holographic solar connectors; antireflection coating, holophotoelasticity; [8]

Book:

1. Optical Holography, Principle Techniques and applications: P. Hariharan, Cambridge University Press.
2. Holographic Recording materials; H.M.Smith, Springer Verlag

This course has direct bearing on employability

COURSE INFORMATION SHEET

Course code: PH 102
Course title: ELECTRICITY AND MAGNETISM
Pre-requisite(s): Intermediate Physics
Co- requisite(s):
Credits: 4 L: 3 T:1 P: 0
Class schedule per week:
Class: I.M.Sc.
Semester / Level: I
Branch: PHYSICS
Name of Teacher: Dr R. Kumar

Theory: 50 Lectures

Code: PH 102	**Title: ELECTRICITY AND MAGNETISM**	**L-T-P-C [3-1-0-4]**

0	know and apply the basic theorems related to electrostatics potential and field
2	know how to deal electrostatics situation when dielectric is involved.
3	know the various laws of magnetostatics in vacuum and when there is magnetic medium
4	know the laws of electrodynamics and its application in AC circuits.
5	know about Network theorems in linear circuits

Course Outcomes : After the completion of this course, students will be able to

0	apply Gauss's law and uniqueness theorem to calculate electric field
1	to calculate various quantities like displacement vector and polarization in the presence of dielectircs.
2	to apply the laws of magnetostatics-like Biot-Savart law, Ampere's circuital law, and to calculate the hysteresis energy loss .
3	to apply Maxwell's equations, and the laws of electromagnetic induction to deal AC circuits.
4	to apply network theorems to get the information about the voltage and current in various branches of a dc circuit

Module-1	**Electric Field and Electric Potential** Electric field: Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry. Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. The Uniqueness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole.	**10**
Module-2	Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere **Dielectric Properties of Matter:** Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector **D**. Relations between **E**, **P** and **D**. Gauss' Law in dielectrics.	**10**
Module-3	**Magnetic Field**: Magnetic force between current elements and definition of Magnetic FieldB. Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Properties of B: curl and divergence. Vector Potential. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic Field. Magnetic Properties of Matter: Magnetization vector (**M).** Magnetic Intensity(**H).** Magnetic Susceptibility and permeability. Relation between **B, H, M**. Ferromagnetism. B-H curve and hysteresis.	**10**
Module-4	**Electromagnetic Induction:** Faraday's Law. Lenz's Law. Self Inductance and Mutual Inductance. Reciprocity Theorem. Energy stored in a Magnetic Field. Introduction to	**10**

	Maxwell's Equations. Charge Conservation and Displacement current . **Electrical Circuits:** AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit.	
Module-5	**Network theorems:** Ideal Constant-voltage and Constant-current Sources. Network Theorems Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem. Applications to dc circuits **Ballistic Galvanometer:** Torque on a current Loop. Ballistic Galvanometer: Current and Charg Sensitivity. Electromagnetic damping. Logarithmic damping. CD	**10**

References:

Text books:

0 Introduction to Electrodynamics by D.J. Griffits, Prentice Hall(1999).
1 Electricity and Magnetism by E. M. Purcell and D. J. Morin, Cambridge. University press(2013)
2 Schaum's outline of Theory and Problems of Electrical Circuits, TMH 2002, by Mahmood Nahri & J. Edminister

Reference books:

1. Classical electrodynamics, J.D. Jackson, John and Wiley press, Third edition

POs met through Topics beyond syllabus/Advanced topics/Design

Course Delivery methods
Lecture by use of boards/LCD projectors/OHP projectors
Tutorials/Assignments
Seminars
Mini projects/Projects
Laboratory experiments/teaching aids
Industrial/guest lectures
Industrial visits/in-plant training
Self- learning such as use of NPTEL materials and internets
Simulation

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	25
End SemExamination Marks	50
Two Quizzes	10+10
Teacher's assessment	5

Assessment Compoents	CO1	CO2	CO3	CO4	CO5
Mid Sem Examination Marks	√	√	√		
End Sem Examination Marks	√	√	√	√	√
Quiz I			√		
Quiz II				√	

Indirect Assessment –

Student Feedback on Faculty
Student Feedback on Course Outcome

Semester II

COURSE INFORMATION SHEET

Course code: PH 105
Course title: MATHEMATICAL PHYSICS-I
Pre-requisite(s): Intermediate Physics and Mathematics
Co- requisite(s):
Credits: 4 L: 3T: 1 P: 0
Class schedule per week:
Class: I.M.Sc.
Semester / Level: II
Branch: PHYSICS
Name of Teacher: Dr. S. Keshri

Theory: 50 Lectures

Code: PH 105	**Title: MATHEMATICAL PHYSICS-I**	**L-T-P-C [3-1-0-4]**
Course Objectives: 0 To give students an understanding of expressing periodic functions as discrete Fourier series, and complex representation of Fourier series. 1 To provide fundamental concepts for solving ordinary differential equations which is required to understand the formulation of specialized courses in Physics. 2 To familiarize students with some special integrals and their solutions which frequently appear while modeling physical systems. 3 To train to estimate various errors in solving equations due to approximations or uncertainty in initial conditions. 4 To introduce the concepts of partial differential equations and their applications in various problems in physics. **Course Outcomes:** The student should be able to 0 Determine Fourier series of a given periodic function by evaluating Fourier coefficients. 1 Analyze first-order and second-order differential equations and recognize special functions as solutions of some differential equations. 2 Identify special integrals. 3 Calculate standard errors while solving equations. 4 Solve partial differential equations using classical solution methods.		
Module-1	**Fourier Series**: Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non-periodic functions over an interval. Even and odd functions and their Fourier expansions. Application. Summing of Infinite Series. Term-by-Term differentiation and integration of Fourier Series. Parseval Identity.	**10**
Module- 2	Frobenius Method and Special Functions: Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions ($J_o(\mathbf{x})$ and $J_1(x)$) and Orthogonality.	**10**
Module-3	**Some Special Integrals:** Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral). **Theory of Errors:** Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error. Least-squares fit. Error on the slope and intercept of a fitted line.	**10**
Module-4	**Partial Differential Equations**: Solutions to partial differential equations, using	**10**

	separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Wave equation and its solution for vibrational modes of a stretched string, rectangular and circular membranes. Diffusion Equation.	
Module-5	**Orthogonal Curvilinear Coordinates:** Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems.	**10**

Text Books:

0 T1: Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
1 T2: Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
2 T3: Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.

Reference Books:

0 R1: Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
1 R2: Partial Differential Equations for Scientists & Engineers, S.J. Farlow, 1993, Dover Pub.
2 R3: Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press
3 R4: Mathematical methods for Scientists & Engineers, D.A. McQuarrie, 2003, Viva Books

Course Delivery methods	
Lecture by use of boards/LCD projectors/OHP projectors	Yes
Tutorials/Assignments	Yes
Seminars	Yes
Mini projects/Projects	No
Laboratory experiments/teaching aids	No
Industrial/guest lectures	No
Industrial visits/in-plant training	No
Self- learning such as use of NPTEL materials and internets	Yes
Simulation	No

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	25
End SemExamination Marks	50
Two Quizzes	10+10
Teacher’s assessment	5

Assessment Compoents	CO1	CO2	CO3	CO4	CO5
Mid Sem Examination Marks	√	√	√		
End Sem Examination Marks	√	√	√	√	√
Quiz I			√		
Quiz II				√	

Indirect Assessment –

0 Student Feedback on Faculty
1 Student Feedback on Course Outcome

Course code: PH 106
Course title: WAVES AND OPTICS
Pre-requisite(s): Intermediate Physics and Mathematics
Co- requisite(s):
Credits: 4 L:3 T: 1 P: 0
Class schedule per week: 3
Class: I.M.Sc.
Semester / Level: II
Branch: PHYSICS
Name of Teacher:Dr Nishi Srivastava

Theory: 50 Lectures

Code: PH 106	**Title: WAVES AND OPTICS**	**L-T-P-C [3-1-0-4]**

23	To provide thorough knowledge of superposition principle, superposition of collinear and perpendicular oscillations; and basic information about waves
24	To appreciate the variation in velocity of waves and formation of standing waves.
25	To understand the concept of interference and instruments based on this phenomenon.
26	To know the concept of diffraction, its theory and classes
27	To understand the polarized light and its basic principles.

Course Outcomes: After the completion of this course, students will

5888	Be able to explain superposition principle, formation of Lissajous figure and classes of waves
5889	Be able to understand changes in waves and characteristics of standing waves
5890	Be able to explain the optical phenomenon interference and working of instruments based on this phenomenon
5891	Get familiar with optical phenomenon diffraction and various theory explaining it
5892	Acquire knowledge of polarization, various class of polarized light and its construction

Module-1	**Superposition of Collinear Harmonic oscillations**: Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats). Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences. **Superposition of two perpendicular Harmonic Oscillations**: Graphical and Analytical Methods Lissajous Figures with equal an unequal frequency and their uses. **Wave Motion:** Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Water Waves: Ripple and Gravity Waves.	12
Module-2	**Velocity of Waves:** Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction. **Superposition of Two Harmonic Waves**: Standing (Stationary) Waves in a String: Fixed and Free Ends. Analytical Treatment. Phase and Group Velocities. Changes with respect to Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's Experiment. Longitudinal Standing Waves and Normal Modes. Open and Closed Pipes.Superposition of N Harmonic Waves. **Wave Optics:** Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence.	12
Module-3	**Interference:** Division of amplitude and wavefront. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive index **Interferometer**: Michelson Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes. Fabry-Perot interferometer.	12
Module-4	**Diffraction:** Kirchhoff's Integral Theorem, Fresnel-Kirchhoff's Integral formula. (Qualitative discussion only)	10

	Fraunhofer diffraction: Single slit. Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating. **Fresnel Diffraction**: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire.	
Module-5	**Polarization:** Unpolarised light, linear, circular, eliptical polarized light, Malus law, Polarisation by reflection, refraction, and scattering, double refraction, Nicol's prism, Babinet compensator, Jones vector, Jones matrices.	4

Text Books

T1: Optics, Ajoy Ghatak, 2008, Tata McGraw Hill

Reference Books

R1: Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
R2: Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
R3: Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
R4: The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
R5: The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
R6: Fundamental of Optics, A. Kumar, H.R. Gulati and D.R. Khanna, 2011, R. Chand Publications.

Course Delivery methods	
Lecture by use of boards/LCD projectors/OHP projectors	Y
Tutorials/Assignments	Y
Seminars	N
Mini projects/Projects	N
Laboratory experiments/teaching aids	Y
Industrial/guest lectures	N
Industrial visits/in-plant training	N
Self- learning such as use of NPTEL materials and internets	Y
Simulation	N

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	25
End SemExamination Marks	50
Two Quizzes	10+10
Teacher's assessment	5

Assessment Compoents	CO1	CO2	CO3	CO4	CO5
Mid Sem Examination Marks	√	√	√		
End Sem Examination Marks	√	√	√	√	√
Quiz I			√		
Quiz II				√	

Indirect Assessment –

23 Student Feedback on Faculty
24 Student Feedback on Course Outcome

IPA2005 Boundary layer Meteorology and Air Pollution (3-0-0-3)

Module 1:

Meaning and scope of micrometeorology. Divisions of the atmosphere. Importance of the lower region of the atmosphere. Distinctive features of micrometeorology compared with macro and mesometeorology. Distribution of important meteorological parameters in the boundary layer. (6L)

Module 2:

Profiles of temperature, humidity and wind under different stability conditions. Laminar and turbulent conditions; Reynold and Richardson number. Turbulent transfer of mass, momentum and energy. Concepts of exchange co-efficient, exchange coefficient relationships. Application of turbulent transfer processes to agricultural phenamena such as photosynthesis under field conditions. (6L)

Module 3:

Concept of boundary layer, governing equations, scaling laws, mean and turbulent quantities, atmospheric dispersion, surface fluxes, Monin-Obukhov similarity theory, boundary layer over land and ocean , boundary layer structure and its importance (6L)

Module 4

Boundary layer modeling and parameterization schemes, interaction between clouds and boundary layer. (6L)

Module 5:

Sources of air pollution; Classification of aerosols, Gases vapors, natural pollutants; Properties of air pollutants; Meteorological factors influencing dispersion of air pollutants; Gaussian plume model for dispersion of air pollutants and its applications; Effects on man, material, vegetation, art treasure. (6L)

Module 6:

Air pollution disasters; Economic Effects of air pollution; Global Effects of Air pollution; Air pollution Due to Automobiles and emission control; General concept of transport planning for prevention of air pollution; Control technology for particulate and gaseous pollutants. (6L)

Books:

Arya, S.P., 1988: Introduction to Micrometeorology. Academic Press, San Diego, 303 pp.

1. Garrratt, J.R., 1992: The Atmospheric Boundary Layer. Cambridge University Press,
2. Kaimal, J.C., and J.J.Finnigan, 1994: Atmospheric Boundary Layer Flows, Oxford University Press, New York/Oxford,
3. R. B. Stull, An Introduction to Boundary Layer Meteorology, Kluwer Academic Publishers, 1988.
4. Sorbjan, Z., 1989: The Structure of the Atmospheric Boundary Layer, Prentice Hall, Englewood Cliff, N.J.

T.R. Oke, Boundary Layer Climates, Roultedge Publications, Taylor & Fransis, 2nd ed., 2003

5. Sorbjan, Z., Structure of the Atmospheric Boundary Layer. Prentice-Hall, 1989.
6. Seinfeld J.H. and S. Pandis, Atmospheric Chemistry and Physics, John Wiley, 1998
7. Zannetti, P. Air Quality Modelling, Volume 1 fundamentals, EnviroComp Institute and Air & Waste Management Association, 2003.
8. Arya, S.P.S., Air Pollution Meteorology and Dispersion, Oxford Univ. Press, 1999.

This course has direct bearing on employability

M.Sc Physics -II Semester

SAP 2001 Electronics Devices and Circuits

Electronic Devices **[3-1-0-4]**

Varactor diode, photo-diode, Schottky diode, solar cell, Principle of Operation and I-V Characteristics of MOSFET. Thyristors (SCR, LASCR, Triac and Diac). **[7]**

Amplifiers using discrete devices **[8]**

BJT amplifiers, h-parameters and their variations. Low frequency and high frequency (hybrid-pi model), small signal analysis of BJT amplifiers in CE and CC modes with reference to gain, input and output impedance, gain-bandwidth product, stability and distortion in BJT amplifiers, cascaded multistage amplifiers and cascode amplifiers. Amplifiers using FETs, MOSFETs and their analysis,

Feedback in amplifiers **[9]**

Characteristics of Negative Feedback Amplifiers, Input Resistance, Output Resistance, Method of Analysis of a Feedback Amplifier, Voltage Series Feedback, Voltage Series Feedback Pair, Current Series Feedback, Current Shunt Feedback, Voltage Shunt Feedback, Bode Plots, Nyquist plots, two-pole and three–pole transfer function with Feedback, Approxi mate Analysis of a multipole feedback amplifier, Stability, Gain and Phase Margins, Compensation, Dominant-Pole Compensation, Pole-Zero Compensation,

Audio and Radio Frequency Oscillators **[5]**

Sinusoidal Oscillators, Phase-Shift Oscillator, Resonant Circuit Oscillators, Radio frequency oscillators: Hartley, Colpitt, Clapp and crystal oscillators (including analysis)

Operational amplifiers **[7]**

Differential Amplifier, Emitter-Coupled Differential Amplifier, Transfer Characteristics of a Differential Amplifier, operational Amplifier offset error voltages and currents, temperature drift of input offset voltage and current, Measurement of Operational Amplifier Parameters, Frequency Response of Operational Amplifiers, Dominant–Pole Compensation, Pole-Zero Compensation, Lead Compensation, Step Response of Operational Amplifiers

Linear applications of op-amps **[8]**

Op-amp circuits: voltage gain, input impedance, output impedance and bandwidth of inverting amplifier, noninverting amplifier; phase inverter, scale changer, integrator, differentiator. voltage multiplier, limiter, clipper, clamper and peak-to-peak detector, difference amplifier, instrumentation amplifier, log and anti-log circuits, precision rectifiers, active filters (low-pass, high-pass, band-pass, band-reject/ notch), Analog computation circuits, RC phase shift and Wein bridge oscillators.

Nonlinear applications of op-amps **[6]**

Comparators, schmitt trigger, multivibrators, AMV and MMV using 555 timer, waveform generation, power supply circuits, analog computation using op-amps. D/A converters, binary weighted, ladder type, A/D converters, simultaneous, counter type, successive approximation type, dual slope converter.

Textbooks:

1. Electronic Devices: Solid State Electronic Devices – B. G. Streetman, PHI
2. Physics of Semiconductor Devices – S. M. Sze.
3. Integrated Electronics, Jacob Millman and Christos C. Halkias, - Tata McGraw Hill Publication
4. Electronic Devices and Circuit Theory, R. Boylestad and L. Nashelsky
5. Operational Amplifiers and Linear Integrated Circuits - R. F. Coughlin, F. F. Driscoll, PHI,
6. Operational Amplifiers and Linear Integrated Circuits - R. A. Gayakwad, PHI.

References:

1. Electronic Devices and Circuits – T.F. Bogart Jr., J.S.Beasley and G.Rico, Pearson Education, 6th edition,2004.
2. Electronics Fundamentals and Applications, J. D. Ryder, Prentice Hall of India , New Delhi , 1987.

This course has direct bearing on skill development

SAP 3005 Materials Science (3-0-0-3)

Introduction: Metallic materials, Polymeric materials, Ceramic materials, Composite materials, Electronic materials, New materials. (2)

Imperfections in solids: Types of imperfections, Point defects. Dislocations: Edge dislocation & Screw dislocation, Burger's vector, Concepts of dislocation density, Surface defects, Volume defects, vibrational defects. (4)

Mechanical Properties of Materials: Elastic and plastic deformation, effects of temperature, effect of grain size, creep fracture and fatigue, factors affecting mechanical properties of solids, defects i crystalline solids, dislocations, strengthening mechanics, cold working and annealing, solute-solutio hardening, precipitation hardening, diffusion hardening, strain hardening, dispersion hardening. (6)

Phase Equilibrium: Concept, phase stability, diagrams, rules. Fe-C phase transformations in ferrous alloys, properties of ferrous and non-ferrous alloys and their applications, Techniques for ph diagrams, Single & Binary phase diagram, Lever's rule, Gibbs phase rule. (4)

Glasses, ceramics, composite and Polymeric materials: Ceramic and refractories, glassy state, clay products, characterization, properties and applications of glass-ceramic materials. Composites: particle- reinforced composites, fibre-reinforced composites, their applications.

Polymers: Molecular shape, structure and configuration, crystallinity, copolymers, thermoplastic an thermosetting polymers, mechanical behavior of polymers, elastomers, polymer additives, Applications of different types of polymers. (9)

Superconducting materials: Basic phenomena, Meissner effect, Magnetic properties of type-I and type-II superconductors, Energy gap, London equations, Coherence length, Cooper pairs, BCS theo (qualitative), Josephson effect, SQUID, Flux quantization, Introductory information about hig temperature superconductors, applications. (5)

Introduction to new materials: Smart materials, Nanomaterials & Biomaterials - definitions, classifications, examples and applications. (3)

Advanced experimental techniques: Introduction to RBS, SIMS, FTIR, ESR & Mossbauer spectroscopy and their applications for identifications of materials. (7)

Textbook:

1. Materials Science and Engineering, An Introduction, W.D. Callister, Wiley

References:

1. Solid state physics, N.W. Ashcroft and N. D. Mermin, Saunders College.
2. Principles of the solid state, H. V. Keer, Wiley Eastern.
3. Material Science, J. C. Anderson, K. D. Leaver, J. M. Alexander, R. D. Rawlings, ELBS.
4. Handbook of Liquid Crystal by Kelker and Hatz, Chemie-Verlag.

This course has direct bearing on employability

COURSE INFORMATION SHEET

Course code: PH 202
Course title: DIGITAL SYSTEMS AND APPLICATIONS
Pre-requisite(s): Intermediate Physics and Mathematics
Co- requisite(s):
Credits: 4 L:4 T: 0 P: 0
Class schedule per week:
Class: I.M.Sc.
Semester / Level: III
Branch: PHYSICS
Name of Teacher: Dr Ela Sinha

Theory: 50 Lectures

Code PH 202	Title: DIGITAL SYSTEMS AND APPLICATIONS	L-T-P-C 4-0-0-4]
Course objectives : Students will try to learn 1. To understand number representation and conversion between different representation in digital electronic circuits 2. To analyze logic processes and implement logical operations using combinational logic circuits. 3. To understand characteristics of memory and their classification. 4. To understand concepts of sequential circuits and to analyze sequential systems. 5. To understand basic architecture of 16 bit and 32 bit microprocessors. **Course outcomes:** After successful completion of the course student will be able:- 1. To develop a digital logic and apply it to solve real life problems. 2. To analyze, design and implement combinational logic circuits. 3. To classify different semiconductor memories. 4. To analyze, design and implement sequential logic circuits. 5. To write programs to run on 8085 microprocessor based systems.		
Module-1	**Introduction to CRO:** Block Diagram of CRO. Electron Gun, Deflection System and Time Base. Deflection Sensitivity. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference. **Integrated Circuits** (Qualitative treatment only): Active & Passive components. Discrete components. Wafer. Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI (basic idea and definitions only). Classification of ICs. Examples of Linear and Digital lCs.	**10**
Module-2	**Digital Circuits:** Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity Checkers. **Boolean algebra:** De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map.	**10**
Module-3	**Data processing circuits**: Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders. **Arithmetic Circuits:** Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor. **Sequential Circuits:** SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S JK Flip-Flop. **Timers**: IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator.	**10**
Module-4	**Shift registers:** Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in Parallel-out Shift Registers (only up to 4 bits). **Counters(4 bits):** Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter. **Computer Organization**: Input/Output Devices. Data storage (idea of RAM and ROM). Computer memory. Memory organization & addressing. Memory Interfacing. Memory Map.	**10**
Module-5	**Intel 8085 Microprocessor Architecture:** Main features of 8085. Block diagram. Components. Pin-out diagram. Buses. Registers. ALU. Memory. Stack memory. Timing Control circuitry. Timing states. Instruction cycle, Timing diagram of MOV and MVI.	**10**

	Introduction to Assembly Language: 1 byte, 2 byte & 3 byte instructions.	

Text Books:

1. Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., 2011, Tata McGraw (T1)
2. Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.(T2)
3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.(T3)
4. Digital Electronics G K Kharate ,2010, Oxford University Press(T4)

Reference Books

1. Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, 2001, PHI Learning (R1)
2. Logic circuit design, Shimon P. Vingron, 2012, Springer.(R2)
3. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.(R3)
4. Digital Electronics, S.K. Mandal, 2010, 1st edition, McGraw Hill (R4)
5. Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall. (R5)

Gaps in the syllabus (to meet Industry/Profession requirements) : NA
POs met through Gaps in the Syllabus : NA
Topics beyond syllabus/Advanced topics/Design : NA
POs met through Topics beyond syllabus/Advanced topics/Design

Course Delivery methods	
Lecture by use of boards/LCD projectors/OHP projectors	Y
Tutorials/Assignments	Y
Seminars	N
Mini projects/Projects	N
Laboratory experiments/teaching aids	N
Industrial/guest lectures	N
Industrial visits/in-plant training	N
Self- learning such as use of NPTEL materials and internets	Y
Simulation	N

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	25
End SemExamination Marks	50
Quiz	10+10
Teacher’s assessment	5

Assessment Compoents	CO1	CO2	CO3	CO4	CO5
Mid Sem Examination Marks	√	√	√		
End Sem Examination Marks	√	√	√	√	√
Quiz I			√		
Quiz II				√	

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

BIRLA INSTITUTE OF TECHNOLOGY
A Deemed University u/s 3 of UGC Act, 1956
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To whomever it may concern

This is to certify that the following courses were not active in the Department of Physics.

Sl no	Title of course	Course code
1	SEMICOND. OPTOELECT. MATERIALS & DEVICES	TNT1009
2	OPTICAL COMMUNICATIONS	SAP4017

It is also endorsed that the courses whose COs are not available, the direct bearing of the courses on employability/skill-development/entrepreneurship have been mentioned below the corresponding syllabi.

Head of the Department