Shri Rawatpura Sarkar University, Raipur

Examination Scheme & Syllabus

of CBCS Pattern for

Master of Science in Physics

Semester-III

(Effective from the session: 2022-2023)

Shri Rawatpura Sarkar University, Raipur
Faculty of Science
Department of Physics

Two Years Master of Science Program
Scheme of Teaching & Examination
M. Sc. in Physics Semester-III
Outcome Based Education (OBE) & Choice Based Credit Systems (CBCS)
(Effective from the Academic Year: 2022-2023)

S. No.	Course Code	Course Title	Hours/ Week			Credit	Maximum Marks			Sem End Exam Duration (Hrs)
			L	T	P		Continuous Evaluation	Sem End Exam	Total	
1.	SMS10301T	Nuclear And Particle Physics	4	-	-	4	30	70	100	3.0
2.	SMS10302T	Solid State Physics-I	4	-	-	4	30	70	100	3.0
3.	SMS10331T	Solid State Physics - II	4	-	-	4	30	70	100	3.0
	SMS10332T	Laser Physics and Applications								
4.	SMS10333T	Biological Physics	4	-	-	4	30	70	100	3.0
	SMS10334T	Physics of Nano-Materials								
5.	SMS10335T	Analog System and Applications	4	-	-	4	30	70	100	3.0
	SMS10336T	Astronomy and Astrophysics								
6.	SMS10391P	Physics Lab course V	-	-	4	2	15	35	50	5.0
7.	SMS10392P	Physics Lab Course VI	-	-	4	2	15	35	50	5.0
	Total teaching hrs/week: 28		**Total Credits**			**24**	**Total Marks**		**600**	

Master of Science in Physics
Semester-III
2022-2023

<table>
<tr><td>Course Title</td><td colspan="5">Physics IX: NUCLEAR AND PARTICLE PHYSICS</td></tr>
<tr><td>Course Code</td><td colspan="5">SMS10301T</td></tr>
<tr><td rowspan="2">Course Credit</td><td>L</td><td>T</td><td>P</td><td>TC</td><td></td></tr>
<tr><td>4</td><td>-</td><td>-</td><td>4</td><td></td></tr>
<tr><td>Prerequisite</td><td colspan="5">Student must have the knowledge of nuclear and particle physics.</td></tr>
<tr><td>Course Objective</td><td colspan="5">• To study nuclear and particle physics in advance and establish foundation to research in the respective domain.</td></tr>
<tr><td>Course Content</td><td colspan="5">UNIT-I
Nuclear Interactions: Nucleon-nucleon interaction, Two-nucleon system, The ground state of the deuteron, Tensor forces, Nucleon-nucleon scattering at low energy, Scattering length, Effective range theory, Spin dependence of nuclear forces, Charge independence and charge symmetry of nuclear forces, Iso-spin formalism, Exchange forces, Meson theory of nuclear forces and the Yukawa interaction.
UNIT-II
Nuclear Reactions: Reaction energetics: Q-equation and threshold energies, Reactions cross sections, Resonance: Breit-Wigner single-level formula, Direct and compound nuclear reactions, Formal reaction theory: Partial wave approach and phase shifts, Scattering matrix, Reciprocity theorem,
UNIT-III
Nuclear Decay: Beta decay, Shape of the beta spectrum and problems in conservation laws, Pauli's neutrino hypothesis, Femi's theory of beta decay, Total decay rate, Angular momentum and parity selection rules, Comparative half-lives, Allowed and forbidden transitions, Parity violation, Detection and properties of neutrino. Gamma decay, Multiple transitions in nuclei, Angular momentum and Parity selection rules, Internal conversion.
UNIT–IV
Nuclear models: Liquid drop model, Bohr-Wheeler theory of fission, Shell Model, Experimental evidence for shell effects, Single particle shell model, Spin-orbit interaction and magic numbers, Analysis of shell model predictions, Magnetic moments and Schmidt lines, Collective model of Bohr and Mottelson.
UNIT –V
Elementary particle Physics: The fundamental interactions, Classification of elementary particles, Leptons and Hadrons, Symmetries, groups and conservation laws, SU(2) and SU(3) multiplets and their properties, Quark model, Properties of Quarks, the standard model.</td></tr>
</table>

Course Outcome	• On the completion of this course, successfully student will be able to understand the development of the nuclear and particle physics. 1. The purpose of the course is to introduce students to knowledge about Nucleon-nucleon interaction, Effective range theory & Meson theory of nuclear forces. 2. The purpose of the course is to introduce students to learning about Q-equation and threshold energies. 3. The purpose of the course is to introduce students to introduction about Beta decay, Shape of the beta spectrum and problems in conservation laws. 4. The purpose of the course is to introduce students to information about Liquid drop model & Bohr-Wheeler theory of fission. 5. The purpose of the course is to introduce students to knowledge about the fundamental interactions & Classification of elementary particles. 6. Develop required classical phenomenon to solve problems in Nuclear Physics, Particle Physics and other fields of theoretical physics.
Text Books	1. Bohr and B.R. Mottelson, Nuclear structure, vol. 1 (1969) and vol.2, Benjamin, Reading, A, 1975. 2. Kenneth S. Krane, Introductory Nuclear Physics, Wiley, New York, 1988. 3. Ghoshal, Atomic and Nuclear Physics vol.2. 4. P.H. Perking, Introduction to high energy physics, Addison-Wesley, London, 1982. 5. Shriokov Yudin, Nuclear Physics vol.1 & 2, Mir Publishers, Moscow, 1982. 6. D. Griffiths, introduction to elementary particles, harper and row, New York, 1987.
Reference Books	1. H.A. Enov, introduction to Nuclear Physics, Addison-Wesley, 1973. 2. G.E. Brown and A.D. Jackson, Nucleon-Nucleon interaction North-halland Amsterdam, 1976. 3. S.D. Benedetti, Nuclear interaction, John Willey and sons, NewYork, 1964. 4. M.K. Pal, theory of Nuclear structure, affiliated East West, Madras, 1982. 5. Y.R. Waghmare, introductory nuclear physics, Oxford, IBH, Bombay, 1981. 6. J.M. Longo, elementary particles, McGraw Hill, New York, 1971. 7. R.R. Roy and B.P. Nigam, Nuclear Physics, Wiley-Easterm Ltd. 1983.

Master of Science in Physics
Semester-III
2022-2023

Course Title	**Physics X: SOLID STATE PHYSICS-I**				
Course Code	**SMS10302T**				
Course Credit	**L**	**T**	**P**	**TC**	
	4	**-**	**-**	**4**	
Prerequisite	Student must have the knowledge of solid state physics.				
Course Objective	• To study solid state physics in advance and establish foundation to research in the respective domain.				
Course Content	**Unit- I** **Electrons in Solids and Electronic Properties:** Energy bands: nearly free electron model, origin of energy gap and its magnitude, Bloch function, Kronig-Penny model, Wave equation of electron in periodic potential, restatement of Bloch theorem, crystal moment of an electron, solution of Central equation, Kronig-Penny model in reciprocal space, empty lattice Approximation, approximate solution near zone boundary, Number of orbitals in a band, metals and insulators. **Unit -II** **Fermi surfaces and metals:** Effect of temperature on F-D distribution, free electron gas in three dimension. Different zone schemes, reduced and periodic zones, construction of Fermi surfaces, nearly free electrons, electron, hole, open orbits, Calculation of energy bands, Tight binding, Wigner-Seitz, cohesive energy, pseudo potential methods. Experimental methods in Fermi surface studies, quantization of orbits in a magnetic field, de Haas van Alphen Effect, External orbits, Fermi surface of copper. **Unit- III** **Crystal vibration and thermal properties:** Lattice dynamics in monoatomic and diatomic lattice: two atoms per primitive basis, optical and acoustic modes, quantization of elastic waves, phonon momentum, inelastic neutron scattering by phonons, Anharmonic crystal interactions-thermal expansion, thermal conductivity, thermal resistivity of phonon gas, umklapp processes, imperfections. **Unit –IV** **Electron-Phonon interaction- superconductivity:** Experimental survey: occurrence of superconductivity, Destruction of superconductivity by magnetic field, Meissner effect, heat capacity, energy gap, MW, and IR properties, isotope effect. Theoretical survey: thermodynamics of superconducting transition, London equation, Coherence length, Cooper pairing due to phonons, BCS theory of superconductivity, BCS ground state, flux quantization of superconducting ring, duration of persistent currents, Type II superconductors, Vortex states, estimation of Hc1 and Hc2, single particle and Josephson superconductor tunneling, DC/AC Josephson effect, Macroscopic quantum				

	interference. High temperature superconductors, critical fields and currents, Hall number, fullerenes ring. **Unit – V** **Semiconductor crystals:** Band gap, equation of motion, physical derivation of equation of motion, holes, effective mass, physical interpretation of effective mass, effective masses of semiconductors Si and Ge, intrinsic carrier concentration, intrinsic mobility, impurity conductivity, donor and acceptor states, thermal ionization of donors and acceptors, thermo-electric effects.
Course Outcome	• On the completion of this course successfully student will be able to understand the development of the solid state physics. 1. The purpose of the course is to introduce students to knowledge about Energy bands: nearly free electron model, origin of energy gap and its magnitude. 2. The purpose of the course is to introduce students to learning about Effect of temperature on F-D distribution, free electron gas in three dimensions. 3. The purpose of the course is to introduce students to introduction about Lattice dynamics in monoatomic and diatomic lattice: two atoms per primitive basis. 4. The purpose of the course is to introduce students to information about Experimental survey: occurrence of superconductivity, Destruction of superconductivity by magnetic field & Meissner effect. 5. The purpose of the course is to introduce students to knowledge about Band gap, equation of motion and physical derivation of equation of motion.
Text books	1. C. Kittel: Introduction to Solid State Physics (Wiley and Sons). 2. J.M. Ziman: Principles of theory of solids (Cambridge Univ. Press). 3. Azaroff: X-ray crystallography. 4. Weertman and weertman : Elementary Dislocation Theory.
References Books	1. Verma and Srivastava: Crystallography for Solid State Physics. 2. Azeroff and Buerger: The Power Method. 3. Buerger: Crystal Structure Analysis.

Course Title	**Major Elective I: Solid State Physics - II**				
Course Code	**SMS10303T**				
Course Credit	**L**	**T**	**P**	**TC**	
	4	**-**	**-**	**4**	
Prerequisite	Student must have the knowledge of Solid State Physics.				
Course Objective	• To study Solid State Physics in advance and establish foundation to research in the respective domain				
Course Content	**UNIT- I** **Plasmons, Polaritons:** Dielectric function of the electron gas, Plasma optics, Dispersion relation for EM wave, Transverse optical modes in Plasma, Transparency of Alkali metals in the ultraviolet, Longitudinal Plasma oscillations, Plasmon, electrostatic screening and screened Coulomb potential, Mott metal-insulator transition, screening and phonons in metals, Polaritons, LST relation. **UNIT –II** **Dielectric and ferroelectrics:** Maxwell's equations, polarization, macroscopic electric field, depolarization filed, E1;local electric field at an atom, Lorentz filed E2, fields of dipoles inside cavity E3; dielectric constant and polarizability, electronic polarizability; structural phase transition; ferro-electric crystals, classification; displacive transition, soft optical phonons, Landau theory of phase transitions, first and second order transition, antiferro-electricity, ferro- electric domain, piezoelectricity, ferro-elasticity, optical ceramics. **UNIT –III** **Magnetism:** General ideas of diamagnetism and paramagnetism, quantum theory of paramagnetism, rare earth ions, Hund rule, iron group ions, crystal field splitting, quenching of orbital angular momentum, spectroscopic splitting factor, van vleck temperature dependent paramagnetism, Cooling by isentropic demagnetization, nuclear demagnetization, paramagnetic Susceptibility of conduction electrons. **UNIT –IV** **Ferromagnetism and anti-ferromagnetism:** Ferromagnetic order, Curie point and exchange integral, temp dependence of saturation magnetization, saturation magnetization at absolute zero; magnons, quantization of spin waves, thermal excitation of magnons; neutron magnetic scattering, Ferrimagnetic order, Curie temp and susceptibility of ferrimagnets, iron garnets. Antiferromagnetic order, susceptibility below neel temp, antiferromagnetic magnons, ferromagnetic domains.				

	UNIT – V **Optical Processes & Excitons and defects:** Optical reflectance, excitons, Frenkel and Mott-Wannier excitons, Alkali Halides and Molecular crystals Defects: lattice vacancies, Schottkey and Frenkel point effects, colour centers, F and other centres, Line defect. Shear strength of single crystals, dislocations-edge and screw dislocations, Burger vectors, Stress fields of dislocations, low angle grain boundaries, dislocation densities, dislocation multiplication and slip, strength of alloys, dislocations and crystal growth, hardness of materials.
Course Outcome	• On the completion of this course successfully student will be able to understand the development of the Solid State Physics - II. 1. The purpose of the course is to introduce students to knowledge about Dielectric function of the electron gas & Plasma optics. 2. The purpose of the course is to introduce students to learning about Maxwell's equations, polarization, macroscopic electric field, depolarization filed. 3. The purpose of the course is to introduce students to introduction about General ideas of diamagnetism and Para magnetism. 4. The purpose of the course is to introduce students to information about Ferromagnetic order, Curie point and exchange integral, temp dependence of saturation magnetization. 5. The purpose of the course is to introduce students to knowledge about Optical reflectance, excitons, Frenkel and Mott-Wannier excitons, Alkali Halides and Molecular crystals Defects.
Text Books	1. C. Kittel: Introduction to Solid State Physics (Wiley and Sons). 2. J.M. Ziman: Principles of theory of solids (Cambridge Univ. Press). 3. Azaroff: X-ray crystallography. 4. Weertman: Elementary Dislocation Theory.
References Books	1. Verma and Srivastava: Crystallography for Solid State Physics. 2. Azeroff and Buerger: The Power Method. 3. Buerger: Crystal Structure Analysis.

Course Title	**Major Elective I: Laser Physics and Applications**				
Course Code	**SMS10303T**				
Course Credit	**L**	**T**	**P**	**TC**	
	4	**-**	**-**	**4**	
Prerequisite	Student must have the knowledge of Laser Physics and Applications.				
Course Objective	• To study Laser Physics and Applications in advance and establish foundation to research in the respective domain.				
Course Content	**UNIT-I** **Laser Characteristics:** Spontaneous and stimulated emission, Einstein's quantum theory of radiation, theory of some optical processes, coherence and monochromacity, kinetics of optical absorption, line broadening mechanism, Basic principle of lasers, population inversion, laser pumping, two & three level laser systems, resonator, Q-factor, losses in cavity, threshold condition, quantum yield. **UNIT–II** **Laser Systems:** Solid state lasers- the ruby laser, Nd:YAG laser, ND: Glass laser, semiconductor lasers – features of semiconductor lasers, intrinsic semiconductor lasers, Gas laser - neutral atom gas laser, He-Ne laser, molecular gas lasers, CO2 laser, Liquid lasers, dye lasers and chemical laser. **UNIT-III** **Advances in Laser Physics:** Production of giant pulse -Q-switching, giant pulse dynamics, laser amplifiers, mode locking and pulling, Non-linear optics, Harmonic generation, second harmonic generation, Phase matching, third harmonic generation, optical mixing, parametric generation and self-focusing of light. **UNIT–IV** **Multi-Photon Processes:** multi-quantum photoelectric effect, Theory of two-photon process, three- photon process, second harmonic generation, parametric generation of light, Laser spectroscopy: Rayleigh and Raman scattering, Stimulated Raman effect, Hyper-Raman effect, Coherent anti-stokes Raman Scattering, Photo-acoustic Raman spectroscopy. **UNIT–V** **Laser Applications:** ether drift and absolute rotation of the Earth, isotope separation, plasma, thermonuclear fusion, laser applications in chemistry, biology, astronomy, engineering and medicine. Communication by lasers: ranging, fiber Optics Communication, Optical fiber, numerical aperture, propagation of light in a medium with variable index, pulse dispersion.				

Course Outcome	• On the completion of this course, successfully student will be able to understand the development of the Laser Physics and Applications. 1. The purpose of the course is to introduce students to knowledge about Spontaneous and stimulated emission, Einstein's quantum theory of radiation. 2. The purpose of the course is to introduce students to learning about Solid state lasers- the ruby laser, Nd:YAG laser, ND & Glass laser. 3. The purpose of the course is to introduce students to introduction about Production of giant pulse -Q-switching, giant pulse dynamics. 4. The purpose of the course is to introduce students to information about multi-quantum photoelectric effect, Theory of two-photon process. 5. The purpose of the course is to introduce students to knowledge about ether drift and absolute rotation of the Earth, isotope separation, plasma, thermonuclear fusion.
Text Books	1. Laud, B.B.: Lasers and nonlinear optics, (New Age Int.Pub.1996). 2. Thyagarajan, K and Ghatak, A.K.: Lasers theory and applications (Plenum press, 1981). 3. Ghatak, A.K. and Thyagarajan, K: Optical electronics (Cambridge Univ. Press 1999). 4. Seigman, A.E.: Lasers (Oxford Univ. Press 1986)
References Books	1. Maitland, A. and Dunn, M.H.: Laser Physics (N.H. Amsterdam, 1969). 2. Hecht, J. The laser Guide book (McGraw Hill, NY, 1986). 3. Demtroder, W.: Laser Spectroscopy (Springe series in chemical physics vol.5, Springe verlag, Berlin, 1981). 4. Harper, P.G. and Wherrett B.S. (Ed.): Non-linear-optics (Acad. press, 1977).

Title	**Major Elective II: Biological Physics**				
Code	**SMS10304T**				
Course Credit	**L**	**T**	**P**	**TC**	
	4	**0**	**0**	**4**	
Prerequisite	Preliminary Knowledge of Physics.				
Course	To study Biological Physics in advance and establish foundation to research in				

Objective	the respective domain.
Course Contents	**UNIT-I** The boundary, interior and exterior environment of living cells. Processes: exchange of matter and energy with environment, metabolism, maintenance, reproduction, evolution. Self-replication as a distinct property of biological systems. Time scales and spatial scales. Universality of microscopic processes and diversity of macroscopic form. Types of cells. Multicellularity. Allometric scaling laws. **UNIT-II** Metabolites, proteins and nucleic acids. Their sizes, types and roles in structures and processes. Transport, energy storage, membrane formation, catalysis, replication, transcription, translation, signaling. Typical populations of molecules of various types present in cells, their rates of production and turnover. Energy required to make a bacterial cell. Simplified mathematical models of transcription and translation, small genetic circuits and signaling pathways. Random walks and applications to biology. Mathematical models to be studied analytically and computationally. **UNIT-III** At the level of a cell: The numbers of distinct metabolites, genes and proteins in a cell. Complex networks of molecular interactions: metabolic, regulatory and signaling networks. Dynamics of metabolic networks; the stoichiometric matrix. Living systems as complex organizations; systems biology. Models of cellular dynamics. The implausibility of life based on a simplified probability estimate, and the origin of life problem. At the level of a multicellular organism: Numbers and types of cells in multicellular organisms. **UNIT-IV** Cell types as distinct attractors of a dynamical system. Stem cells and cellular differentiation. Pattern formation and development. Brain structure: neurons and neural networks. Brain as an information processing system. Associative memory models. Memories as attractors of the neural network dynamics. At the level of an ecosystem and the biosphere: Food webs. Feedback cycles and self - sustaining ecosystems. **UNIT-V** The mechanism of evolution: variation at the molecular level, selection at the level of the organism. Models of evolution. The concept of genotype-phenotype map. Examples.
Course Outcome	• On the completion of this course successfully student will be able to understand the development of the Biological Physics. 1. The purpose of the course is to introduce students to knowledge about the boundary, interior and exterior environment of living cells. 2. The purpose of the course is to introduce students to learning about Metabolites, proteins and nucleic acids. Their sizes, types and roles in

	structures and processes. 3. The purpose of the course is to introduce students to introduction about the numbers of distinct metabolites, genes and proteins in a cell. 4. The purpose of the course is to introduce students to information about Cell types as distinct attractors of a dynamical system. Stem cells and cellular differentiation. 5. The purpose of the course is to introduce students to knowledge about the mechanism of evolution.
Text Books	1. Physics in Molecular Biology; Kim Sneppen & Giovanni Zocchi (CUP 2005) 2. Biological Physics: Energy, Information, Life; Philip Nelson (W H Freeman & Co, NY, 2004)
References Books	1. Physical Biology of the Cell (2nd Edition), Rob Phillips et al (Garland Science, Taylor & Francis Group, London & NY, 2013) 2. An Introduction to Systems Biology; Uri Alon (Chapman and Hall/CRC, Special Indian Edition, 2013) 3. Evolution; M. Ridley (Blackwell Publishers, 2009, 3rd edition)

<table>
<tr><td>Course Title</td><td colspan="5">Major Elective II: Physics of Nano-Materials</td></tr>
<tr><td>Course Code</td><td colspan="5">SMS10304T</td></tr>
<tr><td rowspan="2">Course Credit</td><td>L</td><td>T</td><td>P</td><td>TC</td><td></td></tr>
<tr><td>4</td><td>-</td><td>-</td><td>4</td><td></td></tr>
<tr><td>Prerequisite</td><td colspan="5">Student must have the knowledge of Physics of Nano-Materials.</td></tr>
<tr><td>Course Objective</td><td colspan="5">• To study Physics of Nano-Materials in advance and establish foundation to research in the respective domain</td></tr>
<tr><td>Course Content</td><td colspan="5">UNIT I
Nano Materials: Properties of Nano-Particles: Metal nano-clusters, theoretical modeling of nanoparticles, geometric and electronic structure, magnetic clusters, Semiconductor nanoparticles, optical properties, rare gas and molecular clusters, Bulk nano-structured materials: Solid disordered nanostructures, methods of synthesis, properties, nano-cluster composite glasses, porous silicon, nano structured crystals.
UNIT II
Carbon Nano Tubes (CNTs): Nature of carbon bonds, different allotropies of</td></tr>
</table>

	carbon, structure and properties of C_{60}, graphene, carbon nanotubes and its types, laser vaporization techniques, arc discharge method and chemical deposition technique, purification techniques, Properties of Carbon Nanotubes and Graphene: Optical, electrical, electronic, mechanical, thermal, optical, and vibrational properties. **UNIT III** **Synthesis of Nano-Materials:** Top-down & Bottom-up approaches: Formation of nanostructures by mechanical milling (ball milling) and mechanical attrition, Chemical Vapor Deposition (CVD), Physical Vapour Deposition (PVD), thermal and e beam evaporation, Pulsed Laser Ablation (PLD). Chemical Routes for synthesis of Nanomaterials: Chemical precipitation and co-precipitation, chemical bath deposition (CBD), Sol-gel synthesis, Microemulsions or reverse micelles, Solvothermal synthesis, Thermolysis routes and spray pyrolysis. **UNIT IV** **Characterization of Nano-materials (a):** X-ray Diffraction (XRD), powder and single crystal Diffraction, X-ray fluorescence (XRF), X ray photoelectron spectroscopy (XPS), Energy Dispersive X-ray analysis (EDAX), Extended X ray absorption and fluorescence spectroscopy (EXAFS), Dispersive high pressure XRD and Diamond anvil cells (DAC). Nuclear Magnetic Resonance (NMR) and Raman spectroscopy: description and analysis. Surface analysis methods: Secondary ion mass spectroscopy (SIMS), Auger Electron Spectroscopy, ESCA, Deep Level Transient Spectroscopy (DL TS), Thermo Gravimetric Analysis (TGA), Differential Scanning Calorimetry (DSC), Differential Thermal Analysis. **UNIT V** **Characterization of Nano-materials (b):** Scanning Tunneling Microscopy (STM), Contact and non-contact Atomic Force Microscopy (AFM), Magnetic Force Microscopy (MFM), Nano indentation. Scanning Electron Microscopy (SEM), Transmission electron microscopy (TEM), High resolution TEM Field emission SEM, Electron Energy Loss Spectroscopy (EELS). Spectrophotometry: UV-Vis spectrophotometers, IR spectrophotometers, Fourier Transform Infrared Radiation (FTIR), Photoluminescence (PL), electroluminescence and thermoluminescence spectroscopy, Near-field Scanning Optical Microscopy (NSOM).
Course Outcome	• On the completion of this course successfully student will be able to understand the development of the Physics of Nano-Materials. 1. The purpose of the course is to introduce students to knowledge about Properties of Nano-Particles: Metal nano-clusters, theoretical modeling of nanoparticles. 2. The purpose of the course is to introduce students to learning about Nature of carbon bonds, different allotropies of carbon, structure and properties of C_{60}. 3. The purpose of the course is to introduce students to introduction about

	Top-down & Bottom-up approaches: Formation of nanostructures by mechanical milling (ball milling) and mechanical attrition. 4. The purpose of the course is to introduce students to information about X-ray Diffraction (XRD), powder and single crystal Diffraction, X-ray fluorescence (XRF), X ray photoelectron spectroscopy (XPS). 5. The purpose of the course is to introduce students to knowledge about Scanning Tunneling Microscopy (STM), Contact and non-contact Atomic Force Microscopy (AFM).
Text Books	1. Nano materials: Synthesis properties, characterization and application: A.S Edelstein and R.C. Cammaratra 2. Introduction to Nanotechnology: Charles P. Poole Jr and Franks J. Qwens. 3. Nanotechnology, Kohlr, Michael. 4. Nanoelectronics and Nanosystems, Karl Goser, Peter Glosekotter, Jan Dienstuhl, Springer, 2004 5. Handbook of Analytical instruments, R.S. Khandpur 6. X-ray diffraction procedures, H. P. Klung and L.E.Alexander 7. The Powder Method IV. Azaroff and M. J. Buerger 8. Elements of X-ray diffraction, B. D.Cullity
References Books	1. Differential Thermal Analysis, R.C. Mackenzie 2. Thermal Methods of Analysis, W.W. Wendlandt 3. Synthesis, Functionalization and Surface treatment of Nanoparticles:Maric Isbella and Buraton 4. Encyclopedia of Nanotechnology, H.S. Nalwa 5. Nanomaterial Systems Properties and Application, A.S. Eldestein and R.C. Cammarata. 6. Handbook of Nanotechnology: Bhushan (Ed), Springer Verlag, New York (2004). 7. Nanostructures and Nanomaterials- Synthesis properties and Applications by Guozhong Cao (Empirical College Press World Scientific Pub., 2004). 8. Nanocomposite Science and Technology, Ajayan, Schadler and Braun 9. Fullerene & Carbon nanotubes, Dressel Shaus 10. Carbon Nanotubes, Elizer 11. Physical properties of CNT, Saito Carbon nanotechnology, Liming Dai

Master of Science in Physics
Semester-III
2022-2023

<table>
<tr><td>Course Title</td><td colspan="5">Major Elective III: Analog System and Applications</td></tr>
<tr><td>Course Code</td><td colspan="5">SMS10305T</td></tr>
<tr><td rowspan="2">Course Credit</td><td>L</td><td>T</td><td>P</td><td>TC</td><td></td></tr>
<tr><td>4</td><td>0</td><td>0</td><td>4</td><td></td></tr>
<tr><td>Prerequisite</td><td colspan="5">Preliminary Knowledge of Physics.</td></tr>
<tr><td>Course Objective</td><td colspan="5">• To study Physics in advance and establish foundation to research in the respective domain.</td></tr>
<tr><td>Course Content</td><td colspan="5">UNIT-I
Semiconductor Diodes: P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity. PN Junction Fabrication (Simple Idea). Barrier Formation in PN Junction Diode. Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode. Derivation for Barrier Potential, Barrier Width and Current for Step Junction.

UNIT-II
Two-terminal Devices and their Applications: Rectification, Rectifier Diode: Half-wave Rectifiers, Full wave Rectifiers and Bridge Rectifiers, Calculation of Ripple factor and Rectification efficiency, Filter Circuits, Series inductor filter, Shunt capacitor filter, L section filter and π section filter, Zener Diode and Voltage Regulation, Tunnel Diode. Principle and structure of LEDs, Photodiode and Solar Cell.

UNIT-III
Bipolar Junction transistors: NPN and PNP Transistors. Characteristics of CB, CE and CC Configurations. Current amplification factors, Relations between Current gains α, β and γ. Active, Cutoff and Saturation Regions.
Amplifiers: Bipolar transistor as amplifier, classification of amplifier, Common base transistor amplifier, Common emitter transistor amplifier, Common collector transistor amplifier, Feedback amplifier.

UNIT-IV
Sinusoidal Oscillators: Principle of feedback in amplifier, Advantage of negative feedback, Transistor as an oscillator, Principle of an oscillator and Bark-Hausen condition, Requirement for an oscillator, Classification of oscillator, Application of oscillator, Wein bridge oscillator, Hartley oscillators.

UNIT-V
Operational Amplifiers (Black Box approach): Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of virtual ground.
Applications of Op-Amps: (1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Log amplifier, (7) Zero crossing detector (8) Wein bridge oscillator.
Conversion: Resistive network (Weighted and R-2R Ladder). Accuracy and</td></tr>
</table>

	Resolution. A/D Conversion (successive approximation).
Course Outcome	• On the completion of this course, successfully student will be able to understand the development of the Physics. 1. The purpose of the course is to introduce students to knowledge about P and N type semiconductors & Energy Level Diagram. 2. The purpose of the course is to introduce students to learning about Rectification, Rectifier Diode: Half-wave Rectifiers, Full wave Rectifiers and Bridge Rectifiers. 3. The purpose of the course is to introduce students to introduction about NPN and PNP Transistors. Characteristics of CB, CE and CC Configurations & Current amplification factors. 4. The purpose of the course is to introduce students to information about Principle of feedback in amplifier, Advantage of negative feedback, Transistor as an oscillator. 5. The purpose of the course is to introduce students to knowledge about Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain.
Text books	1. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill. 2. Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall. 3. Solid State Electronic Devices, B.G. Streetman & S.K. Banerjee, 6th Edn.,2009, PHI Learning 4. Electronic Devices & circuits, S. Salivahanan & N.S. Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill 5. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall
References Books	1. Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Edn., Oxford University Press. 2. Electronic circuits: Handbook of design & applications, U. Tietze, C.S chenk,2008, Springer 3. Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India 4. Microelectronic Circuits, M.H. Rashid, 2nd Edition, Cengage Learning 5. Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

Master of Science in Physics
Semester-III
2022-2023

Course Title	**Major Elective III: Astronomy & Astrophysics**				
Course Code	**SMS10305**				
Course Credit	**L**	**T**	**P**	**TC**	
	4	**0**	**0**	**4**	
Prerequisite	Preliminary Knowledge of Physics.				
Course Objective	• To study Astronomy & Astrophysics in advance and establish foundation to research in the respective domain.				
Course Contents	**Unit – I** Stars-apparent magnitudes, Colour index, Spectral classification, Stellar distances, Absolute magnitude, The H-R diagram of stars. Stellar interiors: The basic equations of stellar structure, Hydrostatic equilibrium, Thermal equilibrium, Virial Theorem, Energy sources, Energy transport by radiation and convection, Equation of state **Unit – II** Formation and evolution of stars: Inter stellar dust and gas, Formation of protostars, Pre-main sequence evolution, Post main sequence evolution and Evolution on the main sequence for low and high mass stars, Late stages of evolution, Fate of massive stars, Supernovae and its characteristics. **Unit – III** End states of stars, Electron degeneracy pressure, White dwarfs, and Chandrasekhar limit, Neutron stars and Pulsars, Black holes. Binary stars and their classification, close binaries, Roche Lobes, Evolution of semidetached systems: Algols, Cataclysmic variables and X-ray binaries. **Unit– IV** Solar Physics: Physical Characteristics of sun, Photosphere: Limb darkening, Granulation, Faculae, Solar Chromosphere and Corona, Prominences, Solar Cycle and Sunspots, Solar Magnetic Fields, Theory of Sunspots, Solar flares, solar wind, Helioseismology. **Unit – V** Kepler's law and its implication to Binary Stars, Doppler Effect and its use in velocity measurement e.g. rotation of Saturn and its Ring, determination of velocity of galaxies, Hubble's law and Age of the Universe, Star clusters, HR diagram of star clusters, distance and age determination through HR diagram. Variable stars, Cepheid Variables, Period Luminosity relation and Distance measurement. Period, dispersion and distance of the Pulsars. Photometer and photoelectric photometry.				

<table>
<tr><td>Course Outcome</td><td>
On the completion of this course, successfully student will be able to understand the development of the Astronomy & Astrophysics.

The purpose of the course is to introduce students to knowledge about Stars-apparent magnitudes, Colour index & Spectral classification.
The purpose of the course is to introduce students to learning about Formation and evolution of stars: Inter stellar dust and gas.
The purpose of the course is to introduce students to introduction about End states of stars, Electron degeneracy pressure, White dwarfs, and Chandrasekhar limit.
The purpose of the course is to introduce students to information about Solar Physics: Physical Characteristics of sun.
The purpose of the course is to introduce students to knowledge about Kepler's law and its implication to Binary Stars.
</td></tr>
<tr><td>Text books</td><td>

Astrophysics for Physicists, Arnab Rai Choudhuri, Camb. University Press, 2010.
Astrophysics: Stars and Galaxies, K.D. Abhayankar, Universities Press (India) Ltd, 2001.
An Introduction to Astrophysics, Baidyanath Basu, PHI, 2010.
Modern Astrophysics, B.W. Carroll and D.A. Ostlie, Addison-Wealey, 2007.
Introductory Astronomy and Astrophysics, M.Zeilik and S.A. Gregory, 4th ed., Saunders College Publishing, 1998.
</td></tr>
<tr><td>References Books</td><td>

The Physical Universe: An introduction to astronomy, F.Shu, University Science Books 1982.
Textbook of astronomy and astrophysics with elements of cosmology, V.B. Bhatia, Narosa Publishing House, 2000.
The new cosmos, A. Unsold and B. Baschek, Newyork, Springer 2002.
Theoretical Astrophysics, vol. I: Astrophysical Processes T. Padmanabhan, Cambridge University Press, 2000.
Theoretical Astrophysics, vol. – II: Stars and stellar systems, T. Padmanabhan, Cambridge University Press 2001.
A Workbook for Astronomy, Jerry Waxman, Cambridge University Press, 1984.
</td></tr>
</table>

Master of Science in Physics
Semester-III
2022-2023

Course Title	**Physics Lab Course V**				
Course Code	**SMS10391P**				
Course Credit	**L**	**T**	**P**	**TC**	
	-	**-**	**2**	**2**	
Prerequisite	Student must have the knowledge of Physics.				
Course Objective	• To enable the students to develop skills Electronics Lab.				
Course Content	1. Experiments with Microprocess or. (a) Convert BCD in to binary & vice versa. (b) To transfer group of data blocks from one location to another location. (c) To write program for addition & subtraction. (d) To write program for multiplication & division. 2. Logic gate study DTL & RTL. 3. To study& verify the De-Morgan's Theorem. 4. Study of Adder/ Subtractor. 5. Study of Encoder & Decoder. 6. Study of Multiplexer & Demultiplexer 7. Study of digital to analog converter. 8. Study of analog to digital converter. 9. Study of 4-bit Counter/ ripple Counter. 10. Study of left/right shift register. 11. Study of read only memory. 12. Study of Random Access Memory. 13. Study of Phase locked loop. 14. Study of BCD to seven segment Decoder. 15. Study of modulation & demodulation. 16. Optical fiber based experiment. 17. Microwave characterization and measurements.				
Course Outcome	• On the completion of this course lab, successfully student will be able to understand the development of the Electronics Lab.				
Text Books	1. Introduction to Physics Lab - H.E. White (T).				

	2. Fundamentals of Physics Lab – C.N. Banwell and E.M McCash(T).
References Books	1. Introduction to Physics Lab – J.M. Brown. 2. Fundamentals of Physics Lab –P.F. Bemath.

Master of Science in Physics
Semester-III
2022-2023

Course Title	**Physics Lab Course VI**				
Course Code	**SMS10392P**				
Course Credit	**L**	**T**	**P**	**TC**	
	-	**-**	**2**	**2**	
Prerequisite	Student must have the knowledge of Physics.				
Course Objective	• To enable the students to develop skills Materials Science & General.				
Course Content	1. To determine activation energy of ionic/superionic solid by Temperature depended conductivity measurement. 2. To study Electron Spin (ESR) Resonance in DPPH (Diphenyl Pricyl Hydrazy) sample. 3. To study I-V characteristics of photovoltaic solar cell and find the efficiency. 4. To study the decay of photoconductivity of given sample and find out trap depth. 5. Study of decay of photoluminescence of a given sample. 6. Measurement of electrical conductivity using Impedance Spectroscopy technique. 7. To determine drift velocities of Ag+ ion in AgI from temperature dependence of ionic transference number study. 8. Electrical conductivity of Ball milled/Mechano-chemical synthesized materials. 9. Determination of strength of a given radioactive source. 10. Study of complete spectra of radioactive sources, and study of photo peak efficiency of NaI (Tl) crystal for different energy gamma rays. 11. Structural analysis of powder sample by XRD and particle size determination using Scherrer's formula. 12. FTIR studies of solid samples. 13. Mechanoluminescence of sucrose crystals. 14. Thermoluminescence of irradiated samples. 15. Study of Op-Amp IC-741 is inverting/ Non inverting amplifier and draw frequency response curve. 16. Construction of Schmitt triggers using IC-741 and study of its characteristics.					

	17. Study of Astable and monostable Multi Vibrator using IC 555. 18. Digital electronics experiments on bread board using IC-7400.
Course Outcome	• On the completion of this course lab, successfully student will be able to understand the development of the Materials Science & General.
Text Books	1. Introduction to Physics Lab - H.E. White(T). 2. Fundamentals of Physics Lab – C.N. Banwell and E.M. McCash(T).
References Books	1. Introduction to Physics Lab – J.M. Brown. 2. Fundamentals of Physics Lab –P.F. Bemath.