VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY

JNANASAGARA CAMPUS, BALLARI-583105

DEPARTMENT OF STUDIES IN

PHYSICS

SYLLABUS

Master of Science in Physics

(IV Semesters)

Effective From

2021-22 Batch and Onwards

VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY

JNANASAGARA CAMPUS, BALLARI-583105

Department of Studies in Physics

Programme: Master of Science (M.Sc.) in Physics

Programme Overview:

Duration: 2 Years (4 semesters) Programme Code:901

Master of Science (M.Sc.) in Physics programme is designed to prepare students for a career in teaching, research or industry by introducing them to a wide range of concepts in physics and training in techniques applicable in various research areas. The programme aims to provide basic understanding of principles & concepts of physics through well structured teaching-leaning process and experimentation to understand the new dimensions of physics.

Programme Educational Objectives (PEOs):

After 3-4 years of completion of the programme the graduates will be able to:

1. Demonstrate competency in physics to solve and anaylse contemporary problems.
2. Demonstrate research skills which might include laboratory techniques, numerical techniques and computer programming.
3. Occupy positions in academic/research institutions / industry.
4. Demonstrate leadership qualities to achieve professional and organizational goals with commitment to ethical standards and team spirit.

Programme Outcomes (POs):

At the end of the programme the students will be able to:

1. Apply the domain knowledge to solve practical problems.
2. Apply the mathematical techniques to interpret behavior of physical systems.
3. Demonstrate the ability to design & execute experiments, anlyse and interpret the results.
4. Demonstrate the ability to propose and execute a research project, and ethically report the results with concern for society and environment.
5. Work in a group to execute a project and contribute as an individual.
6. Effectively communicate the concepts, applications and research results in physics (both written and oral).
7. Develop lifelong learning habits by continuously updating advances in physics / science.

VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY

Distribution of Courses/Papers in Postgraduate Programme I Semester as per Choice Based Credit System (CBCS) Proposed for

PG Program in Physics

M.Sc. IV-SEMESTER

Semester	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
				IA	SEE	Total	L	T	P		
FOURTH	DSC11	21PHY4C11L	Advanced Quantum Mechanics	30	70	100	4	-	-	4	3
	DSC12	21PHY4C12L	Electromagnetics	30	70	100	4	-	-	4	3
	DSE3	21PHY4E3AL	A. Semiconductor Physics	30	70	100	4	-	-	4	3
		21PHY4E3BL	B. Particle Physics								
		21PHY4E3CL	C. Nanoscience								
	DSE4	21PHY4E4AL	A. Lasers and Optical fibers	30	70	100	4	-	-	4	3
		21PHY4E4BL	B. Accelerator Physics								
		21PHY4E4CL	C. Astrophysics								
	GEC2	21PHY4G2AL	A. Physics in Everyday Life	20	30	50	2	-	-	2	1
		21PHY4G2BL	B. Space Research Programs in India and Abroad								
		21PHY4G2CL	C. Exciting Inventions in Physics								
	DSC12P8	21PHY4C12P	Electromagnetics Lab	20	30	50	-	-	4	2	4
	Project	21PHY4C1R	Research Project	30	70	100		-	8	4	4
Total Marks for IV Semester						**600**				**24**	

(I-IV semester)- Total Marks: 2400 Total credits: 96

DSC – Department Specific Core, DSE – Discipline Specific Elective, SEC – Skill Enhancement Course, GEC – Generic Elective Course, IA – Internal Assessment, SEE – Semester End Examination, L – Lecture, T – Tutorial, P – Practical.

Department Name: Physics

Semester - IV

Course Title: Advanced Quantum Mechanics	**Course Code:**21PHY4C11L
Total Contact Hours: 55 Hours	**No. of Credits:** 04
Formative Assessment Marks: 30	**Duration of ESA/Exam:** 03 Hours
Summative Assessment Marks: 70	

Course Outcomes (COs):

At the end of the course, students will be able to:

1. Apply time dependent perturbation methods to study the behaviour of atoms in constant and periodic potential. Calculate transition probabilities from Fermi's Golden rule.
2. Distinguish the identical particles and apply wave equations.
3. Analyse the angular momentum and apply relativistic Quantum mechanics to identify the elementary particles.
4. Solve problems related to perturbation theory, identical particles, symmetric principles and relativistic in quantum mechanics.

DSC11: Advanced Quantum Mechanics (21PHY4C11L)

Unit	Description	Hours
1	**Time-dependent phenomena:** Perturbation theory for time evolution, Schrodinger, Heisenberg and interaction picture, first and second order transition amplitudes and their physical significance. Application of first-order theory: constant perturbation, wide and closely spaced levels' Fermi golden rule, scattering by a potential. Harmonic perturbation: interactions of an atom with electromagnetic radiation, dipole transitions and selection rules; spontaneous and induced emission, Einstein A and B coefficients. Sudden approximation. (Ref. 1, 2 and 3**)**	11
2	**Identical particles and spin:** Indistinguishability of identical particles. Symmetryand antisymmetric wave functions. Construction from unsymmetrized functions. Bosons and Fermions. Pauli exclusion principle. Singlet and triplet states of He atom and exchange integral Spin angular momentum, Connection between spin and statistics, Angular momentum: Definition, eigen values and eigenvectors, matrix representation, orbital angular momentum. Addition of angular momenta, Clebsch-Gordon coefficients for simple cases.-j_1 =1/2, j_2=1/2 and j_1=1, j_2=1/2.**(Ref. 4, 2)**	11
3	**Symmetry Principles:** Symmetry and conservation laws, Symmetry and degeneracy. Space-time symmetries, Displacement in space- conservation of linear momentum, Displacement in time – conservation of energy, Rotation in space–conservation of angular momentum, Space inversion–parity. Time reversal invariance.Supersymmetry:supersymmetry quantum mechanics. (**Ref. 2 and 3)**	11

4	**Relativistic Quantum Mechanics:** Klein- Gordon equation, Dirac equation and its plane wave solution, Dirac matrices, significance of negative energy solutions, spin angular momentum of the Dirac particle, non-relativistic limit of Dirac equation. Electron in electromagnetic fields, spin magnetic moment. spin-orbit interaction, Dirac equation for a particle in a central field. Fine structure of hydrogen atom, **[Ref. 2, 3, 5,]**	11
5	**Relativistic Quantum Field Theory:** Classical field equations: Resume of Lagrangian and Hamiltonian formalism. Second quantization: Concepts and illustrations with Schrodinger field. Quantization of a real scalar field and its application to one meson exchange potential**.** Classical theory of electromagnetic field. Quantization of electromagnetic field. Lamb shift.Quantization electromagnetic field. Commutation relations. Covariant perturbation theory. Introduction to Feynman Graphs and applications. Lamb shift. **(Ref. 3, 5, 6, 7)**	11

References:

1.Quantum Mechanics: Nouredine Zettili 2nd Ed Willey (2009).
2.Quantum Mechanics: G Aruldas 2nd Ed. PHI (2009).
3.Quantum Mechanics: M.P. Khanna (HarAnand, New Delhi) (2009).
4. Quantum Mechanics, L I Schiff 3rd Ed. Mc Graw-Hill (1968).
5. A text book of Quantum Mechanics, P.M. Mathews and K. Venkatesan (Tata McGraw Hill, New Delhi) (2004). 32
6. Quantum Mechanics : V.K Thankappan (New Age, New Delhi) (2005).
7. Schwabl F. - Advanced quantum mechanics-Springer (2005)

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Department Name: Physics

Semester - IV

Course Title: Electromagnetics	**Course Code:** 21PHY4C12L
Total Contact Hours: 55 Hours	**No. of Credits:** 04
Formative Assessment Marks: 30	**Duration of ESA/Exam:** 03 Hours
Summative Assessment Marks: 70	

Course Outcomes (COs):

At the end of the course, students will be able to:

1. Illustrate the physical concepts of static electric and magnetic fields.
2. Illustrate the physical concepts of varying electric and magnetic fields.
3. Apply potential and field concepts to electromagnetic systems.
4. Analyze the propagation of wave in different media.
5. Identify and apply appropriate theoretical concepts to solve problems in electromagnetism.

DSC12: Electromagnetics (21PHY4C12L)

Unit	Description	Hours
1	**Electrostatics:** Introduction, Divergence and curl of electrostatic field, Gauss law in integral and differential forms with applications, Poisson's and Laplace's equations, Boundary conditions and Uniqueness theorems, electrostatic potential and The Potential of a Localized Charge Distribution. Multipole expansion of the potential, the Energy of a Point Charge Distribution, monopole and dipole terms, electric field of a dipole, dipole• dipole interaction. Electrostatic fields in matter, polarization, macroscopic field equations, electrostatic energy in dielectric media. The physical problems in electrostatics. **(Ref. Griffiths, Jackson, Laud)**	11
2	**Magnetostatics:** Introduction, Current density, continuity equation, magnetic field of a steady current, the divergence and curl of B, Ampere's law, magnetic vector potential, multipole expansion of vector potential of a localized current distribution, torques and forces on magnetic dipoles, effect of a magnetic field on atomic orbits. Magnetic fields in matter, macroscopic equations, magnetostatic boundary conditions, magnetic scalar potential, Energy in the magnetic field. The physical problems in magnetostatics. **(Ref. Kraus and Carver, Griffiths)**	11
3	**Time-changing Electric and Magnetic Fields:** Introduction, Faraday's Law, Maxwell's equations – Maxwell's Equation from Ampere's Law, Maxwell's equations in matter. Stokes' Theorem, Alternating-current Behavior of Ferromagnetic Materials, Eddy Currents, Displacement Current, Dielectric Hysteresis, Boundary conditions, General Field Relations,	11

	Comparison of Electric and Magnetic Field Relations, Problems. (**Ref. Griffiths**)	
4	**Potential and Fields:** Vector and scalar potentials, Guage transformations – Lorentz gauge and Coulomb guage, Retarded Potentials, Lienard• Wiechert potentials, fields of a moving point charge. **Electromagnetic Radiation:** Electric dipole radiation, Magnetic dipole radiation, Power radiated by a point charge, Larmor formula, Bremsstrahlung radiation, radiation from a charged particle moving in a circular orbit, cyclotron and synchrotron radiation. (**Ref. Griffiths**)	11
5	**Electromagnetic Waves and Wave Guides:** **Electromagnetic Waves:** Propagation of waves in linear media, reflection and transmission at normal and oblique incidence, Electromagnetic waves in non• conducting and conducting medium, skin depth, reflection at conducting surface. **Wave guides:** Fields at the surface and within a conductor, modes in rectangular wave guide, TE waves in a rectangular wave guide, Co• axial transmission line and cylindrical cavities. (**Ref. Griffiths, Laud**)	11

References:

1. Introduction to Electrodynamics, D J Griffths, PHI, Third Edition, 2012.
2. Electromagnetics, B.B. Laud, New Age International PVT. LTD (1987).
3. Classical Electrodynamics, J D Jackson, 4thEdition, John Wiley & Sons, 2005.
4. Electromagnetics, John D Kraus, Keith R Carver, Second Edition, McGraw-Hill Kogakusha Ltd., 1973.

Department Name: Physics

Semester - IV

Course Title: Semiconductor Physics	**Course Code:**21PHY4E3AL
Total Contact Hours: 55 Hours	**No. of Credits:** 04
Formative Assessment Marks: 30	**Duration of ESA/Exam:** 03 Hours
Summative Assessment Marks: 70	

Course Outcomes (COs):

At the end of the course, students will be able to:

1. Explain fundamental concepts in semiconductors.
2. Analyse optical and magnetic field induced properties in semiconductors.
3. Explain band structure and diffusion in semiconductors.
4. Explain fundamentals and applications of amorphous semiconductors.
5. Analyse performance of various semiconductor devices and heterojunctions.

DSE 03: Semiconductor Physics (21PHY4E3AL)

Unit	Description	Hours
1	**Fundamentals of Semiconductors** Classifying materials as semiconductors, Chemical bonds in semiconductors and mechanism of current flow, Forbidden, valence and conduction bands, Band structure for silicon and germanium, Mobility, drift velocity and conductivity of intrinsic semiconductor, Carrier concentration in intrinsic semiconductor, Impurity semiconductors – thermal ionization of impurities, Impurity states and band model, Impurity states, energy band diagram and Fermi level. (Ref.1,4)	11
2	**Optical properties and Magnetic field effects of Semiconductors** Optical Properties: Interband and Intranad absorption, Fundamental absorption process, Exciton absorption, Free-carrier absorption, Absorption process involving impurities, Photoconductivity, Luminescence. (Ref. 2,4) Magnetic field effects: Cyclotron resonance, Hall effect -– Hall voltage, Hall Coefficient, Mobility and Hall angle, Importance of Hall effect, Experimental determination of Hall coefficient. (Ref. 1,2 &4)	11
3	**Band structure, Diffusion and amorphous semiconductors** Band structure of real semiconductors, High electric field and Hot Electrons, Gunn Effect, Diffusion – Diffusion equation for one type of carrier and two types of carrier.(Ref. 1) Amorphous semiconductors: Classification, Band structure, Electronic conduction, Optical absorption, switching, Xerography (Ref. 2,4)	11
4	**Semiconductor Devices** p-n Junction – The junction itself, Junction Transistor, Tunnel Diode, Gunn Diode, Semiconductor laser, Field Effect Transistor, Drift Transistor, Microwave devices, Photodetectors and related devices, Semiconductor Lamp, Solid-State	10

	counters, Integrated circuits and Microelectronics (Ref. 2,4)	
5	**Semiconductor Heterojunctions** Heterojunctions: Introduction, General Properties of Heterojunctions, Growth of Heterostructures – Molecular Beam Epitaxy, Metal-Organic Chemical Vapour Deposition, Band Engineering, Layered Structures – Tunneling Barrier, Quantum Well, Two Barriers – Resonant tunneling, Super lattice, Modulation Doping, Construction of Band diagram. (Ref.3)	11

References:

1. Solid State Physics by S.L. Gupta and V. Kumar, K. Nath & Co.
2. Elementary Solid State Physics by M. Ali Omar, Pearson Education.
3. The Physics of Low- Dimensional Semiconductors by John H. Davies, Cambridge University Press.
4. Introduction to Solid State Physics by C. Kittel, Wiley Eastern Ltd.

Department Name: Physics

Semester - IV

Course Title: Particle Physics	**Course Code:**21PHY4E3BL
Total Contact Hours: 55 Hours	**No. of Credits:** 04
Formative Assessment Marks: 30	**Duration of ESA/Exam:** 03 Hours
Summative Assessment Marks: 70	

Course Outcomes (COs):

At the end of the course, students will be able to:

1. Explain the elements of particle physics.
2. Apply symmetry transformations and conservation laws in particle physics.
3. Describe particle dynamics, relativistic kinematics and scattering phenomena in particle physics.
4. Use various models of elementary particle physics to interpret particle interactions.
5. Describe the various particle accelerators in order to study the particle nature.

DSE 03: Particle Physics (21PHY4E3BL)

Unit	Description	Hours
1	**Particle Phenomenology:** Particle Classification,The fundamental particles: **Leptons** - Lepton multiplets and lepton number, neutrinos, neutrino mixing and oscillations, universal lepton interactions, **hadrons** - Flavour independence and charge multiplets, Gell-Mann Nishijima formula. **Pions and other bosons**: Pions - the Yukawa interaction, spin of pions - intrinsic parity - isotopic spin of pions. Pion-nucleon scattering and resonance, Rho, Omega and Eta and K mesons, Muons: nature and properties of muons, muon interaction, **Baryons** – Baryon generation, baryon spin measurements, Hyperons. **(Ref. Segre, Williams, Burcham, Tayal, Martin, Das and Ferbal, Ghoshal)**	11
2	**Symmetry transformations and conservation laws:** Introduction, Translations in space, Rotations in space, The group SU(2), Systems of identical particles, Parity, Isospin: an example of the SU(2) group- Introduction, The extended Pauli principle, Some consequences of isospin conservation, Charge conjugation, Time reversal, The CPT theorem, The electromagnetic field- Gauge invariance and Maxwell's equations, Polarization and photon spin, Angular momentum, parity, Strange particles: associated production – strangeness quantum number. **(Ref. Burcham and Jobes and Tayal)**	11
3	**Particle Dynamics, Relativistic and Scattering phenomenon:** **Particle Dynamics** The Four Forces, Quantum Electrodynamics (QED): The Dirac Equation,	11

	Feynman Diagrams, Quantum Chromodynamics (QCD): Heavy quark bound states, Jets and Gluons, Colour Counting, The strong interaction and weak interaction. **Relativistic Kinematics** Lorentz Transformations, Four-Vectors, Energy and Momentum, Collisions with examples and applications, Relativistic particles and their lifetimes. **Rutherford Scattering** Rutherford differential cross-section for relativistic and nonrelativistic scattering. (**Ref. Williams, Das and Ferbal, Martin**)	
4	**Standard Models and Particle Astrophysics:** Standard Model, the quark model – The SU(3) generators and their representation, quark model of hadrons, mesons and baryons. Beyond the standard model: The Higgs boson, Grand unification, Super-symmetry (SUSY), The SU(5) model, Theories of everything (Qualitative). Particle astrophysics – neutrino astrophysics, dark matter, matter-antimatter asymmetry, neutrinos in stellar evolution. (**Ref. Martin, Williams, Burcham, Das and Ferbal**)	11
5	**Particle accelerators:** DC Accelerators, AC accelerators - Linear and Cyclic accelerators, Fixed-targetmachines and colliders, Synchrotrons – Synchrocyclotron, Electron and proton synchrotrons, Betatrons, Microtrons and cyclotron accelerators, Storage rings, Accelerator shielding - Safety aspects of accelerators, Accelerators in medical and industrial applications.	11

References:

1. Nuclei and Particles, Segre E, II Edn. (Benjamin, 1977).
2. Nuclear and Particle Physics: W.E. Burcham and M. Jobes, Addison Wesley, 1998, ISE.
3. Nuclear Physics, Ghoshal S N, S Chand & Company Pvt.Ltd, Reprint 2014.
4. Nuclear and Particle Physics, W E Burcham and M Jobes. Longman Group Limited 1995.
5. Introduction to Nuclear and Particle Physics, A Das and T Ferbal, II Edn. World Scientific Publishing Co. Pvt. Ltd. Reprint 2005.
6. Nuclear and Particle Physics – An Introduction, Brian R Martin, John Wiley & Sons, Ltd., 2006.
7. Nuclear and Particle Physics, W S C Williams, Oxford University Press Inc., New York, 1991.
8. Introduction to Atomic and Nuclear Physics, Henry Semat, John R. Albright, Fifth Edition, Fletcher & Son Ltd, Norwich, 1972.

Department Name: Physics

Semester - IV

Course Title: Nanoscience	**Course Code:** 21PHY4E3CL
Total Contact Hours: 55 Hours	**No. of Credits:** 04
Formative Assessment Marks: 30	**Duration of ESA/Exam:** 03 Hours
Summative Assessment Marks: 70	

Course Outcomes (COs):

At the end of the course, students will be able to:

1. To get brief introduction about the nanomaterials and nanotechnology. Also understand the size and shape dependent on the physical properties of materials at nanoscale.
2. Gain knowledge about the importance of size distribution, size selectivity, self-assembly on properties of nanoscale materials. Understand various nanofabrication techniques used to synthesis nanomaterials.
3. Analyze the advantages of using nanotechnology for various electronic applications.
4. Understand molecular recognition, molecular encapsulation, nanocomposites, nanoreactors, nano porous materials for catalysis and smart applications.
5. Gain knowledge about nanomedicine, targeted drug delivery, diagnosis and treatment. Understand bio-inspired, biomimicking and bio-compatible nano-materials.

DSE 03: Nanoscience (21PHY4E3CL)

Unit	Description	Hours
1	**Introduction** Introduction to nanoscience: physics of low-dimensional materials, quantum effects, 1D, 2D and 3D confinement, Density of states, Excitons, Coulomb blockade, Zero-, One-, Two- and Three dimensional structure, Size control of metal nanoparticles and their properties: optical, electronic, magnetic properties; surface plasmon resonance, change of bandgap; Application: catalysis, electronic devices.	11
2	**Nanofabrication** Importance of size distribution control, size measurement and size selection, assembling and self-organization of nanostructures, Nanofabrication: patterning of soft materials by self-organisation and other techniques, chemical self-assembly, artificial multilayers, cluster fabrication, Langmuir-Blodget growth, Nanolithography, Scanning probe lithography, Micro contact printing.	11
3	**Nanoelectronics and devices** Advantages of nano electrical and electronic devices, micro and nano-	11

	electromechanical systems – sensors, actuators, optical switches, bio-MEMS diodes and nano-wire transistors - data memory lighting and displays, filters (IR blocking) – quantum optical devices – batteries - fuel cells and photo-voltaic cells – electric double layer capacitors – lead-free solder – nanoparticle coatings for electrical products	
4	**Nanocatalysts and Nanoporous materials** Nanocatalyts, smart materials, heterogenous nanostructures and composites, nanostructures for molecular recognition (quantum dots, nanorods, nanotubes) – molecular encapsulation and its applications – nanoporous zeolites – self-assembled nanoreactors - organic electroluminescent displays	11
5	**Nanotechnology for Nanomedince** Drug deliveries, drug delivery system, nanoparticle in drug deliveryavailable applications, nanotechnology future application understanding for treatment. Manufacture of nanoparticles, nanopowder and nanocrystals, targeting ligands applications of nanoparticle in drug delivery, cancer treatment, tissue regeneration, growth and repair, impact of drug discovery and development.	11

References:

1. Nanolithography and patterning techniques in microelectronics, David G. Bucknall, Wood head publishing 2005
2. Transport in Nanostructures, D.K. Ferry and S.M. Goodmick, Cambridge university press 1997.
3. Optical properties of solids, F. Wooten, Academic press 1972
4. Micro and Nanofabrication, Zheng Cui, Springer 2005
5. Nanostructured materials, Jackie Y. Ying, Academic press 2001
6. Nanotechnology and nanoelectronics, W.R, Fahrner, Springer 2005
7. Hand book of Nanoscience, Engineering, and Technology, William A. Goddard, CRC press 2003.
8. Nanoelectronics and Information Technology, Rainer Waser, WileyVCH 2003.
9. The MEMS Handbook Frank Kreith, CRC press 2002.
10. Charles P. Poole, Jr., Frank J. Owens, "Introduction to nano technology", Wiley, 2003.
11. Gunter Schmid, "Nanoparticles: From Theory to Applications", WileyVCH Verlag GmbH & Co., 2004.

Department Name: Physics

Semester - IV

Course Title: Lasers and Optical fibers	**Course Code:**21PHY4E4AL
Total Contact Hours: 55 Hours	**No. of Credits:** 04
Formative Assessment Marks: 30	**Duration of ESA/Exam:** 03 Hours
Summative Assessment Marks: 70	

Course Outcomes (COs):

At the end of the course, students will be able to:

1. Explain the working performance of various laser systems and their applications.
2. Determine various non-linear optical properties of materials.
3. Use laser spectroscopic techniques for various purpose.
4. Explain the fundamentals and applications of optical fibers.
5. Analyse characteristics of optical fibers, sources and detectors.

DSE 04: Lasers and Optical fibers (21PHY4E4AL)

Unit	Description	Hours
1	**Laser Systems and Applications** Review of laser fundamentals, Laser systems: Argon Ion Laser, Nitrogen Laser, Far-Infrared Gas Lasers, Chemical Lasers , X-Ray Plasma Lasers , Neodymium:Yttrium Vanadate lasers, Titanium Sapphire Laser, Fiber Lasers, Color Center Lasers, Semiconductor Diode Lasers; Applications of lasers: Thermonuclear reaction, Absolute rotation of earth, Chemistry, Industry, Biology, Atmospheric optics, Medicine (Ref.1,2)	11
2	**Dynamics of Laser Processes and Non-Linear Optics** Production of Giant pulse-Q switching: Mechanical shutter, Electro-optical shutters, Shutters using saturable dyes, Peak power emitted during the pulse; Giant Pulse Dynamics; Laser Amplifiers; Mode Locking; Ultra-short light pulses; Mode Pulling; Hole Burning (Ref.2) Harmonic Generation; Second Harmonic Generation; Phase Matching; Third Harmonic Generation; Optical Mixing; Parametric Generation of Light; Self Focusing of Light. (Ref.2)	11
3	**Laser Spectroscopy** Rayleigh and Raman Scattering; Stimulated Raman Effect; Hyper Raman Effect: Classical quantum mechanical treatments, Coherent Anti-Stoke's Raman Scattering (SARS); Spin-flip Raman Laser; Photo Acoustic Raman Spectroscopy (PARS); Saturation-Absorption Spectroscopy; Doppler-Free Two Photon Spectroscopy; Surface Enhanced Raman Spectroscopy. Laser Induced Breakdown spectroscopy (qualitative). (Ref.2)	11

4	**Optical Fibers A** Structure of Optical Fibers; Propagation of light through a cladded fibre – acceptance angle & acceptance cone; Fractional refractive index change, Modes of propagation; Types of Optical fibers, V-number. Materials used in optical fibers; Fabrication methods – Double crucible technique & Vapour oxidation process; Application of optical fibers – Medical, Military, Fiber optic sensors - (temperature, pressure, pollution, liquid level, Interferrometric); optical fiber communication system (qualitative). (Ref. 3)	11
5	**Optical Fibers B** **Transmission characteristics of optical fibers:** Attenuation; Material absorption losses in silica glass fibers – Intrinsic & Extrinsic; Linear scattering losses – Rayleigh & Mie types; Non-linear scattering losses – stimulated Brillouin scattering & stimulated Raman scattering; Fiber Bend losses; Dispersion; Chromatic dispersion – Material dispersion & waveguide dispersion; Intermodal dispersion in multimode fibers **LED sources for optical fibers:** LED power and Efficiency; LED structures – planar, dome & surface emitter types; Lens coupling to fibers; LED characteristics – optical output power, output spectrum, modulation band width & reliability. **Optical detectors:** Performance characteristics of detectors; Optical detection principles; Absorption – Absorption coefficients, Direct and Indirect absorption, III-V alloys; Quantum efficiency; Responsivity; Long wavelength cut-off; p-n and p-i-n photodiodes. (Ref. 3 & 4)	11

References:

1. Laser Fundamentals by William T. Silfvast, Cambridge University Press, 2nd Edition, 2004.
2. Lasers and Non-linear Optics by B. B. Laud, New Age International Publishers, 3rd Edition, 2011.
3. A Text Book of Engineering Physics by M.N. Avadhanulu & P.G. Kshirsagar, S.Chand Publications, 2012. (ISBN: 81-219-0817-5).
4. Optical fiber communications: The principles and Practice by John M Senior, Pearson Princtice Hall, 3rd Edition, 2009.

Department Name: Physics

Semester - IV

Course Title: Accelerator Physics	**Course Code:**21PHY4E4BL
Total Contact Hours: 55 Hours	**No. of Credits:** 04
Formative Assessment Marks: 30	**Duration of ESA/Exam:** 03 Hours
Summative Assessment Marks: 70	

Course Outcomes (COs):

At the end of the course, students will be able to:

1. Gain knowledge about the natural and developed accelerators.
2. Acquire the theoretical aspect of beam transport.
3. Apply the knowledge of theory in the development of accelerators.
4. Understand the application of accelerators.

DSE 04: Accelerator Physics (21PHY4E4BL)

Unit	Description	Hours
1	**Introduction:** Natural Accelerators, Electrostatic accelerators, induction accelerators, RF accelerators, colliders and storage rings, Synchrotron Radiation storage rings, Layout and components of accelerators: Accelerator cavities, dipoles quadrupoles and other important accessories, accelerators applications: Industrial, medical and research application: high energy and nuclear physics, The Resonant transformer - Cascade generator.	11
2	**Particle Dynamics in Electromagnetic fields:** Lorentz force, fundamental of charged particle beam optics: particle beam guidance, focusing, equation of motion from Lagrangian, canonical momenta, equation of motion from Hamiltonian, Harmonic oscillator, linear unperturbed equation of motion, matric formulation, Wronskian and perturbation terms.	11
3	**Beam optics and transport:** Definition of Beam parameters: Beam energy, time structure, beam current beam dimensions, Damping: Robinson criterion, particle distribution: energy spread, bunch length, Transverse beam emittance: Equilibrium Beam emittance, emittance increase, vertical beam emittance, beam size and divergence. Variation of damping distribution Beam life time and vacuum: high vacuum and ultra-high vacuum systems.vacuum measurement gauges, Control & interlock system, Leak detection techniques.	11
4	**Particle Accelerators:** Ion source: Production of charged particles, space charge limitation; extraction & focusing geometries, positive and negative ion sources, radio frequency sources, penning ionization source, Duoplasmatron, sputter ion source, ECR source (room temperature and superconducting).Electrostatic accelerators - Cockroft-Walton,	11

	Van-de-Graaff, Principle of tandem accelerator, Pelletron accelerator; Pulsed accelerators - cyclotron, synchrotron; Radio frequency linear accelerators; Superconducting linac, Radio frequency quadrupole; Drift tube linac; Storage rings	
5	**Application of Accelerators:** Future trends. Trace element analysis: various methods, RBS - measurement of elemental ratios & concentrations, channeling RBS, ERDA - depth resolution & sensitivity, high resolution sub monolayer thickness studies, Nuclear Reaction Analysis (NRA), Particle Induced X-ray emission (PIXE) studies, Accelerator Mass Spectrometry (AMS), Medical applications of accelerators.	11

References:

1. Accelerator Physics S Y Lee, 2nd Ed. World Sci. Pub. (199)
2. Particle Accelerator, H Wiedemann Spinger (2001)
3. Hands on accelerator physics using MATLAB, ZiemannVolkar, CRC press (2019)
4. Measurement and Detection of radiation, Nicholas Tsoulfanidis and Sheldon Landsverger 4th Ed., CRC press (2015).
5. Topics in Accelerator Physics, A Chao, lecture notes (2002).

Department Name: Physics

Semester - IV

Course Title: Astrophysics	**Course Code:**21PHY4E4CL
Total Contact Hours: 55 Hours	**No. of Credits:** 04
Formative Assessment Marks: 30	**Duration of ESA/Exam:** 03 Hours
Summative Assessment Marks: 70	

Course Outcomes (COs):

At the end of the course, students will be able to:

1. Understand the basics of astrophysics and astronomical units.
2. Explain the H-R diagram, and formation, evolution & properties of stars.
3. Discuss the theory of solar system.
4. Explain the structure of Milky Way galaxy and the origin of early universe.
5. Understand concepts of astronomical instrumentation.

DSE 04: Astrophysics (21PHY4E4CL)

Unit	Description	Hours
1	**Basics of Astrophysics:** Coordinate systems, time systems, trigonometric parallaxes, parsec, apparent and absolute magnitudes, atmospheric extinction, angular radii of stars, Michelson's stellar interferometer, binary stars and their masses, radial and transverse velocities.	11
2	**Properties of stars:** Spectra of stars, spectral sequence-temperature and luminosity classifications, H-R diagram, Saha's ionization formula and application to stellar spectra, Virial theorem, stellar structure equations, star formation and main sequence evolution, mass luminosity relation, white dwarfs, pulsars, magnetars, neutron stars and black holes, variable stars.	11
3	**The solar system:** The surface of the sun, solar interior structure, solar rotation, sun spots, the active sun, properties of interior planets and exterior planets, satellites of planets, comets, asteroids, meteorites, Kuiper belt object and Oort cloud, theories of formation of solar system.	11
4	**Star clusters, galaxies and the universe:** Open and global clusters, the structure and contents of Milky Way galaxy, Hubble's classification of galaxies, Galactic structure and dark matter, galactic motions, Hubble's law, Olber's paradox, big bang theory and the origin of the early universe, nucleosynthesis, cosmic microwave background radiation and evolution of the universe.	10

5	**Telescopes and Detectors:** Basic Optics, Types of telescopes. Telescope mounting systems. Optical telescopes, Infrared, Ultraviolet, X-ray and Gamma-ray telescopes. Schmidt telescopes. Solar telescopes. Design and construction of a simple optical telescopes, Photomultiplier tube, Semiconductor PIN photodiode, Charge coupled device image sensor, pulse counting electronics.	11

References:

1. Introduction to Stellar Astrophysics, E. Bohm-Vitense, 3rd Volume, Cambridge University Press, (1992).
2. Astrophysics and Stellar Astronomy, T.L. Swihart, Wiley (1968).
3. Galaxies; their Structure and Evolution, R.J. Taylor, Cambridge University Press, (1993).
4. Solar System Astrophysics, J.C. Brandt, P. Hodge, McGraw-Hill, (1964).
5. Introduction to Modern Astrophysics, Ostlie and Carroll, Pearson, (2006).
6. An Introduction to Astrophysics Baidyanath Basu, Second Edition, PHI Learning Private Limited, (2010).
7. A Textbook of Astronomy and Astrophysics with Elements of Cosmology, V.B. Bhatia, Alpha Science International Ltd., (2001)
8. Stars and Galaxies, K.D. Abhyankar, University Press, (2001).
9. Pulsar Astronomy, A.G. Lyne and G. Smith, Cambridge University Press, (2012).
10. C. R. Kitchin: Astrophysical Techniques, 4th Edition, CRC Press, (2003).
11. Astronomical Techniques, W. A. Hiltner, University of Chicago Press, (1969).

Department Name: Physics

Semester - IV

Course Title: Physics in Everyday Life	**Course Code:**21PHY4G2AL
Total Contact Hours: 26 Hours	**No. of Credits:** 02
Formative Assessment Marks: 15	**Duration of ESA/Exam:** 1 Hours
Summative Assessment Marks: 30	

Course Outcomes (COs):

At the end of the course, students will be able to:

1. Explain phenomenon in everyday life using laws of motion.
2. Explain phenomenon in everyday life using projectile motion, friction, periodic motion and law of forces.
3. Explain phenomenon in everyday life using concept of resistance.
4. Explain phenomenon in everyday life fluid flow and heat transfer.

GEC 02: Physics in Everyday Life (21PHY4G2AL)

Unit	Description	Hours
1	**The Laws of Motion:** Qualitative discussion of Newton's first law of motion, Inertia and types of inertia; Examples in everyday life: Falling backward when a bus moves quickly from rest, Moving forward when driver of a bus suddenly applies break, Getting down from a moving bus or train, Athlete taking a short run before a jump. Qualitative discussion of Newton's second law of motion; Examples in everyday life: Pushing a car and a truck, Pushing a shopping cart, Hitting a ball, Rocket launch, Driving a car and car crash. Qualitative discussion of Newton's third law of motion; Examples in everyday life: Pulling an elastic band, Swimming, Standing on the ground or sitting on a chair, Bouncing of a ball and the recoil of a gun.	09
2	**Projectile Motion, Friction, Periodic Motion and Law of Forces:** Qualitative discussion of projectile motion – maximum height, time of flight and range of the projectile; Examples in everyday life: Firing a Canon, Javelin throw, Hitting a Cricket Ball, Archery, Car and Bike Stunts, Disc throw. Qualitative discussion of friction and its types; Examples in everyday life: Walking, Writing, Skating, Lighting a matchstick, Driving of a vehicle on the surface, Flight of aeroplanes, Drilling of a nail into the wall. Qualitative discussion on Law of parallelogram of forces: Swimming, Boat movement, Flying of a bird, Shot of an arrow with Bow, Weight lifting. Qualitative discussion of periodic motion; Examples in everyday life: Swing, Hands of a clock, Motion of earth round the Sun, Motion of Moon around the Earth, Heartbeats, Rocking chair.	09

3	**Resistance, Fluid flow and Heat transfer:** Qualitative discussion of Resistance, Heating effect of electric current; Examples in everyday life: Electric Stove, Iron Box, Electric heater, Electric bulb. Qualitative discussion on Streamline and turbulent flow; Examples in everyday life: flow of water in a pipe, flow of water in a river, waterfalls, Qualitative explanation of Bernoulli's principle, Examples in everyday life: Sprayer, gas burner, Carburetor. Qualitative discussion of heat transfer – conduction, convection & radiation; Examples in everyday life: Copper vessels, Packing of ice in saw dust, Wearing two shirts reduces cold, Bricks for cold storage, Wooden / ebonite handles of utensils, Heating of water in a vessel, Heat energy from the Sun.	08

References:

1. How Things Work – The Physics of Everyday Life by Louis A. Bloomfield, Wiley, 6^{th} Edition, 2016.
2. NCERT 11^{th} and 12^{th} Standards Text Books.
3. https://examples.yourdictionary.com/examples-of-inertia.html
4. https://byjus.com/physics/newtons-second-law-of-motion-and-momentum/
5. https://openstax.org/books/university-physics-volume-1/pages/5-5-newtons-third-law
6. https://studiousguy.com/projectile-motion-examples/
7. https://byjus.com/questions/give-10-examples-of-friction-in-our-daily-life/

Department Name: Physics

Semester - IV

Course Title: Space Research Programs in India and Abroad	**Course Code:**21PHY4G2BL
Total Contact Hours: 26 Hours	**No. of Credits:** 02
Formative Assessment Marks: 15	**Duration of ESA/Exam:** 1 Hours
Summative Assessment Marks: 30	

Course Outcomes (COs): At the end of the course, students will be able to:

1. Explain basic ideas of space missions.
2. Recognise major space centers and space scientists in the World.
3. Explain the contributions of ISRO for space missions.
4. Explain the applications of satellite.

GEC 02: Space Research Programs in India and Abroad (21PHY4G2BL)

Unit	Description	Hours
1	**Introduction to Space Missions** Rockets, types and their applications, Orbits - Different types of orbits, Artificial satellites – basic idea and their applications, Introduction to Space Missions, Beginning of Space Missions - World and India, Applications of Space Research, Space crafts, Launching Vehicles. Major Space Centres in the World (at least 10) – brief idea about their location, establishment, capabilities and achievements.	09
2	**Indian Space Research Organisation (ISRO)** About ISRO and its Goals, History of Creation. General Satellite Programmes: The IRS series, The INSAT series. Gagan Satellite Navigation System, Navigation with Indian Constellation (NavIC), Other satellites. Launch vehicles: Satellite Launch Vehicle (SLV), Augmented Satellite Launch Vehicle (ASLV), Polar Satellite Launch Vehicle (PSLV), Geosynchronous Satellite Launch Vehicle (GSLV). Experimental Satellites: Details and applications (Any Five)	08
3	**Applications of satellites and Success Stories of Space missions** Earth Observation Satellites: Details and applications (Any Five), Communication satellites: Details and applications (Any Five), Application of satellites in agriculture, communication, weather forecasting, exploration of natural resources and Global positioning system (GPS). Success stories: Apollo 11, Chandrayaan 1, Mars Orbiter Mission (MoM). Proposed space programmes of NASA and ISRO.	09

References:

1. https://www.britannica.com/topic/NASA
2. https://www.isro.gov.in/

Department Name: Physics

Semester - IV

Course Title: Exciting Inventions in Physics	**Course Code:**21PHY4G2CL
Total Contact Hours: 26 Hours	**No. of Credits:** 02
Formative Assessment Marks: 15	**Duration of ESA/Exam:** 1Hours
Summative Assessment Marks: 30	

Course Outcomes (COs):

At the end of the course, students will be able to:

1. Explain about the exciting inventions in atomic and molecular Physics.
2. Explain about the exciting inventions in nuclear and radiation Physics.
3. Explain about the exciting inventions in other areas of Physics.

GEC 02: Exciting Inventions in Physics (21PHY4G2CL)

Unit	Description	Hours
1	**Inventions in Atomic and molecular Physics:** *About the discoverer, discovery and Applications of -* a) Discovery of X-rays by Wilhelm Conrad Röntgen. b) The Wave Nature of the Electron by Prince Louis-Victor Pierre Raymond de Broglie. c) Discovery of Raman Effect by Sir Chandrasekhara Venkata Raman. d) Development of Neutron Spectroscopy by Bertram N. Brockhouse. e) Efficient blue light-emitting diode which has enabled bright and energy-saving white light sources by Isamu Akasaki. **(Ref. 1)**	09
2	**Inventions in Nuclear and Radiation Physics:** *About the discoverer, discovery and Applications of -* a) Discovery of spontaneous radioactivity and Investigations of radiation phenomena by Antoine Henri Becquerel, Pierre Curie and Marie Curie. b) Glimpses at the History of the Nuclear Structure Theory by J. Hans D. Jensen and Maria Goeppert Mayer. c) Rotational Motion in Nuclei by Aage N Bohr. d) Existence of mesons on the basis of theoretical work on nuclear forces by Hideki Yukawa. e) The Neutrino: From Poltergeist to Particle by Frederick Reines. **(Ref. 1)**	09
3	**Inventions in Other areas of Physics:** *About the discoverer, discovery and Applications of -* a) Energy production in stars by Hans Albrecht Bethe. b) Development of the holographic method by Dennis Gabor. c) Development of laser spectroscopy by Arthur Leonard Schawlow. d) Physical processes of importance to the structure and evolution of the stars by Subramanyan Chandrasekhar.	08

	e) Invention of the integrated circuit by Jack S. Kilby.	**(Ref. 1)**	

References:

1. https://www.nobelprize.org/prizes/lists/all-nobel-prizes-in-physics/.

Department Name: Physics

Semester - IV

Course Title: Electromagnetics Lab	**Course Code:** 21PHY4C12P
Total Contact Hours: 52 Hours	**No. of Credits:** 02
Formative Assessment Marks: 20	**Duration of ESA/Exam:** 04 Hours
Summative Assessment Marks: 30	

Course Outcomes (COs):

At the end of the course, students will be able to:

1. Design experiments related to electromagnetism.
2. Conduct experiments related to electromagnetism.
3. Analyze and interpret experimental data related to electromagnetism.

DSC12P8: Electromagnetics Lab (21PHY4C12P)

List of Experiments

1. Magnetic field in a conductor (solenoid).
2. Dielectric constant measurement.
3. Magnetic filed in Helmholtz coil experiment.
4. Ferromagnetic Hysteresis.
5. Magnetic Induction.
6. Measuring velocity by electromagnetic induction.
7. Study of Eddy Current and Lenz's law.
8. Study of Biot-Savart Law.
9. Study of Faraday's laws of Induction.
10. Study of Ohms law.
11. Study of RC Circuits.
12. LCR Series and Parallel circuits.
13. Study of Kirchoff's laws.
14. Magnetic field of coils.

Note:

1. Minimum of EIGHT computations must be carried out.
2. Computations may be added as and when required with the approval of BoS.

References:

1. Physics Laboratory Manual, David H Loyd, Third Edition, Thomson Higher Education, USA.
2. PRACTICAL PHYSICS, J.A. GROWTHER, Sc.D., F.Inst.P, 1922.
3. Practical Physics In S.I., Edward Armitage, John Murray Publishers Ltd., 1972.
4. General Physics II Laboratory Manual, IZMIR Institute of Technology.October, 2020.

Department Name: Physics

Semester - IV

Course Title: Research Project	**Course Code:**21PHY4C1R
Total Contact Hours: 96 Hours	**No. of Credits:** 04
Formative Assessment Marks: 30	**Duration of ESA/Exam:** 04 Hours
Summative Assessment Marks: 70	

Course Outcomes (COs):

At the end of the course, students will be able to:

1. Conduct literature survey on specified area of research.
2. Define or state the research problem.
3. Plan the activities of the project and its timeline.
4. Identify requirements of hardware/software for performing specified project.
5. Conduct investigations on defined research problem.
6. Analyse experimental observations by scientific methods / approaches.
7. Report results of investigation ethically with concern for society/environment.
8. Work effectively in a team.
9. Effectively communicate (oral and written) the results of his/her investigation.

Project: Research Project (21PHY4C1R)

Research Project must be carried out at the rate of 8 hours per week under the guidance of a course teacher. At the end of the study every student shall have to submit a written project report which would be assessed for 20 marks during Semester End Examination. Both project report and viva-voce examinations must be assessed by two examiners drawn from the panel of examiners prepared by the BOS.

The Scheme of Evaluation for Internal Assessment (IA-30 Marks) and Semester End Examination (SEE-70 Marks) shall be as follows;

1. Internal Assessment(IA)

Activities	C1	C2	Total Marks
Review of Literature and Formulation of Research Problem	10	-	10
Research Design & Approach	05	-	05
Analysis and Findings	-	05	05
Pre-submission Presentation	-	10	10
Total	**-**		**30 Marks**

2. Semester End Examination (SEE)

Activities	Marks
Dissertation/Report	30
Presentation	15
Viva-Voce	15
Novelty of the work *(Fundamental Research, Applied Research, Adding to Existing Knowledge, New Knowledge, Cost effectiveness, Society, Environment)*	10
Total	**70Marks**