IV Semester Syllabus

Department Name: Physics

Semester - IV

Course Title: Advanced Quantum Mechanics	**Course Code:** 23PHHCT41
Total Contact Hours: 60 Hours	**No. of Credits:** 04
Internal Assessment Marks: 30	**Duration of SEE :** 03 Hours
SEE 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.

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)	12
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, 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)**	12
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. **(Ref. 2 and 3)**	12
4	**Relativistic Quantum Mechanics:**	12

	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,]**	
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. **(Ref. 3, 5, 6, 7)**	12

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 - II

Course Title: Computational Physics	**Course Code:** 23PHHCT42
Total Contact Hours: 60 Hours	**No. of Credits:** 04
Internal Assessment Marks: 30	**Duration of SEE :** 03 Hours
SEE Marks: 70	

Course Outcomes (COs):

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

1. Write C-Program to simple situations.
2. Solve physical problems using numerical techniques.
3. Apply partial differential equations to physical systems.
4. Explain the basic concepts of probability and statistics.
5. Compute errors in any physical problems and experiments.

Unit	Description	Hours
1	**C Programming** Compiler and interpreter, constants and variables, arithmetic expressions, data types, input and output statements, control statements, switch statements, loop statements, format specifications, arrays, algorithms, flowcharts, functions. Simple C programs i) area of a triangle ii) to check the entered letter is an vowel or consonant using switch iii) computing the sum and average of ten numbers using one dimensional arrays iv) to calculate Fibonacci series using while loop v) sorting numbers in ascending and descending order vi) computing the factorial of a number using for loop vii) addition of two matrices using arrays. (Ref. 1 & 2)	12
2	**Numerical Techniques** Numerical methods. Solutions of algebraic and transcendental equations: Bisection and Newton-Raphson methods. Interpolation: Newton's and Lagrange's methods. Curve fitting: Method of least squares. Differentiation:	12

	Newton's formula. Integration: Trapezodal rule, Simpson's 1/3 and 3/8 rules. Solutions of ordinary differential equations: Euler's modified method and Runge-Kutta methods. Gauss elimination method for solving a system of linear equations. (Ref: 3 & 4).	
3	**Partial Differential Equations and applications in Physics** Basic Concepts of PDEs, Modeling: Vibrating String, Wave Equation, Solution by Separating Variables. D'Alembert's Solution of the Wave Equation. Characteristics, Modeling: Heat Flow from a Body in Space. Heat Equation, Heat Equation: Solution by Fourier Series. Steady Two-Dimensional Heat Problems. Dirichlet Problem, Heat Equation: Modeling Very Long Bars. Solution by Fourier Integrals and Transforms, Laplace's Equation in Cylindrical and Spherical Coordinates. (Ref: 5).	12
4	**Probability** Introduction, Basic probability theorems, Conditional probability - Theorem, permutations and combinations – Theorems, Random variables – Introduction, Discrete random variables and distributions, Continuous random variables and distributions, mean and variance of a distribution, Transformation of mean and variance, Binomial distribution, Poisson distribution and Normal distribution. (Ref: 5 & 6). **Mathematical Statistics** Introduction, Concept of random sampling, Point estimation of parameters – Maximum likelihood method, Confidence intervals - Normal distribution with known and unknown σ^2, Chi-square distribution, Central Limit theorem (without proof). (Ref: 5 & 6)	12
5	**Experimental measurements and errors** Types and sources of experimental errors, significant digits in measurements, evaluation of errors in derived quantities with more than one variable, propagation of errors, mean and standard deviation, estimation of error, reporting experimental results with error bars. (Ref: 7 & 8). Data fitting: Lagrange interpolation and least squares fit methods, specific example of fitting experimental data on exponential decay, goodness of fit.	12

	Error analysis: Estimation of errors in the numerical integration and differentiation in the specific example of exponential decay (Ref: 3 & 5).	

References:

1. Computer Concepts and C Programming by P. B. Kotur, Sapna Book House (P) Ltd., Bangalore, 2013.
2. Programming in ANSI – C, E Balaguruswamy, 2ndEdition, Tata McGraw Hill, 1992.
3. Introductory Methods of Numerical Analysis by S.S. Sastry, PHI Learning Pvt. Ltd., 5^{th} Edition, 2019.
4. Mathematical Physics by Satya Prakash, Sultan Chand & Sons, 6^{th} Edition, 2019.
5. Advanced Engineering Mathematics by Erwin Kreyszig, Tenth Edition, John Wiley and Sons, Inc.
6. Mathematical Methods for Physicist, George Arfken and Hans J Academic press San Diego, 1995
7. Experimental errors and uncertainty, Rochester University notes, Web link: http://www2.ece.rochester.edu/courses/ECE111/error_uncertainty.pdf
8. Introduction to experimental errors, Susan Cartwright, University of Sheffield, weblink: https://www.sheffield.ac.uk/polopoly_fs/1.14221!/file/IntroToExperimentalErrors_y2.pdf

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Department Name: Physics

Semester - IV

Course Title: Semiconductor Physics	**Course Code:** 23PHSCT41A
Total Contact Hours: 60 Hours	**No. of Credits:** 04
Internal Assessment Marks: 30	**Duration of SEE :** 03 Hours
SEE 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.

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)	12
2	**Optical properties and Magnetic field effects of Semiconductors** Optical Properties: Interband and Intraband 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)	12
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)	12
4	**Semiconductor Devices** p-n Junction – The junction itself, Junction Transistor, Tunnel Diode, Gunn Diode, Semiconductor laser, Field Effect Transistor, Drift Transistor,	12

	Microwave devices, Photodetectors and related devices, Semiconductor Lamp, Solid-State 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)	12

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:** 23PHSCT41B
Total Contact Hours: 60 Hours	**No. of Credits:** 04
Internal Assessment Marks: 30	**Duration of SEE :** 03 Hours
SEE 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.

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)**	12
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)**	12
3	**Particle Dynamics, Relativistic and Scattering phenomenon:** **Particle Dynamics**	12

	The Four Forces, Quantum Electrodynamics (QED): The Dirac Equation, 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)**	12
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.	12

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:** 23PHSCT41C
Total Contact Hours: 60 Hours	**No. of Credits:** 04
Internal Assessment Marks: 30	**Duration of SEE :** 03 Hours
SEE 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.

Unit	Description	Hours
1	**Nanomaterials:** Introduction, history of nanomaterials, concepts of nanoscience & nanotechnology, importance of nanotechnology. Physics of nanomaterials – size and surface effects, variation of density of states, classification of nanomaterials – Shape & intrinsic - zero dimensional, one-dimensional & two-dimensional nanostructures. Size and shape dependent properties of nanomaterials and societal implications. Metal nanocrystals.	12
2	**Metal and Semiconductors Nanomaterials:** Plasmons, Surface Plasmon Resonance (SPR) - Gold, silver & iron nanoparticles. Quantum Dots, Quantum wires and Quantum wells - importance. Variation of energy gap with particle size. Organic capping, core shell structures and self-assembly-Intermolecular forces. Properties Nanomaterials: Melting Point and Heat Capacity, Electronic and Optical properties- (Quantum Confinement of Superlattices and Quantum Wells – Dielectric Constant of Nanoscale Silicon – Doping of a Nanoparticle – Excitonic Binding and Recombination Energies – Capacitance in a Nanoparticle) and Magnetic properties.	12

3	**Methods for Preparation of Nanomaterials:** Top-down and Bottom-up approaches: Solution growth and gas phase techniques chemical vapor deposition (CVD), ion sputtering, laser ablation, and chemical precipitation. Carbon Nanoclusters: Introduction, Fullerene, Graphene and carbon nanotubes (CNT) – properties and applications - Solar cells, composite materials, sensors.	12
4	**Nanoelectronic devices** Advantages of nano electrical and electronic devices, micro and nano-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	12
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.	12

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:** 23PHSCT42A
Total Contact Hours: 60 Hours	**No. of Credits:** 04
Internal Assessment Marks: 30	**Duration of SEE :** 03 Hours
SEE 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.

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)	12
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)	12
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)	12

4	**Fabrication and Applications of optical fibers** 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)	12
5	**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)	12

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: Electronics and Applications	**Course Code:** 23PHSCT42B
Total Contact Hours: 60 Hours	**No. of Credits:** 04
Internal Assessment Marks: 30	**Duration of SEE :** 03 Hours
SEE Marks: 70	

Course Outcomes (COs):

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

1. Students understand the principle and working of various Electrical and Electronics instruments and their applications
2. Students are also able to design and develop various Electrical and Electronic Instruments viz. Ammeter, Voltmeter, Ohmmeter, Multimeter, Frequency meter, phase meter etc.
3. The students will understand the architecture, Instruction set, programming skills and Interfacing of different devices with microcontrollers.
4. The students will be able to design and fabricate microcontroller-based systems for various applications.
5. Students will understand the role of Microcontroller in Instrumentation.

Unit	Description	Hours
1	**General Analog Measuring Instruments** Permanent-magnet moving coil (PMMC) Galvanometer: Torque and deflection, PMMC Mechanisms, DC Ammeters, DC Voltmeters, Ohmmeters: serial and shunt types, extension of range of meters, multi-meters. AC meters: Electrodynamometers, rectifier type, thermo instruments.	12
2	**Analog Measuring Instruments** Electronic voltmeters (Transistor, FET & Op-Amp Versions), AC Voltmeters: Rectifier type, RMS voltmeters, AC milli/micro voltmeters, Nano-ammeter, Analog frequency meter, Analog phase meter, Cathode Ray Oscilloscope: Single beam, dual trace, dual beam.	12
3	**Digital Measuring Instruments and Wave Form Generators** Digital voltmeters, Digital multimeter, Digital frequency meter, Digital phase meter, Q-meter, Digital storage oscilloscope and sampling oscilloscopes, Sine/Square wave generators, Radio frequency signal generator, Standard signal generator, function generator, Spectrum analyzer, Vector impedance meter.	12
4	**Microcontroller Architecture** Block diagram of 8051 microcontroller, Description of functional units of microcontroller, addressing modes, Classification of instructions set and programming, Comparative study of 8051 with 8031, 8751 and 89C51.	12
5	**Interfacing of Peripherals** Interfacing of memory (RAM & amp; EPROM), Programmable peripherals	12

	8155, 8755 and their interfacing, Interfacing of A/D & D/A converters. Interfacing of seven segment display, Multiplexed display, LCD module, Stepper motor with 8051 microcontroller.	

References:

1. Electronic Instrumentation and Measurement Techniques — William David Cooper & Albert D Helfriek.
2. Electronic Instrumentation - H S Kalsi
3. A Course In Electrical and Electronic Measurements and Instrumentation - K. Sawhney
4. The 8051 Microcontroller: Architecture, Programming and Applications –K. J. Ayala
5. The 8051 Microcontroller and Embedded Systems - Muhammad Ali Mazidi & J G Mazidi
6. Measurement of Systems—Application and Design — Earnest O Doeblin
7. MCS51 User Manual -Intel Corporation
8. Embedded Microcontrollers Data Book- Intel Corporation.

Department Name: Physics

Semester - IV

Course Title: Astrophysics	**Course Code:** 23PHSCT42C
Total Contact Hours: 60 Hours	**No. of Credits:** 04
Internal Assessment Marks: 30	**Duration of SEE :** 03 Hours
SEE 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.

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.	12
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.	12
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.	12
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.	12
5	**Telescopes and Detectors:** Basic Optics, Types of telescopes. Telescope mounting systems. Optical	12

	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.	

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: Computational Physics Lab	**Course Code:** 23PHHCP41
Total Contact Hours: 60 Hours	**No. of Credits:** 02
Internal Assessment Marks: 20	**Duration of SEE :** 04 Hours
SEE Marks: 30	

Course Outcomes (COs):

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

1. Write a computational program for various numerical techniques.
2. Compute errors in any experimentation.
3. Write a computational program for solution of problems in physics.

<u>List of Computations</u>

1. Error, Absolute Error, Relative Error and Percentage Error.
2. Linear least square fitting.
3. Solution of quadratic equation.
4. Solution of polynomial equation.
5. Newton's forward and backward interpolations.
6. Numerical integration by Simpson's 1/3 and 3/8 rules.
7. Numerical integration by Trapezoidal rule
8. Numerical integration by Runge-Kutta Method.
9. Solution of differential equation.
10. Gauss elimination method.
11. Programming in C for solution of problems in physics-examples from atomic and molecular physics, nuclear physics, mechanics, electrodynamics, quantum mechanics, solid state physics.

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. https://www.sanfoundry.com/c-programming-examples-numerical-problems-algorithms/
2. INTRODUCTION TO NUMERICAL ANALYSIS WITH C PROGRAMS by ATTILA M´AT´E, Brooklyn College of the City University of New York, July 2004.

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Department Name: Physics

Semester - IV

Course Title: Research Project	**Course Code:** 23PHRP41
Total Contact Hours: 120 Hours	**No. of Credits:** 04
Internal Assessment Marks: 30	**Duration of SEE :** 04 Hours
SEE 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.

About Research Project:

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 25 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.

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Assessment and Question Paper Pattern