Re-Accredited 'B++' 2.86 CGPA by NAAC
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વીર નર્મદ દક્ષિણ ગુજરાત યુનિવર્સિટી
યુનિવર્સિટી કેમ્પસ, ઉધના-મગદલ્લા રોડ, સુરત - ૩૯૫ ૦૦૭, ગુજરાત, ભારત.
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PROGRAMME STRUCTURE

Master of Science in Physics – M. Sc. - PHYSICS

Syllabus with effect from the Academic Year 2024-2025

Name of Programme	Master of Science in Physics
Abbreviation	M.Sc. - Physics
Duration	2 Years
Eligibility Criteria	B. Sc. Physics
Medium of Instruction	English
Objective of Program	The objective of the M.Sc. (Physics) program is to mold the students for building their carrier in research as well as in other allied fields.
Programme Outcome (PO)	(1) (2) (3) (4) (5)
Programme Specific Outcome (PSO)	(1) Enhancement of the student's knowledge in the subject. (2) Impartment of quality education to the students in the subject through well designed course of fundamental concept and technological importance. (3) Student's skill and capabilities building in the field of research and developments. (4) Students are trained for scientific approach and be able to work with quality, objectivity, ethical responsibilities, efficiency, accuracy and precision.
Mapping between PO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5
PO1					
PO2					
PO3					
PO4					
PO5					

Structure for MSc Physics – Semester - III							
Course Type	Course Code	Course Name	Teaching hours/week	Credit	Internal Marks	External Marks	Total Marks
Core	PH-531	Quantum Mechanics-II	04	04	30	70	100
	PH-532	Basic Nuclear and Particle Physics	04	04	30	70	100
	PH-533	Laser Fundamentals and Applications	04	04	30	70	100
Elective (Any one course can be taken)	PH-534	Elective 1:Microcontrollers	04	04	30	70	100
		Elective 2:Advanced Materials Science	04	04	30	70	100
		Elective 3: Python Programming and Computational Physics	04	04	30	70	100
		Elective 4:Nuclear Reactions	04	04	30	70	100
	PH-535	Practical	12	06	50	100	150
Skill based course	PH-536	Microprocessors	02	02	20	30	50
		Total	30	24	190	410	600

Course Name	PH-531: Quantum Mechanics-II
Course Code	PH-531
Course Type	Core
Course Outcome (CO)	(1) By studying the course student will be able to explore applications of Quantum Mechanics to single and many particles in three dimensions extending to approximate methods. (2) Students will be able to solve the Schrödinger equation for spinless particles moving in three-dimensional potentials. (3) Students will be able to deal with rotations, the properties of addition of angular momenta, and the properties of tensor operators. (4) Students will be able to examine how to describe systems with many identical particles. (5) Students will get conceptual knowledge and application of approximation methods that deal with stationary states.

Course Content	
Unit 1	**Three-Dimensional Problems** 3D Problems in Cartesian Coordinates: General Treatment: Separation of Variables, The Free Particle, The Box Potential, The Harmonic Oscillator, 3D Problems in Spherical Coordinates: Central Potential: General Treatment, The Free Particle in Spherical Coordinates, The Spherical Square Well Potential, The Isotropic Harmonic Oscillator, The Hydrogen Atom, Effect of Magnetic Fields on Central Potentials.
Unit 2	**Rotations and Addition of Angular Momenta** Rotations in Classical Physics, Rotations in Quantum Mechanics: Infinitesimal Rotations, Finite Rotations, Properties of the Rotation Operator, Euler Rotations, Representation of the Rotation Operator, Rotation Matrices and the Spherical Harmonics, Addition of Angular Momenta: Addition of Two Angular Momenta: General Formalism, Calculation of the Clebsch–Gordan Coefficients, Coupling of Orbital and Spin Angular Momenta, Addition of More Than Two Angular Momenta, Rotation Matrices for Coupling Two Angular Momenta, Isospin, Scalar, Vector, and Tensor Operators: Scalar Operators, Vector Operators, Tensor Operators: Reducible and Irreducible Tensors, Wigner–Eckart Theorem for Spherical Tensor Operators.
Unit 3	**Identical Particles** Many-Particle Systems: Schrödinger Equation, Interchange Symmetry, Systems of Distinguishable Non-interacting Particles, Systems of Identical Particles: Identical Particles in Classical and Quantum Mechanics, Exchange Degeneracy, Symmetrization Postulate, Constructing Symmetric and Anti-symmetric Functions, Systems of Identical Non-interacting Particles, The Pauli Exclusion Principle, The Exclusion Principle and the Periodic Table.
Unit 4	**Approximation Methods for Stationary States** Time-Independent Perturbation Theory: Non-degenerate Perturbation Theory, Degenerate Perturbation Theory, Fine Structure and the Anomalous Zeeman Effect, The Variational Method, The Wentzel–Kramers–Brillouin Method: General Formalism, Bound States for Potential Wells with No Rigid Walls, Bound States for Potential Wells with One Rigid Wall, Bound States for Potential Wells with Two Rigid Walls, Tunneling through a Potential Barrier.

Reference Books	
1.	Quantum Mechanics: Concepts and Applications: Nouredine Zettili, A John Wiley and Sons Ltd., Second Edition, (2004).
2.	A text book of Quantum Mechanics: P. M. Mathews and K. Venkatesan, Tata McGraw Hill Education Private Limited, Second Edition, (2011).
3.	Quantum Mechanics: L. I. Schiff, McGraw-Hill Inc., US, Third Edition, (1968).
4.	Introduction to Quantum Mechanics: David Griffiths, Pearson Education; Second Edition, (2015).
5.	Quantum Mechanics: A. K. Ghatak and S. Lokanathan Macmillan-India, Fifth Edition, (2004).
6.	Quantum Mechanics: Claude Cohen-Tannoudji, Bernard Diu, Franck Laloe Vol. I & II, Wiley-CH, (1997).

Course Name	PH-532:Basic Nuclear and Particle Physics
Course Code	PH-532
Course Type	Core
Course Outcome (CO)	(1) To understand basic properties of nucleus and study concepts such as isospin, parity etc. in context to nucleons. (2) To learn about the fundamental interactions and their comparative properties and study nuclear radioactivity and associated properties. (3) To learn about nuclear detectors and study various nuclear models. (4) To get introduction to Particle Physics and classify particles and learn their properties. (5) To learn various quantum numbers of the particles and their conservation laws.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1					
CO2					
CO3					
CO4					
CO5					

Course Content	
Unit 1	**Basics of Nuclear Physics** History and overview, some introductory terminology, nuclear properties, units and dimensions, nuclear mass and binding energy, nuclear spin and parity, magnetic dipole moment, electric quadrupole moment, isospin, fundamental interactions and their properties.
Unit 2	**Nuclear Decay and Radioactivity** The radioactive decay law, production and decay of radioactivity, types of decays, natural radioactivity, interaction of radiation with matter, heavy charged particles, electrons, electromagnetic radiation, gas-filled counters, scintillation detectors, semiconductor detectors, magnetic spectrometers, counter telescopes, multiwire proportional counters, polarimeters.
Unit 3	**Nuclear Models** Nuclear models, the shell model, shell model poetical, spin-orbit potential, magnetic dipole moments, electric quadrupole moments, valence nucleons, even-Z even-N nuclei and collective structure, nuclear vibrations, nuclear reactions, more realistic nuclear models, many-particle shell model, single-particle states in the deformed nuclei
Unit 4	**Particle Physics** Introduction, productions of elementary particles, classification of particles, quanta of forces, matter particles, antiparticles, symmetries and conservation laws, energy and momentum, angular momentum, parity, baryon number, lepton number, isospin, strangeness and charm, the quark model, color quarks and gluons.

Reference Books	
1.	Introduction to Nuclear Physics: H. Enge
2.	Introductory Nuclear Physics: K. Krane, Wiley India Pvt. Ltd. (1988)
3.	Introduction to Elementary Particles: Griffiths
4.	Nuclear Physics: S. N. Ghoshal, S. Chand & Co. Pvt. Ltd., Revised enlarged Edition, (2014)
5.	Introduction to Nuclear and Particle Physics: Mittal, Gupta and Verma,PHI Learning Pvt. Ltd., Third Edition, (2017)
6.	Nuclear Physics: D. C. Tayal

Course Name	PH-533: Laser Fundamentals and Applications
Course Code	PH-533
Course Type	Core
Course Outcome (CO)	(1) The course provides all the important physical principles concerned in the laser devices and tried to offer a consistent treatment of each. (2) Throughout the course the dealing has been kept as easy as possible and understandable to students with variety of backgrounds. (3) Some awareness with elements of electromagnetic theory and of spectroscopy will be helpful. (4) By studying this course, students are aware of various applications of Laser and fiber optic communication system. (5) Post completion of the course, student would be able to understand how the laser physics related with molecular spectra.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1					
CO2					
CO3					
CO4					
CO5					

Course Content	
Unit 1	**LASER I** Introduction, Einstein coefficients, Light amplification, Threshold conditions, Laser rate equations: Two level system, three level system and four level system, Variation of Laser power around threshold, Optimum output coupling. Neodymium lasers (Nd:YAG and Nd: Glass), Gas Lasers: Neutral Atom Gas Lasers: Helium-Neon Laser, CO_2 laser, Argon ion laser, Dye laser, Semiconductor lasers.
Unit 2	**LASER II** Introduction, Optical Resonators: Modes of a rectangular cavity and the open planar resonator, Quality factor, Ultimate line width of the laser, Mode selection: Transverse mode selection and longitudinal mode selection, Q-switching, Techniques for Q-switching, Mechanical Shutter, Electro-optic effect, Acoustooptic effect, Shutters using saturable absorber, Mode locking in lasers, Techniques for mode locking.
Unit 3	**Non-linear optics** Harmonic generation, Second harmonic generation, Phase matching, Third harmonic generation, Optical mixing, Parametric generation light, Self focusing of light, Multiphoton process: Multiquantum Photoelectric effect, Two photon processes, Experiments in two photon processes, Three photon processes, Parametric generation of light, Parametric light oscillator, Frequency up conversion, Phase conjugate optics, Laser Spectroscopy: Rayleigh and Raman scattering, Stimulated Raman effect, Hyper- Raman effect : Classical treatment, Coherent anti stokes Raman Scattering, Spin Flip Raman laser, Free- electron laser, Photo-acoustic Raman spectroscopy, Brillouin Scattering, Saturation Absorption spectroscopy, Doppler free two Photon spectroscopy.

Unit 4	**Light wave communications** Light information carrying-capacity of light waves, Introduction to fiber propagation using a ray model: Step index fiber: numerical aperture and multipath dispersion, Propagation and multipath dispersion in graded index fiber, Material dispersion, Refractive index of the bulk media: theory and experimental values, Time dispersion in Bulk media. The combined effect of Material dispersion and Multipath dispersion, Root- mean- square Pulse widths and Frequency response: RMS pulse widths, Frequency response, Total RMS pulse width.

Reference Books	
1.	Optical Electronics: A. K. Ghatak and K. Thyagarajan, Cambridge University press, (1990).
2.	Lasers and Non – linear Optics: B. B. Laud, Wiley Eastern Limited, (1993).
3.	Lasers Theory and Applications: K. Thyagarajan and A. K. Ghatak, Macmillan India Limited, (1981).
4.	Lasers Fundamentals: William T. Silfvast, (Second Edition), Cambridge University press, (2004).
5	Solid State Laser Engineering: Walter Koechner, (Sixth Revised Edition) Springer.
6	Optical Communication Systems: John Gowar, Prentice-Hall of India (1984).

Course Name	PH-534: Elective 1 Microcontrollers
Course Code	PH-534
Course Type	Elective 1
Course Outcome (CO)	(1) After completion of the course, students shall acquire knowledge about the concepts and understanding of Microcontrollers and 8051 Architecture. (2) Students are familiar with different microcontrollers, numbering systems and binary codes. Students are acquired knowledge from conversion of one number system into another number system. (3) Students are to become familiar with internal hardware design, the architecture of the device and to determine the type, number and size of the registers and other circuitry. (4) Students learn the detailed study of the operational codes of the 8051 and understand the machine control concerns sensing the on-off states of external circuitry. (5) Students learn the operation of jump and call instructions that alter the flow of the program examining the results of the action codes.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1					
CO2					
CO3					
CO4					
CO5					

Course Content	
Unit 1	**Microprocessors and Microcontrollers** Comparing Microprocessors and Microcontrollers, Four bit to thirty-two bit Microcontrollers. Numbering systems and Binary Arithmetic: Positional number systems, Integer binary numbers, Fractional binary numbers, Binary addition and Subtraction, Binary multiplication and Division. Binary Codes: Character code, Numeric code, Packed and unpacked BCD numbers, Gray codes, Error correction and detection codes.
Unit 2	**8051 Architecture** 8051 Microcontroller Hardware, 8051 Block diagram, 8051 Programming model, 8051 Oscillator and clock, Internal memory, Internal RAM, Stack and stack pointer, Special Function Registers, Input / Output pins ports and circuits, External memory, Counters and Timers, TCON-SFR, TMOD-SFR, Timer Counter Interrupts, Timing, Timer Modes of Operation, Counting, Serial data Input / Output, SCON-SFR, PCON-SFR, Serial Data interrupts, Data transmission, Data reception, Serial data transmission modes, Interrupts, IE-SFR, IP-SFR, Timer flag Interrupt, Serial Port Interrupt, External Interrupt, Reset, Interrupt control, Interrupt Priority, Interrupt Destinations, Software-Generated Interrupts,
Unit 3	**Moving data and Arithmetic operations:** Addressing modes, Immediate addressing mode, Register addressing mode, Direct addressing mode, Indirect addressing mode, External data moves, Code Memory Read-

	Only data moves, Push and Pop opcodes, Data exchanges, Example Programs. Flags, Instruction affecting flags, Incrementing and Decrementing, Unsigned addition, Signed addition, Unsigned subtraction, Signed subtraction, Multiplication, Division, Decimal arithmetic, Example Programs.
Unit 4	**Logical operation and Jump and Call instructions:** Byte level logical operations, Bit level logical operations: Internal RAM bit addresses, SFR bit addresses, Bit level Boolean operations, Rotate and Swap operations, Example Programs. Jump and Call program range: Relative range, Short absolute range, Long absolute range, Jumps: Bit jumps, Byte jumps, Unconditional jumps, Calls and Subroutine: Subroutine: Calls and the Stack, Calls and Returns, Example Programs.

Reference Books	
1.	The 8051 microcontroller, Architecture, Programming and Applications: Kenneth J. Ayala, West Publishing Company (1997).
2.	The 8051 Microcontroller and Embedded Systems: M.A. Mazidi, J. G. Mazidi, R. D. McKinlay.

Course Name	PH-534: Elective 2- Advanced Materials Science
Course Code	PH-534
Course Type	Elective 2
Course Outcome (CO)	(1) Students will learn brief classification of all Engineering materials varies from indigenous Metals to modern exotic materials with their distinguish properties and applications. (2) Student will learn most advance materials like Quantum Dot, Spintronics, Nitilon and nanomaterials with their synthesis and advance applications. (3) Course prepare students to be proficient and confident in all aspects of novel materials dicount, characterization and applications **(4)** Students are able to work in variety of industries such as medical devices, Automation industry, Electronic and Semiconductor devices, Advanced Ceramic, Composites, Polymer and their advance Classification.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1					
CO2					
CO3					
CO4					
CO5					

Course Content	
Unit 1	**MATERIALS SCIENCE AND CIVILIZATION** Materials Science, Materials Science and their Ages, Classification of Engineering Materials, Stone age to Exotic Ages. Schematics of Materials Science and their elements, Structure, Properties and Performance Materials Science activities in India.
Unit 2	**STATE OF MATTERS** States of Matter and their classification, Theory of Liquid State, Plasma State and their Criterions, Crystalline, Amorphous Dendrities, spherulites, Gas, Bose Einstein Condensate, Fermi Dirac Condensate, Liquid Crystals and their applications, Colloidal States of matter, Types of Colloidal states, Gel, Emulsion, Emulsifier Agent and their role.
Unit 3	**POLYMER, CERAMICS AND COMPOSITES** Types of organic Materials, Polymer, Classification of Polymers, Polymerization and their types, Rubber, Ceramics, Classification of Ceramics. Applications of Ceramics, Composites Classification Matrix Phase PMC, CMC, MMC, Reinforcement, Types of Reinforcement, Composites, Application of Composites.
Unit 4	**ADVANCED MATERIALS** Advanced Materials, Quantum Dots, Spintronic, Biomaterials, Nano materials, Fullerene, History of Nano science, Seeing the Nano materials, Applications of Nano materials - In Cancer, Drug management, Cosmetics, Water purification, Textile, Future Lightning. Quantum Computers, Laboratory on Chip (LOC), Carbon Nano tubes, Types of Carbon nano tubes.

Reference Books	
1.	Elements of Materials Science and Engineering: Lawrence H. Van Vlack, Pearson Education, Sixth Edition, (2006).
2.	Materials Science and Metallurgy: U.C. Jindal, Atish Mozumder, Pearson Education, Third Edition, (2013).
3.	Engineering Materials (Polymers, Ceramics and Composites) : A. K. Bhargava PHI Learning Pvt. Ltd., Fourth Edition, (2010)
4.	Materials Science – An Intermediate Test: William F. Hosfold, Cambridge University Press, First Edition, (2007).
5.	Materials Science and Engineering: A First Course: V. Ragavan, Prentice – Hall of India Pvt. Ltd., Fifth Edition, (2005).
6.	Materials Science and Metallurgy: Parashivamurthy K. I., Pearson Education, First Edition, (2012).

<table>
<tr><td>Course Name</td><td>PH-534: Elective 3-Python Programming and Computational Physics</td></tr>
<tr><td>Course Code</td><td>PH-534</td></tr>
<tr><td>Course Type</td><td>Elective 3</td></tr>
<tr><td>Course Outcome (CO)</td><td>(1) This course provides the knowledge to simulate the physical systems using Python.
(2) Students will be Proficient in the use of Python for scientific tasks, including data manipulation, scripting, and file operations.
(3) Students will able to use conditional statements, loops and plotting for data analysis.
(4) Students will acquire the knowledge of nonlinear dynamics, chaos theory, and their applications in modelling oscillatory motion, predator-prey systems, and chaotic phenomena.
(5) Students will develop the skill of simulation of quantum wave packets and electromagnetic waves using numerical methods, including algorithm implementation, visualization, and results assessment.</td></tr>
<tr><td>apping between CO and PSO</td><td>
<table>
<tr><td></td><td>PSO1</td><td>PSO2</td><td>PSO3</td><td>PSO4</td><td>PSO5</td></tr>
<tr><td>CO1</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO2</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO3</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO4</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>CO5</td><td></td><td></td><td></td><td></td><td></td></tr>
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<table>
<tr><td colspan="2">Course Content</td></tr>
<tr><td>Unit 1</td><td>PYTHON Language
Introduction to Python for Science and Engineering, Interacting with Python, Installing Python on Your Computer, The Spyder Window, The IPython Pane: Magic commands, System shell commands, Tab completion, Recap of commands, Interactive Python as a Calculator: Binary arithmetic operations in Python, Types of numbers, Important note on integer division in Python, Variables: Names and the assignment operator, Legal and recommended variable names, Reserved words in Python, Script Files and Programs, Python Modules: Python modules and functions: A first look, Some NumPy functions, Different ways of importing modules, Getting Help: Documentation in IPython, Stand-alone IPython, Programming Errors,
Strings, Lists, Arrays, and Dictionaries
Strings, Lists: Slicing lists, The range function: Sequences of numbers, Tuples, Multidimensional lists and tuples, NumPy Arrays: Creating arrays (1-d), Mathematical operations with arrays, Slicing and addressing arrays, Fancy indexing: Boolean masks, Multi-dimensional arrays and matrices, Differences between lists and arrays, Dictionaries, Objects,
Input and Output
Keyboard Input, Screen Output: Formatting output with str.format(), Printing arrays, File Input: Reading data from a text file, Reading data from an Excel file: CSV files, File Output: Writing data to a text file, Writing data to a CSV file</td></tr>
<tr><td>Unit 2</td><td>PYTHON Language
Conditionals and Loops</td></tr>
</table>

	Conditionals: *if, elif,* and *else* statements, Logical operators, **Loops:** for loops, while loops, Loops and array operations, List Comprehensions **Plotting** An Interactive Session with PyPlot, Basic Plotting, Specifying line and symbol types and colors, Error bars, Setting plotting limits and excluding data, Subplots, **Logarithmic Plots:** Semi-log plots, Log-log plots, **More Advanced Graphical Output:** An alternative syntax for a grid of plots, Plots with multiple axes, Mathematics and Greek symbols, **The Structure of matplotlib: OOP and All That:** The backend layer, The artist layer, The PyPlot (scripting) layer, **Contour and Vector Field Plots:** Making a 2D grid of points, Contour plots, Streamline plots**,** Three-Dimensional Plots **Functions** **User-Defined Functions:** Looping over arrays in user-defined functions, Fast array processing for user-defined functions, Functions with more than one input or output, Positional and keyword arguments, Variable number of arguments, Passing function names and parameters as arguments, **Passing data (objects) to and from functions:** Variables and arrays created entirely within a function, Passing lists and arrays to functions: Mutable and immutable objects, Anonymous Functions: lambda Expressions, NumPy Object Attributes: Methods and Instance Variables.
Unit 3	**Oscillatory Motion and Chaos** Free nonlinear oscillation, Nonlinear Oscillators, Bug Population Dynamics, The Logistic Map (Model), Properties of Nonlinear Maps (Theory and Exercise),Fixed Points, Period Doubling, Attractors, Mapping Implementation, Bifurcation Diagram (Assessment), Bifurcation Diagram Implementation, Visualization Algorithm: Binning, Feigenbaum Constants (Exploration), Logistic Map Random Numbers (Exploration), Other Maps (Exploration), Signals of Chaos: Lyapunov Coefficient and Shannon Entropy, Coupled Predator–Prey Models, Lotka–Volterra Model, Lotka–Volterra Assessment, Predator–Prey Chaos, Exercises, LVM with Prey Limit, LVM with Predation Efficiency, LVM Implementation and Assessment, Two Predators, One Prey (Exploration), Chaotic Pendulum, Free Pendulum Oscillations, Solution as Elliptic Integrals, Implementation and Test: Free Pendulum, Visualization: Phase-Space Orbits, Chaos in Phase Space, Assessment in Phase Space, Exploration: Bifurcations of Chaotic Pendulums, Alternate Problem: The Double Pendulum, Assessment: Fourier/Wavelet Analysis of Chaos, Exploration: Alternate Phase-Space Plots, Further Explorations.
Unit 4	**Quantum Packets and Electromagnetic** Quantum Wave Packets, Time-Dependent Schrödinger Equation (Theory), Finite-Difference Algorithm, Wave Packet Implementation, Animation, Wave Packets in Other Wells (Exploration), Algorithm for the 2D Schrödinger Equation, Exploration: Bound and Diffracted 2D Packet, Wave Packet–Wave Packet Scattering, Algorithm, Implementation, Results and Visualization, E&M Waves via Finite-Difference Time Domain, Maxwell's Equations, FDTD Algorithm, Implementation, Assessment, Extension: Circularly Polarized Waves, Application: Wave Plates, Algorithm, FDTD Exercise and Assessment.

Reference Books	
1.	Introduction to Python for Science and Engineering: David J. Pine, CRC Press Taylor and Francis Group, (2019).
2.	Computational Physics With Python: Dr. Eric Ayars, California State University, (2013).
3.	Computational Physics Problem solving with Python: R. H. Landau, Manuel J. Páze, and Cristian C. Bordeianu, Third Edition, Wiley-VCH, (2015).
4.	Computational Physics: Nicholas Giordano, Hisao Nakanishi, Second Edition, Pearson Prentice Hall, (2006).
5.	An Introduction to Computational Physics: T. Pang, Second Edition, Cambridge University Press (2006).

Course Name	PH-534: Elective 4-Particle Accelerators and Detectors
Course Code	PH-534
Course Type	Elective 4
Course Outcome (CO)	(1) The students will learn basic nuclear properties and different methods of their measurements (2) The students will be introduced to the phenomenon radioactivity, types of radioactive radiations and their properties. They will also learn various applications of radioactivity. (3) The students will have in depth study of α-decay and β- decay processes and theories giving explanation of these decay processes. They will also learn forbidden decays and comparative half-lives. (4) The students will learn the process of γ-emission and basic conservation laws, internal conversion process, γ-ray spectroscopy and Mossbauer effect.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1					
CO2					
CO3					
CO4					
CO5					

Course Content	
Unit 1	**Particle Accelerators** Introduction, classification and performance characteristics of accelerators, electrostatic accelerators, Cockroft-Walton generator, Van de Graaff generator, pelletron accelerator, tandem accelerator, cyclotron, synchrocyclotron, betatron, electron synchrotron, microtron, linear accelerator.
Unit 2	**Nuclear Detectors I** Introduction, methods for the detection of free charge carriers, ionization chamber, mode of operation, integrating type of ion chambers, pulse, chambers, proportional counter, neutron counting, Giger-Muller Counter, counter characteristic, quenching of the discharge, dead-time of the G. M. Counter, efficiency of counting, semiconductor detectors, diffused junction detectors, surface barrier detectors, Si (Li) detector, Ge (Li) detector, HPGe detectors, use of semiconductor detectors.
Unit 3	**Nuclear Detectors II** Methods based on light sensing, scintillation detector, photomultiplier tubes, scintillation counting arrangement, electrical pulse formation, Cherenkov detector, methods of visualization of the tracks of ionizing radiation, Wilson cloud chamber, diffusion cloud chamber, bubble chamber, spark chamber, nuclear emulsion technique, applications of nuclear emulsions, nuclear emulsions in auto-radiography, solid state nuclear state detectors.
Unit 4	**Nuclear Electronics** Introduction, general considerations of electronics for energy spectroscopy, pre-amplifiers, charge sensitive pre-amplifiers, pulse shaping methods, RC pulse shaping circuits, bipolar pulse shaping and zero crossover timing, base-line restorer, electronics for timing with detectors, pulse amplitude analysis (ADC), SCA, MCA.

Reference Books	
1.	Introductory Nuclear Physics: K. Krane, Wiley India Pvt. Ltd. (1988).
2.	Nuclear Physics: S. N. Ghoshal ,S. Chand & Co. Pvt. Ltd., Revised enlarged Edition (2014).
3.	Introduction to Nuclear and Particle Physics by Mittal, Gupta and Verma, PHI Learning Pvt. Ltd., Third Edition (2017).
4.	Nuclear Physics: D. C. Tayal, Himalaya Publishing House (2017).
5.	Radiation Detection and Measurement: G. F. Knoll.
6.	Nuclear Radiation Detectors: S. S. Kapoor and V. S. Ramamurthy.

Course Name	PH-535: Practical
Course Code	PH-535
Course Type	Core
Course Outcome (CO)	(1) Attain proficiency in modern physics experiments, mastering techniques for observation, analysis, and interpretation of phenomena in experimental settings. (2) Develop expertise in radiation experiments, mastering GM tube characteristics, gamma source activity determination, inverse square law verification, energy determination, and spectrometry. (3) Attain proficiency in optical experiments, mastering Michelson's Interferometer, optical fiber characterization, numerical aperture calculations, polarized light intensity measurement, and Kerr effect demonstration.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1					
CO2					
CO3					
CO4					
CO5					

Course Content	
Group A	
1.	Qualitative observation of Compton effect.
2.	To observe the neon spectral bands formation in Frank-Hertz tube.
3.	Study of Zeeman effect
4.	To determine Brewster's Angle using LASER.
5.	To study Beer- Lambert (law) : concentration of chemical solution
Group B	
6.	To study characteristics of a GM tube and determination of its operating voltage, plateau length / slope etc.
7.	To determine activity of a gamma source (Relative Method)
8.	To verify inverse square law for γ – rays.
9.	To determine the Unknown energy of a radioactive isotope.
10.	To study Cs-137 spectrum and calculation of FWHM and resolution for a given scintillation detector.
Group C	
11.	Michelson's Interferometer.
12.	To measure the losses in dB of two optical fibers patch cords and the coefficient of attenuation.
13.	Calculate the numerical aperture and study the losses in optical fiber cable.
14.	To measure the light intensity of plane polarized light as a function of the analyzer position.
15.	To demonstrate the Kerr effect.

Group D (Elective Paper 1)	
16.	To design, build and test Binary to Gray code converter.
17.	To design, build and test a BCD to 7-Segnment ROM.
18.	To design, build and test a BCD to 9'S complement circuit.
19.	To design, build and test a 7 bit hamming code with even and odd parity.
20.	Microcontroller Programming
Group D (Elective Paper 2)	
16.	Study on Diffraction of X-Ray by (i) Brag's law and (2) Laue's Method.
17.	Measuring the diameters of the two diffraction rings for different accelerator voltages.
18.	Determining the wavelength of the electrons for different accelerator voltages by applying the Bragg condition.
19.	Find the permeability and permittivity of free space and air using current balance method.
20.	Determine the Dielectric Constant of different materials.
Group D (Elective Paper 3)	
16.	Write a PYTHON program to perform the simulation of nonlinear oscillators.
17.	Write a PYTHON program to perform the simulation of Logistic Map.
18.	Write a PYTHON program to perform the simulation of simple pendulum.
19.	Write a PYTHON program to perform the simulation of wave packet.
20.	Write a PYTHON program to perform the simulation of time dependent Schrödinger Equation.
Group D (Elective Paper 4)	
16.	To do spectrum analysis of Cs-137 & Co-60 and to explain some of the features of Compton edge and backscatter peak.
17.	To study variation of energy resolution with gamma energy.
18.	To study beta particle range and maximum energy (Feather Analysis).
19.	To determine linear and mass absorption coefficient using GM counter.
20.	To measure short half-life.

Course Name	PH-536:Skill based course-Microprocessors
Course Code	PH-536
Course Type	Skill based course
Course Outcome (CO)	(1) Students learn about conversion of number system and will acquire basic understanding and concept of Microprocessors. (2) Student would know the usage of Intel 8085 instruction set and to learn writing of assembly language programs for beginners. (3) This course is very helpful to work on microprocessor based project.
Mapping between CO and PSO	

	PSO1	PSO2	PSO3	PSO4	PSO5
CO1					
CO2					
CO3					
CO4					
CO5					

Course Content	
Unit 1	**Microprocessor Architecture** Review of number systems, Binary Addition, Binary subtraction, Representation of negative number: 9's Complement, 10's Complement and 1's Complement Conversion of Decimal number to Hexadecimal number and vice versa, Conversion of Decimal number to Octal number and vice versa, Conversion of binary number to Hexadecimal number, Introduction: Intel 8085, ALU, Timing and control unit, Registers, Data and Address bus, Pin configuration, Intel 8085 instructions, Opcode and Operands, Instruction word size, Timing and control signals, Fetch operation, Execute operation, Machine cycle and state, Instruction and data flow, System timing diagram, Memory read, I/O Read and I/O write.
Unit 2	**Instruction set for Intel 8085** Instruction and data formats, Addressing modes: Direct addressing, Register addressing, Register Indirect addressing, Immediate addressing, Status flags, Intel 8085 instructions: Data transfer group, Arithmetic group, Logical group, Branch group, Stack, I/O and machine control group. Examples of assembly language programs: Addition and subtraction of two 8-bit and 16-bit numbers, 1's Complement and 2's Complement of 16-bit number, Mask off least significant 4-bits of 8-bit number, Mask off most significant 4- bits of 8-bit number Shifting of a 16-bit number left by two bits, Find the largest and smallest number from a seriesof numbers.

Reference Books	
1.	Fundamentals of Microprocessors and Microcomputers: B. Ram, Dhanpat Rai Publications (1992).
2.	Microprocessor Architecture, Programming and applications: Ramesh S. Gaonkar, Wiley Eastern Limited.