



Re-Accredited 'B++' 2.86 CGPA by NAAC

VEER NARMAD SOUTH GUJARAT UNIVERSITY

University Campus, Udhna-Magdalla Road, SURAT - 395 007, Gujarat, India.

વીર નર્મદ દક્ષિણ ગુજરાત યુનિવર્સિટી

યુનિવર્સિટી કેમ્પસ, ઉદ્ધના-મગદલા રોડ, સુરત - ૩૯૫ ૦૦૭, ગુજરાત, ભારત.

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-: પરિપત્ર :-

વિજ્ઞાન વિદ્યાશાખા હેઠળની સંલગ્ન ભૌતિકશાસ્ત્ર કોર્સ ચલાવતી તમામ કોલેજોનાં આચાર્યશ્રીઓ તથા ડિપાર્ટમેન્ટનાં વડાશ્રીને જણાવવાનું કે, શૈક્ષણિક વર્ષ ૨૦૨૩-૨૪ થી અમલમાં આવનાર M.Sc. (Part-1) Sem-1 & 2 ભૌતિકશાસ્ત્ર વિષયનો નો સબકમિટીએ તૈયાર કરેલ અભ્યાસક્રમ મંજૂર કરવા ભૌતિકશાસ્ત્ર વિષયની અભ્યાસ સમિતિની તા. ૧૫/૦૪/૨૦૨૩ની સભાનાં ઠરાવ ક્રમાંક: ૨ અન્વયે નીચે મુજબ કરેલ ભલામણ વિજ્ઞાન વિદ્યાશાખાનાં અધ્યક્ષશ્રીએ વિદ્યાશાખાની મંજૂરી અપેક્ષાએ વિજ્ઞાન વિદ્યાશાખા વતી મંજૂર કરી એકેડેમિક કાઉન્સિલને કરેલ ભલામણ એકેડેમિક કાઉન્સિલ તા.૨૦/૦૪/૨૦૨૩ની સભાનાં ઠરાવ ક્રમાંક:૩૩ થી સ્વીકારી મંજૂર કરેલ છે. જેની આથી જાણ કરવામાં આવે છે.

ભૌતિકશાસ્ત્ર વિષયની અભ્યાસ સમિતિની તા. ૧૫/૦૪/૨૦૨૩ની સભાનાં ઠરાવ ક્રમાંક: ૨


- :: આથી ઠરાવવામાં આવે છે કે, શૈક્ષણિક વર્ષ ૨૦૨૩-૨૪ થી અમલમાં આવનાર M.Sc. (Part- 1) Sem-1 & 2 નો સબકમિટીએ તૈયાર કરેલ અભ્યાસક્રમ સર્વાનુમતે મંજૂર કરી વિજ્ઞાન વિદ્યાશાખાને ભલામણ કરવામાં આવે છે.

એકેડેમિક કાઉન્સિલની તા.૨૦/૦૪/૨૦૨૩ની ઠરાવ ક્રમાંક: ૩૩

- :: આથી ઠરાવવામાં આવે છે કે, શૈક્ષણિક વર્ષ ૨૦૨૩-૨૪ થી અમલમાં આવનાર M.Sc. (Part- 1) Sem-1 & 2 નો સબકમિટીએ તૈયાર કરેલ અભ્યાસક્રમ ભૌતિકશાસ્ત્ર વિષયની અભ્યાસ સમિતિની તા. ૧૫/૦૪/૨૦૨૩ની સભાનાં ઠરાવ ક્રમાંક: ૨ અન્વયે કરેલ ઉપરોક્ત ભલામણ વિજ્ઞાન વિદ્યાશાખાનાં અધ્યક્ષશ્રીએ વિદ્યાશાખાની મંજૂરી અપેક્ષાએ વિજ્ઞાન વિદ્યાશાખા વતી મંજૂર કરી એકેડેમિક કાઉન્સિલને કરેલ ભલામણ સ્વીકારી મંજૂર કરવામાં આવે છે.

ક્રમાંક : એસ./ભૌતિકશાસ્ત્ર/પરિપત્ર/ ૯૪૮૩/૨૦૨૩

તા.૨૪-૦૪-૨૦૨૩


કુલસચિવ વતી

પ્રતિ,

- ૧) વિજ્ઞાન વિદ્યાશાખા હેઠળની સંલગ્ન ભૌતિકશાસ્ત્ર કોર્સ ચલાવતી તમામ કોલેજોનાં આચાર્યશ્રીઓ. તથા ડિપાર્ટમેન્ટનાં વડાશ્રી.આપશ્રીની કોલેજના સંબંધિત શિક્ષકોને જાણ કરી અમલ કરવા સારું.
- ૨) અધ્યક્ષશ્રી, વિજ્ઞાન વિદ્યાશાખા.
- ૩) પરીક્ષા નિયામકશ્રી, પરીક્ષા વિભાગ, વીર નર્મદ દ. ગુ. યુનિવર્સિટી, સુરત.

.....તરફ જાણ તેમજ અમલ સારું.

અકેડેમિક કોર્સવર્ક નં. ૨૦૧૫-૨૦૨૩
પાન નં. ૩૩ બિડાણ/પરિશિષ્ટ ૭



ભારત 2023 INDIA

SYLLABUS

for

MASTER OF SCIENCE (M.Sc.)

PHYSICS

(To be implemented from June-2023)



VEER NARMAD SOUTH GUJARAT UNIVERSITY,
UDHNA MAGDALLA ROAD,
SURAT-395007. (GUJARAT)

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PROGRAMME STRUCTURE

Master of Science in Physics – M. Sc. - PHYSICS
Syllabus with effect from the Academic Year 2023-2024

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 Specific Outcome (PSO)	<ol style="list-style-type: none"> (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.

Structure for MSc Physics – Semester - I							
Course Type	Course Code	Course Name	Teaching hours/week	Credit	Internal Marks	External Marks	Total Marks
Core	PH-411	Mathematical Methods of Physics	04	04	30	70	100
	PH-412	Classical Mechanics	04	04	30	70	100
	PH-413	General Electronics	04	04	30	70	100
Elective (Any one course can be taken)	PH-414	Elective 1: Physics of Semiconductor Devices	04	04	30	70	100
		Elective 2: Crystal Growth and Characterization	04	04	30	70	100
		Elective 3: Numerical Methods	04	04	30	70	100
		Elective 4: Basic Nuclear Properties and Radioactivity	04	04	30	70	100
	PH-415	Practical	12	06	50	100	150
Skill based course	PH-416	Measurement and Industrial Instrumentation	02	02	20	30	50
Total			30	24	190	410	600

Course Name	PH-411: Mathematical Methods of Physics
Course Code	PH-411
Course Type	Core
Course Outcome (CO)	<p>(1) By studying this course students will be able to learn different mathematical methods to solve different physical problems.</p> <p>(2) Students are able to solve differential equations using different methods.</p> <p>(3) Students are able to develop a skill to evaluate contour integral and integral transform.</p> <p>(4) Students are able to learn special functions in detail.</p> <p>(5) Students will get conceptual knowledge and application of probability and group theory.</p>

Course Content	
Unit 1	<p>Ordinary Differential Equations: Solution in Closed form: First and second order differential equations: Separable equation, exact equation, linear equation, Bernoulli's equation, Clairaut equation, Homogeneous and inhomogeneous forms, undetermined coefficients method, Variation of parameter method, change of variable method, Power Series Solutions: General theory of series solutions of linear differential equation, Legendre's differential equation, Bessel's differential equation, Schrodinger equation for a one dimensional quantum mechanical harmonic oscillator, Associated Legendre's differential equation, Miscellaneous approximate methods: Graphical approach, dropping small terms and iterating approach, WKB method.</p>
Unit 2	<p>Evaluation of Integrals and Integral Transforms: Evaluation of Integrals: Residue Theorem, Methods to find out Residues, Contour integration, Integral Transforms: Fourier transforms, integral representation of delta function, Parseval's theorem, Fourier cosine transforms, Fourier sine transforms, Laplace transforms, other transforms pairs, Applications of integral transforms- Linearity, Derivatives, Integrals, Translation, Multiplication by an exponential, Multiplication by a power of x, Convolution theorems .</p>
Unit 3	<p>Special Functions: Legendre functions: Rodrigues' formula, Schlafli's integral representation, Laplace's integral representation, Generating function, recursion relations, orthogonality and normalization properties of the Legendre polynomial, Associated Legendre functions, orthogonality and normalization properties of the Associated Legendre polynomial, Spherical Harmonics, Bessel Functions: Generating function, recursion relations, orthogonality and normalization properties of the Bessel functions, integral and half integral orders, Schlafli's integral representation, Bessel's integral representation, Hankel functions</p>
Unit 4	<p>Probability and Group Theory: Probability: Priori and posteriori probabilities, Fundamental probabilities laws, Bayes' theorem, Combinations and permutations, Binomial, Poisson, and Gaussian distributions, General properties of distributions, Multivariate Gaussian distributions, Fitting of experimental data, chi-square test, Group Theory: Introduction and definitions – Group, finite group, order of group, Abelian group, symmetric group, Subgroup and classes, Group representations.</p>

Reference Books	
1.	Mathematical Methods of Physics: Mathews and Walker, 2nd Edition, Pearson Education, 2004.
2.	Mathematical Methods for Physicists: G. Arfken and H. J. Weber, 7 th Edition, Academic Press, 2013.
3.	Mathematical Physics: P. K. Chattopadhyay, Wiley Eastern Limited, 1990
4.	Mathematical Methods: B. S. Rajput, Pragati Prakashan, 1997.
5.	Mathematical Physics: B. D. Gupta, Vikas Publishing House Pvt Ltd, 3 rd Edition, 2004.
6.	Elements of Group Theory for Physicists: A.W.Joshi, New Age International Publication, 1997.

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Course Name	PH-412: Classical Mechanics
Course Code	PH-412
Course Type	Core
Course Outcome (CO)	<p>(1) To develop basic understanding of Lagrangian formulation & Hamilton formulation.</p> <p>(2) To understand the kepler force problem and to apply Lagrangian formulation for solving the kepler's problem.</p> <p>(3) To apply Lagrangian formulation to study liquid body dynamics.</p> <p>(4) To study small oscillation and understand vibration of liner tri-atomic molecules.</p> <p>(5) To understand canonical transformations, Poisson Brackets.</p>

Course Content	
Unit 1	<p><u>Central Force Problem:</u> Reduction of two body problem to one body problem; equation of motion and first integrals; equivalent one-dimensional problem; classification of orbits; differential equation for the orbit; power law potentials; Bertrand's theorem; Kelper's laws; Scattering in a central force field; Rutherford scattering cross section.</p>
Unit 2	<p><u>Rigid Body Motion:</u> Independent coordinates of a rigid body; Orthogonal transformations; transformation matrix; Euler-angles; Euler theorem; angular momentum; kinetic energy; moment of Inertia tensor; principal axis transformation; Euler's and Lagrangian treatment of rigid body motion; force free motion of a symmetrical top; motion of a heavy symmetrical top with one point fixed.</p>
Unit 3	<p><u>Small Oscillations:</u> Eigen-value equation and principal axis transformation; normal modes and normal coordinates for small oscillations; examples: Free vibrations of a linear tri-atomic molecule, coupled pendulums, double pendulum. Hamilton's Equations of Motion: Legendre transformation and Hamiltonian function; canonical equations of motion; examples; ignorable coordinates and conservation theorems; Cyclic coordinates and Routh's procedure; modified Hamilton's Principle.</p>
Unit 4	<p><u>Canonical Transformations:</u> I Generators of Canonical transformations, Equations of canonical transformations; examples; the Harmonic oscillator; The integral invariance of Poincaré and Lagrange and Poisson Brackets; Equation of Motion in Poisson bracket; Infinitesimal canonical transformation; constant of motion and symmetry properties; angular momentum Poisson brackets. Hamilton-Jacobi Theory: Hamilton-Jacobi equation; Hamilton's principal and characteristic function; examples; separation of variables in Hamilton-Jacobi equation; orbit equation for central force problem; periodicity and action angle variables, frequencies of periodic motion.</p>

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Reference Books	
1.	Classical Mechanics: H. Goldstein, (3 rd Ed)., Pearson education, 2002 / (2 nd Ed)., Addison Wesley, 1980
2.	Classical Dynamics of Particles and Systems: J.B. Marion and S.T. Thronton, (4 th Ed)., Saunders College Publishing, 1995
3.	Classical Mechanics: N.C. Rana and P.S. Joag, TMH, 1991.
4.	Classical Mechanics: Y. R. Waghmare, PHI, 1990.
5.	Classical Mechanics: V. B. Bhatia, Narosa Pub. House, 1997.
6.	Introduction to Classical Mechanics: R. G. Takwale and P. S. Puranik, Tata McGraw-Hill, 1990.
7.	Theory & Problems of Theoretical Mechanics: M. R. Spiegel, Schaum's Outline Series.

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Course Name	PH-413: General Electronics
Course Code	PH-413
Course Type	Core
Course Outcome (CO)	<ol style="list-style-type: none"> (1) At the end of the course, the students will be able to understand the fundamentals of circuit analysis and working of analog as well as digital electronics. (2) Students will be able to use different theorems and techniques commonly used for circuit analysis. (3) Operational Amplifier being versatile circuit, students are exposed with different application of the operational amplifier. (4) By studying this course, students will be able to use different tools for combinational digital circuits designing. (5) Post completion of the course, student would be able to design sequential digital circuits.

Course Content	
Unit 1	<u>Network Analysis:</u> Review of Thevenin, Norton and Superposition theorems, Mesh and Node circuit analysis, T-Network analysis, π -Network analysis, conversions between T-Network section and π -Network section, Bridged-T network.
Unit 2	<u>Operational Amplifier Applications:</u> Summing, Scaling and Averaging amplifier, Instrumentation Amplifier, Voltage-to-Current converter with floating and grounded load, Current-to-Voltage converter, Integrator and Differentiator circuit, First-order Low pass, High pass, and Band pass filters. Phase shift oscillator, Square wave generator, Triangular wave generator, Saw tooth wave generator.
Unit 3	<u>Combinational Digital Circuit Design:</u> Standard Gate Assemblies, Arithmetic Functions, Digital Comparator, Parity Checker-Generator, Multiplexer, De-multiplexer, Encoder, Decoder, Digital to Analog Converter, Analog to Digital Converter.
Unit 4	<u>Sequential Digital Circuit Design:</u> Counters: Asynchronous Counter, Synchronous Counter, Ring counter, Application of counters. Shift Registers: Serial-in Serial-out shift register, Parallel-in Parallel-out shift register, Parallel-in Serial-out shift register, Serial-in Parallel-out shift register, Displays: 7-Segment display, Alpha-Numeric display, Dot-matrix display and Multiplexed display system.

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Reference Books	
1.	Electronic Fundamentals and Applications: J.D. Ryder, Prentice Hall of India, 1981.
2.	Electron Devices and Circuits: A Mottershed, Prentice Hall of India, 1981.
3.	Microelectronics: J. Millmann and A Grabel, Mc Graw Hill, 2009.
4.	Electronic Devices and Circuit theory: Robert L Boylestad & Louis Nashelsky, Pearson Education, 2007.

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Course Name	PH-414: Elective 1-Physics of Semiconductor Devices
Course Code	PH-414
Course Type	Elective 1
Course Outcome (CO)	<p>(1) After completion of the course, students shall acquire knowledge about core concepts and understanding the physical mechanism of charge carriers in semiconductor physics.</p> <p>(2) Students deals traditional as well as the contemporary power device and applications of these devices via thyristors family knowledge.</p> <p>(3) In junction diode covers p-n, metal-semiconductor and heterojunctions detailed analysis developed to understand the operation of present-day device operation through the knowledge of the physics of semiconductor materials and devices.</p> <p>(4) In optical device students have acquired knowledge in photonic devices such that detection, generation and conversion of optical energy to electric energy or vice versa.</p>

Course Content	
Unit 1	<p><u>Carrier transport phenomena and Thyristors:</u> Carrier transport phenomena: Mobility, Resistivity and Hall Effect, Recombination process, Phonon spectra, optical thermal and high field properties of semiconductor, basic equation for semiconductor device operation, Basic characteristic of three terminal Thyristor Reverse conducting Thyristors, Light activated Thyristor, DIAC and TRIAC, Uni-Junction Transistor and triggering Thyristor.</p>
Unit 2	<p><u>Junction Diode:</u> Depletion region and depletion capacitance, Abrupt and linearly graded junctions, Current-Voltage characteristics, Ideal case- Shockley equation, Generation and recombination. Diffusion capacitance, Junction breakdown, Thermal instability, Tunneling effect, Avalanche multiplication, Terminal function. Metal-Semiconductor Contact, Energy band relation, Schottky effect, Ohmic contact, Heterojunction.</p>
Unit 3	<p><u>Bipolar transistor:</u> Bipolar transistors, Static characteristic, Microwave transistors, Cutoff frequency, Microwave characterization, Device geometry and performance, Power transistors, switching transistor. Basic static performance parameters, non-ideal effect, Hetro-Bipolar Junction Transistor.</p>
Unit 4	<p><u>Optical Devices:</u> Optical absorption: Photon absorption coefficient, Electron-Hall pair generation, Solar cell: PN Junction solar cell, Conversion efficiency and solar concentration, Heterojunction solar cell, Amorphous silicon solar cell, Photo-detectors, PIN photodiode, Light emitting diode, Laser diode.</p>

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Reference Books	
1.	Semiconductor Physics and devices: D.A. Neamen, Tata McGraw-Hill Publishing Company Limited, 2002.
2.	Physics of semiconductor devices: S.M. Sze, Wiley-Interscience, 1981.
3.	Solid State Electronic Devices: B.G. Streetman,(3 rd Ed.), Prentice-Hall of India Private Limited,1994.
4.	Semiconductor Devices: Jasprit Singh, McGraw-Hill Publishing Company Limited, 1994.

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Course Name	PH-414: Elective 2-Crystal Growth and Characterization
Course Code	PH-414
Course Type	Elective 2
Course Outcome (CO)	<p>(1) The development of crystal growth research group will become a focal point for not only academic based research but more broadly the research interests of the technological development.</p> <p>(2) How we think about the ways to crystallization impacts how we interpret natural crystallization processes in geochemical and biological environments as well as how we design and control synthetic crystal growth processes.</p> <p>(3) The study of different properties plays a major role in developing various applications of such materials grown by different techniques.</p> <p>(4) It is very useful for technological development.</p>

Course Content	
Unit 1	<u>Crystal Growth Techniques:</u> Crystal growth, Crystal growth techniques, The chemical physics of crystal growth, Crystal growth from solution techniques, vapour growth techniques, How to start crystal growth, Advantages and disadvantages of crystal growth methods.
Unit 2	<u>Theory of Crystal Growth:</u> Nucleation, classical theory of nucleation, Gibbs Thomson equation for vapour, Modified Thompson's equation for melt, Gibbs Thomson equation for solution, Energy of formation of a nucleus, Spherical and cylindrical nucleus, Cap shaped and disc shaped nucleus.
Unit 3	<u>Characterization Tools:</u> Ultraviolet and visible absorption spectroscopy, Infrared spectroscopy, Basic components of infrared spectrophotometers, Fourier transform infrared spectroscopy (FTIR), Fluorescence spectroscopy, Principle and measurement Raman spectrometer, pH meters, Principle of pH measurement.
Unit 4	<u>Characterization Tools:</u> Optical microscopy and morphological studies of surfaces, Electron Spin resonance spectrometers, Scanning electron microscopy (SEM), Transmission electron microscopy (TEM) Atomic force microscopy (AFM) Thermo analytical methods, Thermo-gravimetric metric analysis (TGA), Differential thermal analysis (DTA), Simultaneous thermal analysis/Mass spectrometer.

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Reference Books	
1.	Crystal Growth: P. Ramaswamy and Santhan Raghavan, Kru Publications–Chennai, 2000.
2.	Hand book of Analytical Instruments: R.S. Khandpur, Tata McGraw – Hill Professional Electrical Engineering Series (6 th Reprint), 2010.
3.	Crystal Growth Principles and Progress: A.W. Vere, Springer
4.	Nucleation and Crystal Growth: Metastability of Solution and Melts. Keshra Sangwal Wiley, 2010.
5.	Crystal Growth Concepts, Mechanisms and Applications: Jinjin Li, Jianwei Li and Yanhui Chy, 2017.
6.	Crystal Growth: Brain D. Pamplin (2 nd Ed.), 1980.
7.	Crystals and Crystal Growing: Alan Holder and Phylis Morrison, MIT Press, 1982.
8.	Introduction to Crystal Growth: Principles and Practice , H.L. Bhatt, CRC Press, 2014.
9.	Crystal Growth for Beginners Fundamentals of Nucleation, Crystal Growth and Epitaxy: Ivan V. Markov (2 nd Ed.), 2003.

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Course Name	PH-414: Elective 3- Numerical Methods
Course Code	PH-414
Course Type	Elective 3
Course Outcome (CO)	<p>(1) By studying this course students will be able to solve physical problems using numerical methods.</p> <p>(2) Students are able to perform curve and surface fitting using cubic splines.</p> <p>(3) Students are able to solve the simultaneous linear equation using different matrix methods.</p> <p>(4) Students are able to solve ordinary differential equation using different methods.</p> <p>(5) Students are able to solve partial differential equation using different methods.</p>

Course Content

Unit 1	<p><u>Spline Functions:</u> Linear Splines, Quadratic Splines, Cubic Splines, Minimizing Property of cubic splines, Error in the cubic splines and its derivatives, surface fitting by cubic Splines, Cubic B-splines Representation of B-splines, Least Squares, Solution Application of B-Splines.</p>
Unit 2	<p><u>Numerical Linear Algebra:</u> Introduction, Triangular Matrices, LU Decomposition of A Matrix, Vector and Matrix Norms, Solution of Linear Systems—Direct Methods, Gauss Elimination, Necessity for Pivoting, Gauss-Jordan Method, Modification of the Gauss Method to Compute the Inverse, Number of Arithmetic Operations, LU Decomposition Method, Computational Procedure for LU Decomposition Method, LU Decomposition from Gauss Elimination, Solution of Tridiagonal Systems, III-conditioned Linear Systems, Method for III-conditioned Systems, Solution of Linear Systems—Iterative Methods, Matrix Eigen value Problem, A Eigen values of a Symmetric Tridiagonal Matrix, Householder's Method, QR Method, Singular Value Decomposition.</p>
Unit 3	<p><u>Numerical Solution of Ordinary Differential Equation:</u> Introduction, Solution by Taylor's Series, Picard's Method of Successive Approximations, Euler's Method, Error Estimates for the Euler Method, Modified Euler's Method, Runge-Kutta Methods, Predictor-Corrector Methods, Adams-Moulton Method, Milne's Method, Cubic Spline Method, Simultaneous and Higher-order Equations, Some General Remarks, Boundary-value Problems, Finite-difference Method, Cubic Spline Method, Galerkin's Method.</p>
Unit 4	<p><u>Numerical Solution of Partial Differential Equation:</u> Introduction, Laplace's Equation, Finite-difference Approximations to Derivatives, Solution of Laplace's Equation, Jacobi's Method, Gauss-Seidel Method, Successive Over-Relaxation (SOR) Method, ADI Method, Heat Equation in One Dimension, Finite-difference Approximations, Iterative Methods for the Solution of Equations, Application of Cubic Spline, Wave Equation, Software for Partial Differential Equations.</p>

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Reference Books	
1.	Introductory Methods of Numerical Analysis: S. S. Sastry, PHI, 2012.
2.	Numerical Methods for Scientists and Engineers: K. S. Rao, PHI, 2001.
3.	Numerical Mathematical Analysis: J. B. Scarborough, Oxford Books Co., 1962.
4.	Numerical methods for Engineers: S.C. Chapra, R.P. Canale, (5 th Ed.), McGraw Hill, 2006.
5.	Numerical Analysis for Scientists and Engineers: Theory and C Programs, Madhumangal Pal, Alpha Science International Ltd., 2007.

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Course Name	PH-414: Elective 4-Basic Nuclear Properties and Radioactivity
Course Code	PH-414
Course Type	Elective 4
Course Outcome (CO)	<p>(1) The students will learn basic nuclear properties and different methods of their measurements</p> <p>(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.</p> <p>(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.</p> <p>(4) The students will learn the process of γ- emission and basic conservation laws, internal conversion process, γ- ray spectroscopy and Mossbauer effect.</p>

Course Content	
Unit 1	<p><u>Basic Nuclear Properties:</u> The nuclear radius, the distribution of nuclear charge, the distribution of nuclear matter, mass and abundance of nuclides, nuclide abundances, separated isotopes, laser isotope separation, nuclear binding energy, nuclear angular momentum, nuclear electromagnetic moments, nuclear excited states The deuteron, binding energy, spin and parity, magnetic dipole moment, electric quadrupole moment.</p>
Unit 2	<p><u>Radioactive Decay:</u> The radioactive decay law, production and decay of radioactivity, growth of daughter activities, series of decays, types of decays, α-decay, β-decay, γ-decay, spontaneous fission, nuclear emission, branching ratios and partial half-lives, natural radioactivity, radioactive dating, units for measuring radiation, successive disintegrations.</p>
Unit 3	<p><u>Alpha Decay and Beta Decay:</u> Alpha Decay: Why α-decay occurs, basic α-decay processes, α-decay systematics, theory of α-emission, angular momentum and parity in α-decay, α-decay spectroscopy, Beta Decay: Energy release in β-decay, Fermi theory of β-decay, the classical experimental tests of β-decay, the shape of the β-spectrum, the total decay rate, the mass of the neutrino, angular momentum and parity selection rules, allowed decays, forbidden decays, comparative half-lives and forbidden decays.</p>
Unit 4	<p><u>Gamma Decay:</u> Energetics of gamma decay, classical electromagnetic radiation, angular momentum and parity selection rules, angular distribution and polarization measurements, internal conversion, lifetimes of γ-emission, gamma ray spectroscopy, nuclear resonance fluorescence and the Mossbauer effect.</p>

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Reference Books	
1.	Introductory Nuclear Physics: K. Krane, Wiley India Pvt. Ltd.
2.	Nuclear Physics by S. N. Ghoshal, S. Chand & Co. Pvt. Ltd., Revised enlarged edition, 2014.
3.	Nuclear Physics: D. C. Tayal, Himalaya Publishing House, 2017.
4.	Nuclear Physics: Roy & Nigam, Wiley Eastern Ltd., 1979
5.	Atomic and Nuclear Physics: S. N. Ghoshal, S. Chand & Company, 2019.
6.	Nuclear Models: W. Greiner and J.A. Maruhn, Springer, 1996.

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Course Name	PH-415: Practical
Course Code	PH-415
Course Type	Core
Course Outcome (CO)	<p>(1) After completion of the course, the students will be able to operate appropriate laboratory equipments and understand the principle allied with theories.</p> <p>(2) Students will be able to write computer programs as per the requirements.</p> <p>(3) Students are trained for trouble shootings while performing Design Build and Test type laboratory experiments.</p>

Course Content	
Group A	
1.	Find out the power series solution of given differential equations.
2.	Find out the integral of given functions using contour integration.
3.	Find out the Fourier and Laplace transforms of given function.
4.	Find out the Spherical Harmonics for different values of l .
5.	Application of chi-square test.
Group B	
6.	To measure the period of oscillation of pendulum by changing angle and length using Variable 'g' pendulum setup.
7.	Transducer-I
8.	Transducer-II
9.	To determine the range of projectile as a function the angle of inclination using Projectile Motion experiment setup.
10.	To study the elastic and inelastic collision using Linear Air Track with digital timer setup.
Group C	
11.	Design build and test Voltage-to-Current converter using operation amplifier.
12.	Design build and test a Phase shift oscillator using operation amplifier.
13.	Design build and test Triangular wave generator using operation amplifier.
14.	Design build and test combinational logic circuit using multiplexer.
15.	Design, build and test 4- bit Up/Down counter using IC 7493
Group D (Elective Paper 1)	
16.	UJT relaxation oscillator.
17.	Power control using TRIAC and DIAC.
18.	Regulated power supply using Zener Diode.
19.	Solar cell characterization.
20.	Characteristics of Varactor Diode.
Group D (Elective Paper 2)	
16.	Crystal Grown by Slow Evaporation Method / Precipitation Method.
17.	Study of Piezoelectric effect.
18.	Study of chemical Etching for Grown Crystal.
19.	Structural study of crystalline material by using XRD.
20.	Study of Thermal Properties of material from TGA graph.
Group D (Elective Paper 3)	
16.	Determine the linear, quadratic and cubic spline for given data set.
17.	Solve the system of linear equations using matrix inversion with LU decomposition.

18.	Solve differential equation using the Picard's method.
19.	Solve differential equation using the Runge-Kutta method.
20.	Solve heat conduction problem using Crank-Nicolson formula.
Group D (Elective Paper 4)	
16.	Study of the characteristics of a GM tube and determination of its operating voltage, plateau length/slope etc.
17.	To find the dead time of GM tube using single source method.
18.	To determine the dead time of GM tube using double source method.
19.	To study energy resolution characteristics of a scintillation spectrometer as a function of applied high voltage and to determine the best operating voltage.
20.	To study Cs-137 spectrum and to calculate FWHM and determine resolution of a given scintillation detector.

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Course Name	PH-416:Skill based course-Measurement and Industrial Instrumentation
Course Code	PH-416
Course Type	Skill based course
Course Outcome (CO)	(1) Post completion of the course, student boost their skill for utilization of equipments. (2) Student will acquire basic understanding and concept of measurement. (3) Student would know the usage of various measuring instruments.

Course Content	
Unit 1	<u>Measurement System and Analysis:</u> The Functional elements of an Instrument, Input Output configuration of measuring instruments and instrument systems. Dynamic characteristic: Generalized mathematical model of measurement system. Operational transfer function. Sinusoidal transfer function. Zero, first and second order instruments, frequency, ramp and step responses of first and second order instruments.
Unit 2	<u>Industrial Instrumentation:</u> Pressure measurement: Dynamics response consideration, Bourdon tube pressure gage. Diaphragm and Bellows gages. Transducer: The variable resistance transducer, The Linear Variable Differential Transformer (LVDT), Capacitive Transducer, Piezoelectric transducer, Photoelectric effect, Photoconductive transducer, Strain gauge transducer. Digital Displacement transducers, Flow measurement: Introduction, Flow obstructions methods, Hot wire and hot film anemometers. Magnetic flowmeters, Laser Doppler anemometer.

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Reference Books

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| 1. | Measurement Systems: E. O. Döbelin, McGraw Hill. |
| 2. | Experimental Methods for Engineers: J. P. Holman (7 th Ed) McGraw Hill. |

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भारत 2023 INDIA

SYLLABUS

for

MASTER OF SCIENCE (M.Sc.)

PHYSICS

(To be implemented from June-2023)



**VEER NARMAD SOUTH GUJARAT UNIVERSITY,
UDHNA MAGDALLA ROAD,
SURAT-395007. (GUJARAT)**

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Structure for MSc Physics – Semester - II							
Course Type	Course Code	Course Name	Teaching hours/week	Credit	Internal Marks	External Marks	Total Marks
Core	PH-421	Quantum Mechanics I	04	04	30	70	100
	PH-422	Solid State and Condensed Matter Physics	04	04	30	70	100
	PH-423	Classical Electrodynamics and Plasma Physics	04	04	30	70	100
Elective (Any one course can be taken)	PH-424	Elective 1: Electronic Communication	04	04	30	70	100
		Elective 2: Thin Film Technology and Non Destructive Testing	04	04	30	70	100
		Elective 3: Numerical Techniques and Fortran Programing	04	04	30	70	100
		Elective 4: Nuclear and Particle Physics	04	04	30	70	100
	PH-425	Practical	12	06	50	100	150
Skill based course	PH-426	Electronic and Biomedical Instrumentation	02	02	20	30	50
Total			30	24	190	410	600



Course Name	PH-421: Quantum Mechanics I
Course Code	PH-421
Course Type	Core
Course Outcome (CO)	<p>(1) By studying this course students will be able to learn advanced level of conceptual and numerical problems in quantum mechanics.</p> <p>(2) Students will be proficient in the basic mathematical tools and matrix representation involved in solving quantum mechanics.</p> <p>(3) Students will be able to understand the basic postulates of quantum mechanics.</p> <p>(4) Students will be studied the application of the Schrödinger equation to one-dimensional problems.</p> <p>(5) Student will be able to apply angular momenta formalism to examine various properties of angular momentum and also to determine eigen values and eigenvectors of spin and orbital angular momentum.</p>

Course Content	
Unit 1	<p><u>Mathematical Tools of Quantum Mechanics:</u> The Hilbert Space and Wave Functions: The Linear Vector Space, The Hilbert Space, Dimension and Basis of a Vector Space, Square-Integrable Functions: Wave Functions, Dirac Notation, Operators: General Definitions, Hermitian Adjoint, Projection Operators, Commutator Algebra, Uncertainty Relation between Two Operators, Functions of Operators, Inverse and Unitary Operators, Eigenvalues and Eigenvectors of an Operator, Infinitesimal and Finite Unitary Transformations, Representation in Discrete Bases: Matrix Representation of Kets, Bras, and Operators, Change of Bases and Unitary Transformations, Matrix Representation of the Eigen value Problem, Representation in Continuous Bases: General Treatment, Position Representation, Momentum Representation, Connecting the Position and Momentum Representations, Parity Operator, Matrix and Wave Mechanics: Matrix Mechanics, Wave Mechanics.</p>
Unit 2	<p><u>Postulates of Quantum Mechanics:</u> The Basic Postulates of Quantum Mechanics, The State of a System: Probability Density, The Superposition Principle, Observables and Operators, Measurement in Quantum Mechanics: How Measurements Disturb Systems, Expectation Values, Complete Sets of Commuting Operators (CSCO), Measurement and the Uncertainty Relations, Time Evolution of the System's State: Time Evolution Operator, Stationary States: Time-Independent Potentials, Schrödinger Equation and Wave Packets, The Conservation of Probability, Time Evolution of Expectation Values, Symmetries and Conservation Laws: Infinitesimal Unitary Transformations, Finite Unitary Transformations, Symmetries and Conservation Laws, Connecting Quantum to Classical Mechanics: Poisson Brackets and Commutators, The Ehrenfest Theorem, Quantum Mechanics and Classical Mechanics.</p>
Unit 3	<p><u>One-Dimensional Problems:</u> Properties of One-Dimensional Motion: Discrete Spectrum (Bound States), Continuous Spectrum (Unbound States), Mixed Spectrum, Symmetric Potentials and Parity, The Free Particle: Continuous States, The Potential Step, The Potential Barrier and Well: The Case $E > V_0$, The Case $E < V_0$, The Tunneling Effect, The Infinite Square Well Potential: The Asymmetric Square Well, The Symmetric</p>

	Potential Well, The Finite Square Well Potential: The Scattering Solutions ($E > V_0$), The Bound State Solutions ($0 < E < V_0$), The Harmonic Oscillator: Energy Eigen values, Energy Eigen states, Energy Eigen states in Position Space, The Matrix Representation of Various Operators, Expectation Values of Various Operators, Numerical Solution of the Schrödinger Equation: Numerical Procedure, Algorithm
Unit 4	<u>Angular Momentum:</u> Orbital Angular Momentum, General Formalism of Angular Momentum, Matrix Representation of Angular Momentum, Geometrical Representation of Angular Momentum, Spin Angular Momentum: Experimental Evidence of the Spin, General Theory of Spin, Spin 1/2 and the Pauli Matrices, Eigen functions of Orbital Angular Momentum: Eigen functions and Eigen values of L_z , Eigen functions of L^2 , Properties of the Spherical Harmonics.

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

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Course Name	PH-422: Solid State and Condensed Matter Physics
Course Code	PH-422
Course Type	Core
Course Outcome (CO)	<p>(1) Post completion of the course, student will understand why different materials have different properties.</p> <p>(2) At the end of the course, students will be able to differentiate the 'Perfect' and 'Imperfect' materials and also the role of imperfection in their applications.</p> <p>(3) Students will be able to understand about basic properties of materials like Magnetism, Colour centres and Anisotropy etc.</p> <p>(4) After finishing this course, students understand the importance of organic crystals in technological development and industries.</p> <p>(5) Student will be able to understand starchier – property- performance relationship.</p>

Course Content	
Unit 1	<u>Crystal Structure:</u> Crystal, Single Crystal, Poly Crystals, Amorphous, Importance of Single Crystal, Applications of Single Crystal, Crystal Structure, Crystal Structure determination- Bragg's law. Experimental methods of X-Ray Diffraction, Reciprocal Lattice.
Unit 2	<u>Imperfections in Solids:</u> Perfect and Imperfect Crystals, Point Imperfection, Concentration of Point Imperfection, Line Imperfections, Berger Vector and Berger circuit, Presence of Dislocations, Energy of a Dislocation, Slip Planes and Slip Directions, Surface Imperfections, Effect of Crystal Imperfections.
Unit 3	<u>Properties of Solids:</u> Classification of Magnetic Materials, Dia, Para, and Ferro magnetic materials and their theory, Anti Ferro magnetism, Ferri magnetism, Hard and Soft magnetic materials. Photoconductivity, Photovoltaic Effect, Photoluminescence, Colour Centres, Types of Colour Centres, Generation of Colour Centres, Anisotropic properties of Materials.
Unit 4	<u>Free Electrons in Crystal and Organic Crystal:</u> Three dimensional Potential Well, The Density of states, Effect of Temperature on Fermi Distribution Function, The Electronic Specific Heat, Conductivity and Resistivity of Metals, Hall effect, Materials and Solid State Chemistry: Introduction, Amorphous Semiconductor, Liquid Crystal Polymers. Dielectric, Piezoelectric and Ferro electric properties.

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Reference Books	
1.	Solid State Physics: Structure and Properties of Material: M. A. Wahab, (3 rd Ed.), Narosa Publishing House, 2015.
2.	Solid State Physics: K. Ilangovan C., MJP Publishers, 2013.
3.	Solid State Physics, Solid State Devices and Electronics: C.M. Kachhava , New Age International Publishers.
4.	Solid State Physics : Neil W. Ashcroft, N. David Mermin Harcourt Asia Pvt. Ltd., 2001.

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Course Name	PH-423: Classical Electrodynamics and Plasma Physics
Course Code	PH-423
Course Type	Core
Course Outcome (CO)	<p>(1) The students will study multipole expansions, scalar and vector potentials and gauge transformations.</p> <p>(2) The students will learn about electromagnetic waves in different media, their absorption and dispersion and they will be introduced to wave guides.</p> <p>(3) The students will have in depth study of electromagnetic radiation.</p> <p>(4) The students will learn about plasma and its properties, establish magneto hydrodynamic equations, pinch effect and instabilities of plasma.</p>

Course Content

Unit 1	<p><u>Multipole Expansion, Potentials and Fields:</u> Multipole expansions for a localised charge distribution in free space, linear quadrupole potential and field, static electric and magnetic fields in material media, Boundary conditions, Scalar and vector potentials, Gauge transformations, Coulomb and Lorentz gauge, Retarded potentials and Lienard-Wiechert potentials.</p>
Unit 2	<p><u>Electromagnetic Waves:</u> Waves in One Dimension: The Wave equation, Sinusoidal waves, Boundary conditions: Reflection and Transmission, Polarization, Electromagnetic Waves in Vacuum: The Wave Equation for \mathbf{E} and \mathbf{B}, Monochromatic plane waves, Energy and momentum in electromagnetic waves, Electromagnetic Waves in Matter: Propagation in Linear Media, Reflection and Transmission at Normal Incidence, Reflection and Transmission at Oblique Incidence, Absorption and Dispersion: Electromagnetic Waves in Conductors, Reflection at a Conducting Surface, The Frequency Dependence of Permittivity, Wave Guides: Waves in a Rectangular Wave Guide.</p>
Unit 3	<p><u>Radiation:</u> Introduction of radiation, electric dipole radiation, magnetic dipole radiation, radiation from an arbitrary source, power radiated by a point charge, radiation reaction, radiation from external sources, electric dipole radiations, magnetic dipole and electrical quadrupole radiation, centre-fed linear antenna, Hertzian dipole antenna, Rayleigh scattering at long wavelength and blueness of sky, scalar diffraction theory.</p>
Unit 4	<p><u>Plasma Physics and Magneto-Hydrodynamics:</u> Introduction of plasma physics and magneto-hydrodynamics, magneto-hydrodynamic equations, magnetic diffusion, viscosity and pressure, magneto-hydrodynamic flow between boundaries with crossed electric and magnetic fields.</p>

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Reference Books	
1.	Classical Electrodynamics: J. D. Jackson, Wiley Eastern Ltd., 1975.
2.	Introduction to Electrodynamics: David J. Griffiths, PHI, 2002.
3.	Electromagnetics: B. B. Laud, New Age International Publication, 2006.
4.	Electrodynamics :Gupta, Kumar and Singh, Pragati Prakashan, 2014.
5.	Classical Electrodynamics: Griener, Springer Vaelag, New York, 1998.

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Course Name	PH-424: Elective 1-Electronic Communication
Course Code	PH-424
Course Type	Elective 1
Course Outcome (CO)	<ol style="list-style-type: none"> (1) At the end of the course, the students will be able to understand in depth how the analog and digital electronic communication systems work. (2) Students are familiar with signal analysis (Fourier techniques) and basic understanding of probability theory and variables. (3) The objective is to introduce basic techniques used in amplitude modulation systems and to offer fundamental tools and methodologies workout in analysis and design of said systems. (4) Generalized treatment of angle modulation is provided so the students will be able to differentiate Amplitude modulation-Frequency modulation and Frequency modulation-Phase modulation. (5) Students are familiar with various aspects of digital data transmission with most of the discussion is allied to the binary case. Students would be realize how digital system is more powerful tool compared to analog system.

Course Content

Unit 1	<p><u>Fourier transform and Probability:</u> Sampling function, Response of a linear system, Normalized power, Normalized power in a Fourier expansion, Power spectral density, Effect of transfer function on power spectral density, Fourier transform, Examples of Fourier transform, Convolution, Parseval's theorem, Correlation between waveforms, Autocorrelation, Autocorrelation of a periodic waveform, Autocorrelation of non-periodic waveform of finite energy, Concept of Probability, Random variables: Conditional Probabilities, Cumulative distribution function, and Probability density function.</p>
Unit 2	<p><u>Random Processes and Amplitude Modulation:</u> Random processes, Classification of Random processes, Mean, correlation and covariance functions, Ergodic Processes, Central limit theorem. Amplitude modulation: Double sideband suppressed carrier AM, Modulators: Multiplier modulator, Non linear modulator, Switching modulator, Demodulation of DSB-SC Signals. Conventional amplitude modulation (AM), Sideband and carrier power, Generation of AM signals, Demodulation of AM signals, Amplitude modulation: Single side band (SSB), Time domain representation of SSB signals, Generation of SSB signal, Demodulation of SSB signals. Amplitude modulation: Vestigial side band modulation (VSB), Use of VSB in broadcast television, Comparison of various amplitude modulation systems.</p>
Unit 3	<p><u>Angle modulation and Noise:</u> Angle modulation, Concept of instantaneous frequency, generalized concept of angle modulation, Wideband FM (WBFM), Generation of FM waves: Indirect method of Armstrong, Direct generation: Parameter variation method, Phase locked loop, Analysis of phase locked loop, Stereophonic FM broadcasting, Comparisons: Frequency and phase modulation, Frequency and Amplitude modulation, External and internal noise, Noise calculations, Noise figure, Noise temperature.</p>

Unit 4	<p><u>Digital Communication:</u> Comparison of Analog and digital communication systems, Sampling theorem: low pass signals, Pulse amplitude modulation, other forms of pulse modulation, Time division multiplexing, Quantization of signals, Quantization error, Pulse code modulation, PCM system, Non uniform quantization, Compandor, Differential PCM: analysis of DPCM, Signal to noise ratio improvement, Delta modulation, Threshold of coding and overloading, Adaptive Delta modulation and output signal to noise ratio. Digital carrier schemes: Frequency shift keying (FSK): FSK bit rate and Baud, FSK transmitter and receiver, Bandwidth considerations of FSK, Phase shift keying: Binary PSK transmitter and receiver, Bandwidth considerations of BPSK, M-ary encoding, Differential Phase shift keying (DPSK).</p>
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Reference Books	
1.	Principles of communication systems: H. Taub and D. L. Schilling, (3 rd Ed.), McGraw-Hill. 1986.
2.	Modern Digital and Analog communication systems: B. P. Lathi, (3 rd Ed.), Oxford University Press, 1998.
3.	Electronic communication systems: G. Kennedy, (3 rd Ed.), McGraw-Hill, 1998.
4.	Electronic communications: D. Roddy and J. Coolen, (2 nd Ed.), PHI, 1981.
5.	Advanced Electronic Communications systems: W. Tomasi, (5 th Ed.), PHI, 2003.
6.	Fundamentals of communication systems: J. G. Proakis and M. Salehi, Pearson Education, 2005.
7.	Digital and Analog communication systems: K. Samshanmugum, John Wiley & Sons, 1979.
8.	Communication Systems: S. Haykin, (4 th Ed.), John Wiley & Sons, 1979.
9.	Radio Engineering :G. K. Mithal, Applied Electronics Vol. II, 1987.

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Course Name	PH-424: Elective 2-Thin Film Technology and Non Destructive Testing
Course Code	PH-424
Course Type	Elective 2
Course Outcome (CO)	<ol style="list-style-type: none"> (1) Fundamentals and principles of vacuum and thin film technology are understood by students. (2) The thin film preparation and characterization brief description of the devices in a cohesive manner with the impetus provided for industrial applications and recognized globally research and development work doing smoothly. (3) The emphasis knowledge of thin film technology gives a brief physical basis of technical description offers state of art in various thin film devices applications. (4) The knowledge of practical non-destructive testing is the requirement to understand the capabilities and advantages of non-destructive testing (NDT), non-destructive evaluation (NDE) and non-destructive inspection. Its knowledge benefits to developing the importance and material method systems for process control management and applications.

Course Content

Unit 1	<p><u>Vacuum Science and Vacuum Technology:</u> Introduction: Vacuum characterization and unit of vacuum, Classification of vacuum range and pumps, characterization of good vacuum pumps, Production of vacuum: Rotary pump, Molecular Drag and Turbo-molecular pump, Diffusion pump, Sorption pump, Thermodynamics of adsorption, typical sorbents used in vacuum technology, construction and action of Sorption pump, Gettering and ion pumping. Pressure measurement in vacuum systems: Classification of Vacuum gauges, Mechanical gauges: Diaphragm, McLeod gauge, Thermal conductivity gauge, Hot and cold cathode ionization gauge, Bayard-Alpert Gauge, History, applications and scope of vacuum science and technology.</p>
Unit 2	<p><u>Thin Film Technology:</u> Introduction: Thin and thick films processing and technology, Advantages and applications of thin films. Thin films growth process, Thin film deposition process, Physical vapour deposition (PVD): Thermal evaporations, Sputtering Yield, Sputtering systems: DC diode Sputtering, RF diode Sputtering, Magnetron Sputtering, Ion beam Sputtering, ECR plasma Sputtering, Electron beam evaporation, Pulsed Laser deposition (PLD). Chemical vapour deposition (CVD) process: Decomposition reactions, Reduction reactions, Chemical transport reactions and polymerization. Major advantages of CVD, Spray Pyrolysis and Spin Coating systems.</p>
Unit 3	<p><u>Thin Film Characterization:</u> Deposition rate and thickness measurement(insitu and exsitu) methods, Quartz crystal monitor, Ellipsometry. Electrical, Optical and Mechanical properties of thin films, Sheet resistivity and temperature coefficient measurement, Antireflection and reflection coating, Interference filters and band pass filters. Applications of thin films: Optoelectronic applications, Photon detectors, Photovoltaic devices (Thin Film solar cell). Thin film passive components: Electrical behaviour of metal film, Dielectric behaviour of insulators film,</p>

	Resistors, Capacitors and Inductors, Thin film diode, Surface Acoustic wave (SAW) devices, Charged coupled devices.
Unit 4	Non-Destructive Testing(NDT): Introduction: Comparison of destructive and non-destructive test, The basic principles, applications, advantages and limitations of important NDT methods, Visual inspection: Optical aids used for visual inspection: Microscope, Borescope, Endoscope, Flexible fiber-optic Borescope, Telescope, Liquid penetrate testing, Magnetic particle testing, Ultrasonic testing. Acoustic emission testing, Insitu metallographic examination, Statistical method for quality control.

Reference Books	
1.	Hand book of Vacuum Technology: Willey-VCH Verlag Gmbh & Co. KGaA, 1986.
2.	Hand Book of Thin Film Technology: L. I. Maissel and R. Glang , McGraw-Hill, 1983.
3.	Thin Film Phenomena: K. L. Chopra, McGraw – Hill, 1969.
4.	Preparation of Thin Films: Joy George, Marcelloekker, 1992.
5.	Vacuum Science and Technology: V.V. Rao, I.B. Ghosh and K. L. Chopra Allied Publications Limited.
6.	Thin Film Device Applications: K.L. Chopra and I. Kaur, Plenum Press, 1983.
7.	Practical Non-Destructive Testing: Baldev Raj, T. Jayakumar, M. Thavasimuthu, Narosa Publishing House, 2009.

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Course Name	PH-424 Elective 3: Numerical Techniques and Fortran Programing
Course Code	PH-424
Course Type	Elective 3
Course Outcome (CO)	<p>(1) Students will able to use numerical techniques to solve and simulate physical problem using Fortran Language.</p> <p>(2) Students are able to perform curve fitting using various techniques.</p> <p>(3) Students are able to perform differentiation and integration using various numerical techniques.</p> <p>(4) Students are able to understand Fortran programing.</p> <p>(5) Students are able to construct the Fortran program for various numerical methods.</p>

Course Content	
Unit 1	<u>Least Square Fit:</u> Introduction, Least Squares Curve Fitting Procedures, Fitting a Straight Line, Multiple Linear Least Squares, Linearization of Nonlinear Laws, Curve Fitting by Polynomials, Curve Fitting by a Sum of Exponentials, Weighted Least Squares Approximation, Linear Weighted Least Squares Approximation, Nonlinear Weighted Least Squares Approximation.
Unit 2	<u>Numerical Differentiation and Integration:</u> Introduction, Numerical Differentiation, Errors in Numerical Differentiation, Cubic Splines Method, Differentiation Formulae with Function Values, Maximum and Minimum Values of a Tabulated Function, Numerical Integration, Trapezoidal Rule, Simpson's 1/3-Rule, Simpson's 3/8-Rule, Boole's and Weddle's Rules, Use of Cubic Splines, Romberg Integration, Newton-Cotes Integration Formulae, Euler-Maclaurin Formula, Numerical Integration with Different Step Sizes, Gaussian Integration, Generalized Quadrature, Numerical Calculation of Fourier Integrals, Numerical Double Integration.
Unit 3	<u>FORTRAN Language:</u> Numeric Constants and Variables, Arithmetic Expressions, List-Directed Input Statements, List-Directed Output Statements, Conditional Statements, Relational Operators, The Block IF Construct, Example Programs Using IF Structures Implementing Loops in Programs, The Block DO loop, Count Controlled DO Loop, Rules to be followed in Writing DO Loop, Logical Expressions and More Control Statements.
Unit 4	<u>FORTRAN Programming:</u> Functions and Subroutines: Basics, Defining and Manipulating Arrays, Elementary Format Specifications, Procedure with Array Arguments, Processing files in Fortran, creating a sequential files, Array Operation with mask, FOR ALL Statement. Least Squares Curve Fitting, integration, roots of equations, matrix diagonalization, solution of differential equations. Good programming practices.

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Reference Books	
1.	COMPUTER PROGRAMMING IN FORTRAN 90 AND 95: V. Rajaraman, PHI Learning Private Limited, 2013.
2.	Introductory Methods of Numerical Analysis: S. S. Sastry, fifth edition, PHI Learning Private Limited, 2012.
3.	Computer Oriented Numerical Methods: V. Rajaraman, fourth edition, PHI Learning Private Limited, 2018.
4.	Numerical Methods for Scientists and Engineers: K. S. Rao. Third edition PHI Learning Private Limited, 2006.
5.	Numerical Methods for Math., Science and Engineering: J. H. Mathews, Prentice Hall, 1992.
6.	Programming and computing with FORTRAN 77-90: P.S. Grover, first edition, Allied publishers, 1990.

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Course Name	PH-424 Elective 4: Nuclear and Particle Physics
Course Code	PH-424
Course Type	Elective 4
Course Outcome (CO)	<p>(1) The students will learn some nuclear properties and properties of nuclear forces.</p> <p>(2) The students will be able to study experimental methods of determining some of the nuclear properties.</p> <p>(3) The students will be introduced to different nuclear models, their specifications and applications and their limitations.</p> <p>(4) The students will learn about the sources of elementary particles, classification of fundamental particles and study their various properties.</p>

Course Content	
Unit 1	<p><u>Basics of Nuclear Physics:</u> Brief history: Developments in nuclear and particle physics, fundamental interactions, Nuclear properties: Nuclear mass and binding energy, nuclear spin and parity, magnetic dipole moment, electric quadrupole moment, isospin, Properties of the nuclear forces: The interaction between two nucleons consists to lowest order, the nucleon-nucleon interaction is strongly spin dependent, the inter-nucleon potential includes a non-central term, known as a tensor potential, the nucleon-nucleon force is charge symmetric, the nucleon-nucleon force is nearly charge independent, the nucleon-nucleon interaction becomes repulsive at short distances, the nucleon-nucleon interaction may also depend on the relative velocity or momentum of the nucleons.</p>
Unit 2	<p><u>Determination of Some Nuclear Properties:</u> Measurement of nuclear spin and magnetic moment: hyperfine splitting of the atomic energy levels, hyperfine splitting, nuclear spin from Zeeman effect of hyperfine lines, isotope effect, nuclear spin and statistics from molecular spectra, atomic beam method of nuclear magnetic moment determination (non-resonance method), magnetic resonance method of Rabi, magnetic resonance absorption method of measuring nuclear magnetic moment, electron paramagnetic resonance, nuclear induction method, microwave spectroscopy method, determination of the electric quadrupole moments of nuclei.</p>
Unit 3	<p><u>Nuclear Models:</u> Nuclear models, liquid drop model, Bethe-Weizsacker formula, applications of the semi-empirical binding energy formula, Fermi gas model of the nucleus, nuclear shell structure, single particle states in the nuclei, spin-orbit interaction, applications of extreme single particle shell model, nuclear spin, nuclear magnetic moments, islands of isomerism, quadrupole moments of nuclei, single particle shell model, individual particle model, collective model.</p>
Unit 4	<p><u>Particle Physics:</u> Introduction, productions of elementary particles, classification of particles, quanta of forces, matter particles, antiparticles, fermions, bosons, leptons, hadrons (mesons and baryons), their productions and decays, their properties, their mean-life times, quantum numbers, conservation laws.</p>

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

Ajay

Course Name	PH-425: Practical
Course Code	PH-425
Course Type	Core
Course Outcome (CO)	(1) After completion of the course, the students will be able to understand and evaluate various problems related to Quantum Mechanics. (2) Students are trained experimentally for theories related to solid state and condensed matter physics. (3) Students will be able to perform experiments of general physics

Course Content	
Group A	
1.	Study the hermiticity of given operator/commutator/matrix.
2.	Find the Eigen values and Eigen vectors of given matrix.
3.	Evaluate the given commutators.
4.	Solve time independent Schrödinger Equation for a given potential in one dimensional.
5.	Find the matrices representing the operators J^2 , J_x , J_y and J_z for a given value of j .
Group B	
6.	Measurement of Susceptibility of Liquid by Quinck's Methods.
7.	Study of Hall Effect.
8.	Lattice Dynamics.
9.	X-Ray Diffraction.
10.	Dia , Para and Ferromagnetism.
Group C	
11.	'e/m' by Helical Method.
12.	Measurement of Electrical Conductivity of Graphite.
13.	Measurement of Energy Band Gap of a Semiconductor.
14.	Determination of electron's charge 'Q', by using Milliken's Oil drop Method.
15.	Electrical Conductivity of a Semiconductor using Four Probe Method.
Group D (Elective Paper 1)	
16.	To design, build and test Band Pass Filter.
17.	To design, build and test Digital to Analog Converter.
18.	To design, build and test Analog to Digital Converter.
19.	Study of Delta Modulator and Adaptive Delta Modulator.
20.	Study of Time Division Multiplexing.
Group D (Elective Paper 2)	
16.	Preparation of thin film by Spin Coating unit.
17.	Speed of a vacuum pump.
18.	Liquid Penetrant testing.
19.	Curie temperature of Novel Metal.
20.	Fabrication of Aluminium thin film by thermal evaporation method.
Group D (Elective Paper 3)	
16.	Curve fitting by Least Square method.
17.	Numerical integration using Trapezoidal and Simpson 1/3 rule.
18.	Writing and Testing of FORTRAN program for Least Square fit.
19.	Writing and Testing of FORTRAN program for integration using Trapezoidal rule.
20.	Writing and Testing of FORTRAN program for integration using Simpson 1/3 rule.

Group D (Elective Paper 4)	
16.	To verify inverse square law for γ - rays.
17.	To study nuclear counting statistics.
18.	To study Co-60 spectrum and calculation of resolution of detector in terms of energy.
19.	To determine linear and mass absorption coefficients using Scintillation detector.
20.	To study energy calibration of gamma ray spectrometer (study of linearity).

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Course Name	PH-426:Skill based course-Electronic and Biomedical Instrumentation
Course Code	PH-426
Course Type	Skill based course
Course Outcome (CO)	(1) Student learn about basic of Electronics Instrumentations. (2) Student learn to use and operate morden electronic instrumentations. (3) Students can improve their skill to find the faults in an electronic system and solve it. (4) Student is able to guide and help instrument euroners for smooth operations of Electronic Instruments.

Course Content

Unit 1	<u>Electronic Instrumentation:</u> Signal Generation: Pulse and square wave generator, function generator, Oscilloscope: Oscilloscope block diagram, CRT circuits, Vertical deflection system, Delay line, Multiple trace, Horizontal deflection system, Oscilloscope probes and transducers. Digital Voltmeters: 3½-Digit DVM, Resolution and Sensitivity of Digital Meters General Specifications of DVM. Digital Instruments: Digital frequency meter, Digital multi-meter, Digital panel meter. Digital tachometer, Digital pH meter, Digital phase meter, Digital capacitance meter.
Unit 2	<u>Biomedical Instrumentation:</u> Introduction: Biopotential, Cardiovascular system, Electro Cardiogram (ECG), Blood pressure measuring instruments, Doppler Sonography, Computed Tomography imaging (CT scan, CAT scan), Magnetic Resonance imaging (MRI), Specialized MRI Scans, Biofeedback.

Reference Books

1.	Electronics Instrumentation and Measurement Techniques: W. D Cooper, PHI, New Delhi.
2.	Electronic Instrumentation: H.S. Kalsi, (3 rd Ed.) McGraw Hill.
3.	Electric and Electronic measurements and Instrumentation. (19 th Ed.), A.K.Sawhney, Dhanpat Rai & Co., 2016.

Kapoor
31/3/2023

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