PARVATHANENI BRAHMAYYA

SIDDHARTHA COLLEGE OF ARTS & SCIENCE

Siddhartha Nagar, VIJAYAWADA - 520 010, Andhra Pradesh

Autonomous, NAAC A+ Grade, ISO Certified Institution

NAAC - SSR IV CYCLE

M.Sc. PHYSICS

REGULATION 20

2020-22

PROGRAMME STRUCTURE &

SYLLABUS

Parvathaneni Brahmayya Siddhartha College of Arts & Science: Vijayawada-10.

(An Autonomous college in the jurisdiction of Krishna University)

Accredited at A+ grade by NAAC

2020 Batch M.Sc -Physics

List of Courses

C CODE	COURSE TITLE	CREDITS	TOTAL	CIA	SEE
	MAY -2021 FIRST SEMESTER				
20PH1T1	CLASSICAL MECHANICS	4	100	30	70
20PH1T2	MATHEMATICAL PHYSICS	4	100	30	70
20PH1T3	ATOMIC AND MOLECULAR SPECTROSCOPY	4	100	30	70
20PH1T4	ELECTRONICS	4	100	30	70
20PH1L1	GENERAL PHYSICS LAB-I	4	100	30	70
20PH1L2	ELECTRONICS LAB	4	100	30	70
	TOTAL	**24**	**600**	**180**	**420**
	OCTOBER-2021 SECOND SEMESTER				
20PH2T1	STATISTICAL MECHANICS	4	100	30	70
20PH2T2	QUANTUM MECHANCIS-I	4	100	30	70
20PH2T3	COMPUTATIONAL METHODS & PROGRAMMING	4	100	30	70
20PH2T4	SOLID STATE PHYSICS	4	100	30	70
20PH2L1	GENERAL PHYSICS LAB-II	4	100	30	70
20PH2L2	C-PROGRAMMING & MICROPROCESSOR LAB	4	100	30	70
20OE03	**DATA VISUALIZATION (OPEN ELECTIVE)**	**4**	**100**	**30**	**70**
	TOTAL	**24**	**600**	**180**	**420**

	MARCH-2022 THIRD SEMESTER				
20PH3T1	QUANTUM MECHANCIS-II	4	100	30	70
20PH3T2	ELECTROMAGNETIC THEORY, LASERS & MODERN OPTICS	4	100	30	70
20PH3T3	NUCLEAR AND PARTICLE PHYSICS	4	100	30	70
20PH3T4	CONDENSED MATTER PHYSICS-I	4	100	30	70
20PH3L1	ADVANCED PHYSICS & OPTICS LAB	4	100	30	70
20PH3L2	ELECTRONICS IC-VERSION LAB	4	100	30	70
20OE05	**ENGLISH PRESENTATION & SOFT SKILLS (OPEN ELECTIVE)**	**4**	**100**	**30**	**70**
	TOTAL	**24**	**600**	**180**	**420**
	JULY-2022 FOURTH SEMESTER				
20PH4T1	ANALYTICAL TECHNIQUES	4	100	30	70
20PH4T2	ADVANCES IN MATERIALS SCIENCE	4	100	30	70
20PH4T3	CONDENSED MATTER PHYSICS-II	4	100	30	70
20PH4L1	CONDENSED MATTER PHYSICS LAB	4	100	30	70
20PH4M1	THERMAL PHYSICS **(MOOCS)**	4	100	30	70
20PH4P1	PROJECT WORK (MID TERM REVIEW)- 2 FINAL EVALUATION - 6	8	200	50	150
	TOTAL	**28**	**700**	**200**	**500**

Lab - 1: GENERAL PHYSICS LAB – I

Offered to : M.Sc.(PHYSICS)	Course Code: 20PH1L1
Course Type : Core	Course: GENERAL PHYSICS LAB– I
Year of Introduction : 2004	Year of offering : 2020
Year of Revision : 2020	Percentage of Revision : 25%
Semester : I	Credits : 4

Course Description: Experiments of some basic phenomena are included in this course.

Course Objectives:

1. Learn the applications of semiconductor materials in devices.
2. Understand the need of solar energy for the societal needs toward pollution free power.
3. Apply knowledge to find out the velocity of sound waves in liquids.
4. Learn how the radiation transmits to surroundings from a source.
5. Will be able to handle various equipment in a proper and useful manner.

Course Outcomes: At the end of this course, students should be able to:

CO1: Understand the different concepts of physics through experiments.
CO2: Apply the theoretical concepts of semiconductors to the devices
CO3: Apply the concept of ultrasonics in different liquids to find out their densities and velocities.
CO4: Handle various equipment properly in useful manner
CO5: Analyze the results obtained from different experiments through graphical analysis.

CO - PO MATRIX								
	CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
20PH1L1	CO1		H				L	M
	CO2		M				L	M
	CO3		M				L	M
	CO4				L		L	M
	CO5		L				L	M

Syllabus
GENERAL PHYSICS LAB– I **(Minimum 10 experiments are to be done)** 1. Determination of wavelengths of the spectral lines of mercury spectrum using Hartmann'sdispersion formula-Grating 2. Determination of speed of sound in a liquid using ultrasonic interferometer 3. Characteristics of electromagnetic coils (a) by varying distance between the coils and(b) byvarying current 4. Measurement of band gap of semiconductor 5. Determination of dielectric constant of a liquid 6. Determination of Planck's constant using photodiode 7. Characteristics of LED 8. |B – H Curve 9. Thermo electric power 10. Heat Capacity of solids 11. Lechers wire experiment 12. Determination of the thickness of a thin wire using laser 13. Diffraction grating – determination of wavelength of laser. 14. Two Probe Method for Resistivity Measurement 15.Any two online virtual lab experiments with in the syllabus have to be carried out (usingMHRD web resource).

Reference Books:

1. Advanced practical physics Vol – I Dr. S. P. Singh
2. Advanced practical physics Vol II : DR. S.P. Singh
3. Practical Physics : Gupta, Kumar, Sharma
4. Practical Physics: P. R. Sasi Kumar
5.University Practical physics by D. C. Tayal
6. Viva – Voce in advanced physics : Gupta , Kumar, Sharma

Lab - 2: ELECTRONICS LAB

Offered to : M.Sc.(PHYSICS)	Course Code: 20PH1L2
Course Type : Core	Course: ELECTRONICS LAB
Year of Introduction : 2004	Year of offering : 2020
Year of Revision : 2020	Percentage of Revision : 80%
Semester : I	Credits : 4

Course Description: Circuits using Op-Amps and basic gates are included in the course.

Course Objectives:

1. Understand the connection between theory of different circuits and their experimentation.
2. Understand the characteristics of Op-Amps and transistors practically.
3. Understand the circuits constructed with Op-Amps and gain knowledge on applications of Op-Amps.
4. Understand the principles and theories of different circuits like amplifiers, multi-vibrators and oscillators.
5. Gain knowledge on applications of transistors and Op-Amps for the future work.

Course Outcomes: At the end of this course, students should be able to:

CO1: Apply the concepts of electronics for different circuits
CO2: Design different circuits using op-amp
CO3: Analyze the variation between theory and practical circuits.
CO4: Construct amplifiers with desired gain
CO5: Able to construct any digital circuit using basic gates.

CO - PO MATRIX								
20PH1L2	CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
	CO1		H				L	M
	CO2				M		L	M
	CO3			M			L	M
	CO4				M		L	M
	CO5				H		L	H

Syllabus

ELECTRONICS LAB

(Minimum 10 experiments are to be done)

1. Zener Diode as voltage Regulator
2. Verification of truth tables of various logic gates: AND, OR, NOR and NOT using NAND gateand NOT gate.
3. Construction and verification of the truth tables for De Morgan's theorems
4. Construction of half adder and full adder circuits and verification of their truth tables
5. Construction of multiplexer and de-multiplexer circuits and verification of their truth tables
6. Construction of Encoder and Decoder circuits
7. Verification of truth tables of R-S, J-K, flip-flops
8. R-C Phase shift oscillator
9. Astable Multivibrator using transistor.
10. Determination of practical op amp parameters
11. Wien's Bridge Oscillator.
12. JFET based amplifier.
13. UJT-Characteristics
14. Op amp with more than one input – Inverting and non-inverting configurations.
15. Any two online virtual lab experiments with in the syllabus have to be carried out (usingMHRD web resource).

1. Advanced practical physics Vol – I Dr. S. P. Singh
2. Advanced practical physics Vol II : DR. S.P. Singh
3. Practical Physics : Gupta, Kumar, Sharma

4. Practical Physics: P. R. Sasi Kumar
5.University Practical physics by D. C. Tayal
6. Viva – Voce in advanced physics : Gupta , Kumar, Sharma
7. Op-amps and Linear Integrated Circuits by Ramakanth Gayakwad

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Paper – 1: CLASSICAL MECHANICS

Offered to : M.Sc.(PHYSICS)	Course Code: 20PH1T1
Course Type : Core	Course: CLASSICAL MECHANICS
Year of Introduction : 2004	Year of offering : 2020
Year of Revision : 2020	Percentage of Revision : 50%
Semester : I	Credits : 4
Hours Taught : 60 hrs. per Semester	Max.Time : 3 Hours

Course Description: This course helps to understand the basic concepts behind the classical laws of physics and their mathematical formulation

Course Objectives:

1. To understand the Lagrangian equations for simple classical systems
2. To learn the concept of Hamiltonian mechanics for classical systems
3. To learn the Hamilton-Jacobi formalism of simple classical systems.
4. To understand the canonical transformations and passion bracket relations
5. To impart the methods of solving rigid body dynamics

Course Outcomes: At the end of this course, students should be able to:

CO1: Understand the concepts of Lagrangian formulation and can describe the motion of mechanical systems using Lagrangian formulation.
CO2: Apply the Hamilton formalism to solve problems.
CO3: Apply the concepts of canonical transformations and poission brackets formulation on physical systems
CO4: Understand the formulation of Hamilton-Jacobi equation.
CO5: Apply knowledge the concept of rigid body dynamics and rotating frames on different systems.

CO - PO MATRIX								
	CO-PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
20PH1T1	CO1	H					L	M
	CO2		H				L	M
	CO3		H				L	M
	CO4	H					L	M

	CO5		H				L	M

Syllabus		
Unit	**Learning Units**	**Lecture Hours**
I	**Newtonian Mechanics and Lagrangian mechanics** Newton's laws, Mechanics of a particle: Conservation laws, Mechanics of a system of particles: Conservation laws, Constraints, D'Alembert's principle and Lagrange's equations, Velocity Dependent potentials and the Dissipation function, L-C Circuit, Lagrangian for a Charged Particle Moving in an Electromagnetic field.	12
II	**Variational principles** Hamilton's principle, Deduction of Hamilton's equations from modified Hamilton principle, Derivation of Lagrange's equations from variational Hamilton's principle, Simple applications of the Hamilton principle Formulation-Simple pendulum, Principle of Least Action.	12
III	**Canonical transformations** Legendre transformations, Equations of canonical transformation, Examples of Canonical transformations, The harmonic Oscillator, Poisson brackets and other Canonical invariants, Equations of motion, Infinitesimal canonical transformations, and conservation theorems in the Poisson bracket formulation, the angular momentum Poisson bracket relations.	12
IV	**Hamilton – Jacobi Method** Hamilton – Jacobi equation of Hamilton's principal function, The Harmonic oscillator problem as an example of the Hamilton – Jacobi Method, Hamilton – Jacobi equation for Hamilton's characteristic function, Action – angle variables in systems of one degree of freedom.	12
V	**Dynamics of a rigid body** Independent coordinates of rigid body, The Euler angles, infinitesimal rotations as vectors (angular velocity), components of angular velocity, angular momentum and inertia tensor, principal moments of inertia, rotational kinetic energy of a rigid body, Symmetric bodies, Euler's equations of motion for a rigid body, Torque-free motion of a rigid body.	12

Reference Books:

1. Classical Mechanics, H.GOLDSTEIN (Addison Wesley) 2005.
2. Classical Mechanics, J. C.UPADHYAYA (Himalaya Publishing House) 2010.
3. Classical Mechanics, Gupta, Kumar and Sharma, Pragati Prakashan, 2001.
4. Classical Mechanics, G. Aruldass, PHI Learning Private Ltd, 2009.

Paper – 2: MATHEMATICAL PHYSICS

Offered to : M.Sc.(PHYSICS)	Course Code : 20PH1T2
Course Type : Core	Course : MATHEMATICAL PHYSICS
Year of Introduction : 2004	Year of offering : 2020
Year of Revision : 2020	Percentage of Revision : 20%
Semester : I	Credits : 4
Hours Taught : 60 hrs. per Semester	Max.Time : 3 Hours

Course Description: This course helps to learn various mathematical methods used in physics to solve problems.

Course Objectives:

1. To learn the special type of differential equations with their properties and their solutions.
2. To learn the fundamentals and applications of Laplace transformation
3. To understand the fundamentals and applications of Fourier transformation.
4. To understand the basic properties of complex functions and related theorem.
5. To learn the fundamentals and applications of Tensor analysis.

Course Outcomes: At the end of this course, students should be able to:

CO1: Understand the basic concepts of special functions and apply these functions to solve the solution of problems
CO2: Apply the concept of different transforms and applications in different fields.
CO3: Apply the concepts of Fourier series and its applications
CO4: Understand the basic concepts of complex analysis and evaluation of the contour integrals.
CO5: Understand the concept of tensor analysis.

CO - PO MATRIX								
	CO-PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
20PH1T2	CO1	H					L	M
	CO2		H				L	M
	CO3		H				L	M
	CO4	H					L	M
	CO5	H					L	M

Syllabus

Unit	Learning Units	Lecture Hours
I	**Special Functions** Beta and Gamma Functions – Definitions and properties – Evaluation of integrals- Legendre, Bessel, Hermite and Laguerre differential equations – Solutions - Generating functions, Orthogonal properties of Legendre, Bessel and Hermite Functions (Qualitatively) –Recurrence relations.	12
II	**Laplace Transforms** Definition and notation, Properties of Laplace transforms – First and Second shifting theorems - Change of scale property - Laplace transform of derivatives - Laplace transform of integral, Laplace transforms of Dirac delta function and Laplace transform of periodic functions (Square wave, saw tooth wave). Inverse Laplace transforms: Definition, Null function, Properties, Solution of linear differential equations with constant coefficients.	12
III	**Fourier Transforms** Fourier series: Evaluation of Fourier coefficients, Half range series, Uses of Fourier series.Fourier Transforms: Infinite Fourier transforms - Fourier sine and cosine transforms, Relationship between Fourier transform and Laplace transform, Properties of Fourier transform and Problems. Finite Fourier Transform - Fourier sine and cosine transforms, Fourier integral theorem.	12
IV	**Complex Variables** Complex numbers and their algebra, Variables and Functions – Complex differentiation - Analytic function - Cauchy – Reimann equations –Derivatives of elementary functions – Singular points and classification. Complex integration - Cauchy's integral theorem – Cauchy's integral formula – Taylor's and Laurent's theorem – Residues - calculations of Residues - Residue theorem –- evaluation of definite integrals.	12
V	**Tensor Analysis** Definition – Occurrence of tensors in physics – Notation and conventions - Contra variant vector - Covariant vector – Tensors of second rank (mixed tensors).The algebra of tensors: Equality and null tensor - Addition and subtraction of tensors - Outer product of tensors - Inner product of tensors – Contraction of a tensor - Symmetric and anti-symmetric tensors - Quotient law – Fundamental tensor.	12

Reference Books:

1. Special Functions, J.N. Sharma & R.K. Gupta (Krishna Prakashan Media (P) Ltd.)
2. Laplace and Fourier Transforms, J.K. GOYAL and K.P. GUPTA (Pragati Prakashan,

Meerut).
3. Mathematical Physics, B.D. GUPTA (Vikas Pub.House).
4. Complex Variables, MURRAY R. SPIEGEL (Schaum'sOutlines).
5. Matrices and Tensors in Physics, A.W. JOSHI (Wiley Eastern Ltd.).
6. GERD KEISEROptical Fiber Communications, TataMcGraw-HillBook, 2000

Paper – 3:ATOMICANDMOLECULARPHYSICS

Offered to : M.Sc.(PHYSICS)	Course Code : 20PH1T3
Course Type : Core	Course : ATOMIC AND MOLECULAR PHYSICS
Year of Introduction : 2020	Year of offering : 2020
Year of Revision : xxxxx	Percentage of Revision : xxxxx
Semester : I	Credits : 4
Hours Taught : 60 hrs. per Semester	Max.Time : 3 Hours

Course Description: This course gives theory of the basic concepts of atomic spectroscopy and molecular spectroscopy

Course Objectives:

1. To learn principles, instrumentation and applications of atomic absorption spectroscopy

2. To learn principles, instrumentation and applications of atomic emission spectroscopy

3. To understand the rotational motion of diatomic molecules and role of dipole moment in molecular spectroscopy

4. To learn the vibration rotation spectra of diatomic molecules

5. To learn the electronic spectroscopy of diatomic molecules

CourseOutcomes:

Attheendof thiscoursethestudentsshouldbeableto:

CO1: Understandtheprincipleandapplicationsofatomicabsorption,emissionspectrometer.

CO2: Apply the techniques of the atomic emission spectroscopy and flame photometry to the materials.

CO3: Apply the concept of rotational spectra to find the bond lengths of different molecules.

CO4: Understand the concept of vibrational spectra of different molecules.

CO5: Understand the electronic spectra of diatomic molecules.

CO - PO MATRIX								
	CO-PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
20PH1T3	CO1	H					L	M
	CO2		H				L	M

	CO3		H	H			L	M
	CO4	H					L	M
	CO5	H					L	M

Syllabus		
Unit	**Learning Units**	**Lecture Hours**
I	**Atomic Absorption Spectroscopy** Introduction – Principle – Differences between Atomic Absorption Spectroscopy and Flame Emission Spectroscopy– Advantages of Atomic Absorption Spectroscopy over Flame Emission Spectroscopy–Disadvantages of Atomic Absorption Spectroscopy–Instrumentation– Single and Double beam Atomic Absorption Spectroscopy––Applications of Atomic Absorption Spectroscopy.	12
II	**Atomic Emission Spectroscopy and Flame Photometry** Introduction – Theory of Emission Spectroscopy –Instrumentation –Spectrographs – Applications of Emission Spectroscopy– Advantages and Disadvantages of Emission Spectroscopy– principle and instrumentation of Inductively coupled plasma - atomic emission spectroscopy (ICP-AES) Principle and Instrumentation of Flame Photometry – Applications of Flame Photometry.	12
III	**Rotational Spectroscopy** Introduction – Classification of molecules – Rotational spectra of a diatomic molecule – rigid rotator – Isotopic effect in Rotational spectra–Intensity of rotational lines– non-rigid rotor – linear polyatomic molecules – Symmetric top molecules. Moment of Inertia and bond lengths of linear tri-atomic molecule– Microwave spectrometer. Applications of Rotational Spectroscopy - Microwave Oven.	12
IV	**Vibrational Spectroscopy** Introduction – Diatomic molecule as simple harmonic oscillator – Anharmonic oscillator – vibrating rotator - Energy levels and spectrum, Effect of isotopic substitution on vibrational bands, Sample handling techniques– FTIR spectroscopy – Principle – FTIR Spectrometer - Applications of vibrational spectroscopy	12
V	**Electronic Spectroscopy of Diatomic Molecules** Introduction– Vibrational coarse structure– Vibrational analysis of band systems: Deslandres table – Progressions and sequences information derived from vibrational analysis – Morse potential energy curve – Frank-Condon principle – Rotational fine structure of electronic vibranic spectra- FortratParabolae – Dissociation – Predissociation.	12

Text and Reference Books:

1. Atomic and Molecular Spectroscopy, GurdeepChatwal, Sharma Anand, Himalaya Publishing House

2. Molecular Structure and Spectroscopy, G. Aruldhas, Prentice- Hall of India, Pvt, New Delhi, (2014).

3. Fundamentals of Molecular Spectroscopy, C.N. BANWELL and E.M. McCASH (Tata McGraw-Hill - 2013).

4. Modern Spectroscopy, J.M. HOLLAS (John Wiley &Sons).

5. Molecular Spectroscopy, J.M. Brown, Oxford Science Publications, Oxford. (1998).

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Paper – 4 : ELECTRONICS

Offered to : M.Sc.(PHYSICS)	Course Code : 20PH1T4
Course Type : Core	Course : Electronics
Year of Introduction : 2004	Year of offering : 2020
Year of Revision : 2020	Percentage of Revision : 30%
Semester : I	Credits : 4
Hours Taught : 60 hrs. per Semester	Max.Time : 3 Hours

Course Description : From this course students learn the basics of opamp , their practical properties and applications. Basics of digital electronics and microprocessor are also covered in this course.

.**Course Objectives:**

1. To know the basic concepts of operational amplifier.

2. To understand the practical op-Amp circuits.

3. To understand the importance of communication electronics.

4. To learn the digital electronic circuits.

5. To learn the working of 8085 microprocessor.

Course Outcomes: At the end of this course, students should be able to:

CO1: Understand the concepts of differential amplifier.

CO2: Analyze the practical applications of Op-Am

CO3: Understand the process in communication electronics.

CO4: Understand the fundamentals of digital electronics.

CO5: Analyze the architecture of 8085 micro processor.

CO - PO MATRIX

	CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
20PH1T4	CO1	H					L	M
	CO2	L					L	M
	CO3	M					L	M
	CO4	H					L	M
	CO5	L					L	M

Syllabus		
Unit	**Learning Units**	**Lecture Hours**
I	**Operational Amplifiers** Differential Amplifier – circuit configurations –- DC analysis – Ac analysis, inverting and non-inverting inputs, CMRR, Block diagram of a typical Op-Amp-analysis. Op -Amp Architecture, Open loop configuration inverting and non-inverting amplifiers. Op-amp with negative feedback- voltage series feedback – effect of feedback on closed loop gain, input resistance, output resistance,- voltage follower.	12
II	**Practical Op-amps** Input offset voltage- input bias current-input offset current, total output offset voltage, CMRR frequency response. Summing amplifier, Scaling and Averaging amplifiers, integrator and differentiator. Oscillators principles – oscillator types –The phase shift oscillator, Wein bridge oscillator, LC tunable oscillators – Multivibrators- Monostable and astable –comparators – square wave and triangular wave generators-Voltage regulators.	12
III	**Communication Electronics** Introduction to communication system–Need for modulation – Amplitude modulation– Generation of AM waves – Demodulation of AM waves – DSBSC modulation. Generation of DSBSC waves. Coherent detection of DSBSC waves, SSB modulation, Generation and detection of SSB waves. Vestigial side band modulation, Frequency Division Multiplexing (FDM).	12
IV	**Digital Electronics** Combinational Logic gates- Decoder- encoders- Multiplexer (data selectors)-application of multiplexer - De multiplexer (data	12

	distributors), Sequential Logic gates- Flip-Flops; the R-S Flip – Flop, JK Flip-Flop –JK master slave Flip-Flops – T- Flip – Flop – D Flip – Flop , Registers; Buffer registers- Shift registers – synchronous and asynchronous counters, application of counter.	
V	**Microprocessors** Introduction to microcomputers – Input /Output devices – ALU, Timing and Control Unit – registers memory — Pin configuration Description-Architecture and its operations – Address and Data Busses – generating control signals – instruction set – addressing modes - assembly language Programs –looping, counting and indexing – counters and timing delays – stack and subroutine.	12

Text and Reference Books:

1. Op-Amps & Linear integrated circuits, RAMAKANTH A.GAYAKWAD (PHI).
2. Electronic Communication Systems, George Kennedy (PHI)
3. Semiconductor Electronics, A.K.SHARMA (New Age International Publishers).
4. Fundamentals of Digital Circuits, A. ANANDA KUMAR, (PHI).
5. Digital principles and applications, MALVINO AND LEECH (TMH).
6. Microprocessor Architecture, Programming and Applications with 8085/8086,

R. S.GAONKAR (Wiley Eastern).

7. Electronics: Analog and Digital, I.J. NAGARATH (PHI).

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Lab - 1: GENERAL PHYSICS LAB– II

Offered to : M.Sc.(PHYSICS)	Course Code: 20PH2L1
Course Type : Core	Course: GENERAL PHYSICS LAB– II
Year of Introduction : 2004	Year of offering : 2022
Year of Revision : 2022	Percentage of Revision : 50%
Semester : II	Credits : 4
Hours Taught : 60 hrs. per Semester	Max.Time : 3 Hours

Course Description : This course deals with the experiments using lasers, optical fiber and diffraction experiments in addition to some basic experiments in physics

Course Objectives:

1. To understand the properties of the Laser.
2. To analyze the applications of laser.
3. To observe the process of powder X- ray diffraction.
4. To understand the resistance dependence of magnetic field.
5. To analyze the properties of optical fiber.

Course Outcomes: At the end of this course, students should be able to:
CO1:Apply the principles of propagation of light in materials to different devices
CO2: Determine the refractive indices of different liquids
CO3 : understand and apply the phenomenon of double refraction
CO4 : Evaluate the crystal structure of materials from X ray diffraction pattern
CO5 : Understand the propagation of light in optical fiber.

CO - PO MATRIX								
	CO-PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
20PH2L1	CO1		H	L	M		L	M
	CO2			H	M		L	M
	CO3			H	M		L	M
	CO4			H	M		L	M
	CO5			H	L		L	M

Syllabus

PRACTICAL – III

GENERAL PHYSICS LAB– II

(20PH2L1)

(Minimum 10 experiments are to be done)

1. Determination of Thickness of wire using laser
2. Determination of wavelengths of the laser using grating.
3. Determination of refractive index of liquid using hallow Prism.
4. Double refraction.
5. Powder X-ray diffraction
6. I-V characteristics of solar cell.
7. Magneto Resistance.
8. Determination of numerical aperture of optical fiber.
9. Determination of Young's modulus.
10. Verification Amper's law.
11. DC Conductivity of ferrite material
12. Determination of elastic constants of glass (and Perspex) by Cornu's interference method
13. Determine the radius of curvature of the Plano-convex lens by using Newton's rings experiment
14. Determination of the size of the lycopodium particles by diffraction method using a) Spectrometer method and b) Young's method.
15. Any two online virtual lab experiments within the syllabus have to be carried out (using MHRD web resource).

Reference Books:

1. Advanced practical physics Vol – I Dr. S. P. Singh
2. Advanced practical physics Vol II : DR. S.P. Singh
3. Practical Physics : Gupta, Kumar, Sharma
4. Practical Physics: P. R. Sasi Kumar
5. University Practical physics by D. C. Tayal
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Lab - 2: C – PROGRAMMING AND MICROPROCESSOR LAB

Offered to : M.Sc.(PHYSICS)	Course Code: 20PH2L2
Course Type : Core	Course: C – programming and microprocessor lab
Year of Introduction : 2004	Year of offering : 2020
Year of Revision : 2020	Percentage of Revision : 100%
Semester : II	Credits : 3
Hours Taught: 60 hrs. per Semester	Max.Time : 3 Hours

Course Description: In this course, students execute different programs on computer system and some microprocessor programs on 8085 microprocessor kit.

Course Objectives:

1. To make the student learn a programming language.
2. To teach programming skills
3. To make the students learn to write Cprograms for different problems.
4. To introduce the basic concept of microprocessor.
5. To develop programming skill in microprocessor programming

Course Outcomes: At the end of this course, students should be able to:
CO1: Solve problems through programming.
CO2: Identify situations where computational methods and computers are useful.
CO3: Write a program on a computer, edit, compile, debug, correct, recompile and run it.
CO4: Understand the architecture of 8085 microprocessor and learn its instruction set.
CO5: Develop assembly language programming skills and performs arithmetic and logical operations on a 8085 microprocessor kit.

CO - PO MATRIX

	CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
20PH2L2	CO1		H	M	M		L	M
	CO2		H	M	M		L	M
	CO3				H		L	M
	CO4		H	H	M		L	M
	CO5			H	H		L	M

Syllabus

PRACTICAL – IV: 20PH2L2

C – PROGRAMMING AND MICROPROCESSOR

(Minimum 10 experiments are to be done)

1. Program for the addition of two 8 bit numbers by using Microprocessor 8085
2. Program for subtraction of two 8 bit numbers by using Microprocessor 8085
3. Program for multiplication of two 8 bit numbers by using Microprocessor 8085
4. Program for division of two 8 bit numbers by using Microprocessor 8085
5. Microprocessor 8085 program for conversion of value
6. C Program to find number of odd and even numbers in given list of numbers
7. Write a C program for the multiplication of two matrices using arrays
8. Write a C program for the Newton-Raphson method with necessary algorithm.
9. Write a C Program for Trapezoidal Rule
10. C programs for Simpsons 1/3Rule.
11. C programs for Euler's Method
12. C programs for Solution of first order differential equations using the Runge - Kutta method
13. C programs for Numerical integration using the Simpson's method
14. C programs for Bisection Method
15. Any two online virtual lab experiments with in the syllabus have to be carried out (usingMHRD web resource).

Text and Reference Books:

1. S.S. SASTRY, Introductory methods of Numerical Analysis (PHI).
2. E. BALAGURUSAMY, Numerical Methods (McGrawHill).
3. BYRON S. GOTTFRIED , Programming with (Schaum'sOutlines).
4. E. BALAGURUSAMY, Programming in ANSI C (TataMcGraw-Hill).
5. Microprocessor Architecture, Programming and Applications with 8085/8086, R. S.GAONKAR (Wiley Eastern).

Paper – 1: STATISTICAL MECHANICS

Offered to : M.Sc.(PHYSICS)	Course Code: 20PH2T1
Course Type : Core	Course: Statistical Mechanics
Year of Introduction : 2004	Year of offering : 2020
Year of Revision : 2020	Percentage of Revision : 50%
Semester : II	Credits : 4
Hours Taught : 60 hrs. per Semester	Max.Time : 3 Hours

Course Description: Statistical Mechanics is a mathematical framework that applies statistical methods and probability theory to large assemblies of microscopic entities. It does not assume or postulate any natural laws, but explains the macroscopic behavior of the nature from the behavior of such ensembles

Course Objectives:

1. Understand the basic concepts of statistical mechanics ,phase space and ensembles
2. Understand theorems and applying conclusions to specific problems related to large group of particles
3. Understand the ensembles and partition function
4. Understand the particle distributions and applications .
5. Apply statistical laws to the stellar object and particles to understand the evolution of universe and to study the properties of matter

Course Outcomes: At the end of this course, students should be able to:

CO1 : Understand the basic concepts of statistical mechanics.
CO2 : Understand theorems of statistical mechanics.
CO3 : Understand the ensembles and partition function.
CO4 : Understand the particle distributions and applications.
CO5 : Apply statistical laws to the stellar object and particles.

CO - PO MATRIX								
	CO-PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
20PH2T1	CO1	H					L	M
	CO2	H					L	M
	CO3	H					L	M
	CO4	H	M				L	M
	CO5		H	M			L	M

Syllabus

Unit	Learning Units	Lecture Hours
I	**Unit-I: Basics of Classical Statistical Mechanics** Introduction, Microstates and Macro states, Phase space, Volume in Phase space, Ensembles- Types of Ensembles, Ensemble average, Liouvilles theorem, Conservation of extension in phase, Equation of motion and Liouville theorem, Equal a prior probability, statistical equilibrium.	12
II	**Unit-II: Canonical and Grand Canonical Ensembles** Micro canonical ensemble – Ideal gas in micro canonical ensemble, Gibbs paradox, Canonical ensemble - Ideal gas in canonical ensemble, Grand canonical ensemble - Ideal gas in grand canonical ensemble, Comparison of various ensembles. Equipartition theorem.	12
III	**Unit-III: Partition functions** Canonical partition function, Molecular partition function, Translational partition function, Rotational partition function, Vibrational partition function, Electronic and Nuclear partition function, Application of rotational partition function, Application of vibrational partition function to solids.	12
IV	**UNIT IV: Ideal Bose -Einstein Gas** Bose-Einstein distribution, Bose-Einstein condensation, thermodynamic properties of an Ideal Bose-Einstein gas, liquid helium, Two-fluid model of liquid Helium II, Super fluid phases of ^{3}He.	12
V	**UNIT V: Ideal Fermi-Dirac Gas** Fermi-Dirac distribution, Degeneracy, electrons in metals, Thermionic emission, Magnetic susceptibility of free electrons, White Dwarfs, Nuclear Matter.	12

Reference Books:

1. S. LOKANADHAN and R.S. GAMBHIR , Statistical and Thermal Physics, (PHI).
2. S.K. SINHA, Statistical Mechanics: Theory and Applications, (Tata Mc Graw-Hill).
3. GUPTA AND KUMAR , Statistical Mechanics, (Pragati Prakashan, Meerut).
4. F.REIF , Fundamentals of statistical and Thermal Physics, (Waveland Press, Inc.).
5. K. HUANG , Statistical Mechanics, (John Wiley &Sons).

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Paper – 2: QUANTUM MECHANICS – I

Offered to : M.Sc.(PHYSICS)	Course Code: 20PH2T2
Course Type : Core	Course: Quantum Mechanics - I
Year of Introduction : 2004	Year of offering : 2022
Year of Revision : 2022	Percentage of Revision : 20%
Semester : II	Credits : 4
Hours Taught : 60 hrs. per Semester	Max.Time : 3 Hours

Course Description : Quantum mechanics I describes the physical systems at the scale of atoms and subatomic particles. It is the foundation of all quantum physics including quantum chemistry, quantum field theory, quantum technology, and quantum information science

Course Objectives:

1. To connect the historical development of quantum mechanics with previous knowledge and learn the basic properties of quantum world.
2. To learn different concepts in mathematics applied to physics
3. To apply Schrodinger wave equation for various physical systems.
4. To understand time independent perturbation theory
5. To understand time dependent perturbation theory

Course Outcomes: At the end of this course, students should be able to:
CO1: Apply principles of quantum mechanics to calculate wave functions.
CO2: Solve time independent & time dependent Schrodinger wave equation for simple potentials.
CO3: Apply the required mathematical concepts in Physics
CO4: Solve problems with perturbations
CO5: Apply the concepts of quantum mechanics in other areas

CO - PO MATRIX								
	CO-PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
20PH2T2	CO1	H					L	M
	CO2	H					L	M
	CO3		H				L	M
	CO4	H	M				L	M
	CO5		H	M			L	M

Syllabus		
Unit	**Learning Units**	**Lecture Hours**
I	**Schrodinger wave equation and potential problems in one dimension** Inadequacy of classical mechanics, Necessity of quantum mechanics, Postulates of Quantum Mechanics, Physical interpretation of the wave function, Normalized and orthogonal wave functions, (i) Time independent Schrödinger equation (iii) Time dependent Schrödinger equation, Expectation values of dynamical quantities, Continuity equation, Ehrenfest theorem, Stationary states, ***One - dimensional problems**:* Particle in a box, Potential step, Rectangular potential barrier, Linear Harmonic oscillator by Schrodinger equation.	12
II	**Linear Vector spaces and Operators** Linear Vector Space, Hilbert space, Linear operators: Momentum Operator, Hamiltonian Operator, Hermitian operators and their properties, Parity Operator, Projection Operator, Inverse and Unitary Operators, Eigen values and Eigen functions of an Operator, Dirac's Bra and Ket notations, Uncertainty relation between two operators, Commutator algebra.	12
III	**Equation of motion and Identical Particles** Equation of motion in Schrodinger's picture and Heisenberg's picture, Correspondence between the two, Correspondence with classical mechanics, Application of Heisenberg's picture to Harmonic oscillator, The indistinguishability of identical particles, Symmetric and antisymmetric wave functions, Creation, Annihilation operators and their properties.	12
IV	**Time-independent perturbation** Time-independent perturbation theory: Non-degenerate perturbation theory - evaluation of first order perturbation and second order perturbation - Ground state of Helium atom. Degenerate perturbation theory-Effect of electric field on the n=2 state of Hydrogen (Stark effect in Hydrogen), Variation method - ground state of Helium atom, WKB approximation method. Validity of WKB method.	12
V	**Time dependent perturbation** Introduction, Time - dependent perturbation: General perturbations, variation of constants, and transition into closely spaced levels – Fermi's Golden rule, Interaction of an atom with the electromagnetic radiation, Absorption and emission of radiation, Einstein transition probabilities, Sudden and adiabatic approximation.	12

Text and Reference Books:

1. N. ZETTILI , Quantum mechanics Concepts and Applications, (John Wiley &Sons).
2. G. Aruldhas, Quantum Mechanics
3. D.J. Griffith , Quantum Mechanics, Prentice Hall
4. R.D. RATNA RAJU , Foundations of Quantum Mechanics, (I.K. Int PubHouse).
5. L.I. SCHIFF , Quantum Mechanics, (McGraw-Hill).
6. E. MERZBECHER , Quantum Mechanics, (Wiley).
7. P.M. MATHEWS, K.VENKATESAN , A text book of Quantum Mechanics, (Tata McGraw–Hill).

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Paper – 3: COMPUTATIONAL METHODS AND PROGRAMMING

Offered to : M.Sc.(PHYSICS)	Course Code: 20PH2T3
Course Type : Core	Course: Computational methods and programming
Year of Introduction : 2004	Year of offering : 2020
Year of Revision : 2020	Percentage of Revision : Nil
Semester : II	Credits : 4
Hours Taught : 60 hrs. per Semester	Max.Time : 3 Hours

Course Description: Computational Methods brings to light the numerous uses of numerical methods in engineering. It clearly explains the application of these methods mathematically and practically, emphasizing programming aspects when appropriate.

Course Objectives:

1. To understand the fundamentals of C- language.
2. To improve the Programming skills.
3. To understand the importance and applications of Arrays.
4. To understand various numerical methods used in computation and C- programming.
5. To solve simple problems pertaining to Physics using these methods.

Course Outcomes: At the end of this course, students should be able to:

CO1: Understand the concepts of fundamentals of data types and operators.
CO2: Understand the concepts of I/O statements and control statements.
CO3: Understand the concepts of Arrays.
CO4: Solve the mathematical as well as numerical computations problems by different methods.
CO5: Understand the importance and accuracy of errors and accuracy of the numerical calculations and its practical implementation in the measurements.

CO - PO MATRIX

	CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
20PH2T3	CO1	H					L	M
	CO2	H					L	M
	CO3	H					L	M
	CO4		H				L	M
	CO5	H	L				L	M

Syllabus		
Unit	**Learning Units**	**Lecture Hours**
I	**Fundamentals and Operators** **Fundamentals of C Language**: C character set-Identifiers and Keywords- Constants-Variables- Data types-Declarations of variables – Declaration of storage class - Defining symbolic constants –Assignment statement. **Operators**: Arithmetic operators-Relational Operators-Logic Operators-Assignment operators- Increment and decrement operators –Conditional operators.	12
II	**Expressions, I/O and Control Statements** **Expressions and I/O Statements:** Arithmetic expressions –Precedence of arithmetic operators- Type converters in expressions –Mathematical (Library) functions –Data input and output-The getchar and putchar functions –Scanf – Printf-Simple programs. **Control statements:** If-Else statements –Switch statements-The operators –GO TO –While, Do-While, FOR statements-BREAK and CONTINUE statements.	12
III	**Arrays and User Defined Functions** **Arrays:** One dimensional and two dimensional arrays –Initialization –Type declaration -Inputting and outputting of data for arrays –Programs of matrices addition, subtraction and Multiplication **User Defined Functions:** The form of C functions –Return values and their types – Calling a function – Category of functions. Nesting of functions. Recursion. ANSI C functions-Function declaration.	12
IV	**Linear, Nonlinear and Simultaneous Equations** **Linear and Nonlinear Equations**: Solution of Algebra and transcendental equations-Bisection, False position and Newton-Raphson methods-Basic principles-Formulae-algorithms **Simultaneous Equations**: Solutions of simultaneous linear equations - Gauss elimination and Gauss Seidel iterative methods-Basic principles-Formulae-Algorithms	12
V	**Interpolations, Numerical Differentiation and Integration** **Interpolations:** Concept of linear interpolation-Finite differences-Newton's and Lagrange's interpolation formulae-principles and Algorithms **Numerical Differentiation and Integration:** Numerical differentiation-algorithm for evaluation of first order derivatives using formulae based on Taylor's series-Numerical integration- Trapezoidal and Simpson's 1/3rule-Formulae-Algorithms	12

Text and Reference Books:

1. S.S. SASTRY, Introductory methods of Numerical Analysis (PHI).
2. E. BALAGURUSAMY, Numerical Methods (McGrawHill).
3. BYRON S. GOTTFRIED , Programming with (Schaum'sOutlines).
4. E. BALAGURUSAMY, Programming in ANSI C (TataMcGraw-Hill).

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Paper – 4: SOLID STATE PHYSICS

Offered to : M.Sc.(PHYSICS)	Course Code: 20PH2T4
Course Type : Core	Course: Solid State Physics
Year of Introduction : 2004	Year of offering : 2020
Year of Revision : 2020	Percentage of Revision : Nil
Semester : II	Credits : 4
Hours Taught : 60 hrs. per Semester	Max.Time : 3 Hours

Course Description : In solid state physics the student studies how the large-scale properties of solid materials result from their atomic-scale properties and forms a theoretical basis of materials science.

Course Objectives:

1. To understand the basic theory of structure and composition of the solid.
2. To understand the properties of the crystalline materials.
3. To learn the concepts of reciprocal lattice and Brillouin zone schemes.
4. To Understand the effet of magnetic and electric field on the crystalline materials.
5. To enhance the ability of students to understand electron and band theories.

Course Outcomes: At the end of this course, students should be able to:
CO1: Remember the basic concepts of translation vectors, lattices, symmetry operations, lattice types and simple crystal structures.
CO2: Understand the experimental diffraction methods, reciprocal lattice and Brillouin zones
CO3: Understand the properties of the free electron gas.
CO4: Understand the concepts of Fermi levels and quantization of orbits in magnetic fields.
CO5: Understand the concepts of band gap and various electronics models in solids.

CO - PO MATRIX								
	CO-PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
20PH2T4	CO1	H					L	M
	CO2	H					L	M
	CO3	H			M		L	M
	CO4	H			M		L	M
	CO5	H			M		L	M

Syllabus		
Unit	**Learning Units**	**Lecture Hours**
I	**Introduction to crystallography** Periodic array of atoms- Lattice translation vectors, Basis and the Crystal Structure, Primitive Lattice cell, Fundamental types of lattices-Two Dimensional lattice types, three Dimensional lattice types- Index system for crystal planes- simple crystal structures; sodium chloride- cesium chloride – Hexagonal Close Packed Structure - Diamond Structure- Zinc Sulfide structure	12
II	**Crystal Diffraction and Reciprocal Lattice** Bragg's law, scattered wave amplitude-Reciprocal Lattice vectors-Diffraction conditions-Laue Equations, Brillouin Zones - Reciprocal lattice to SC lattice, BCC lattice and FCC lattices, properties of reciprocal lattice, geometrical structure factor- BCC lattice and FCC lattices, atomic form factor.	12
III	**Free Electron Fermi Gas** Energy levels in one-dimension, Free electron gas in 3 dimensions, Heat capacity of the electron gas- Experimental heat capacity of metals, electrical conductivity and Ohms law – experimental electrical resistivity of metals, Motion in Magnetic Fields, Hall effect, thermal conductivity of metals - Ratio of thermal to electrical conductivity- Widemann Franz ratio.	12
IV	**Fermi Surfaces of Metals** Reduced zone scheme - periodic Zone schemes- Construction of Fermi surfaces- Electron orbits, hole orbits and open orbits, Experimental methods in Fermi surface studies – Quantization of orbits in a magnetic field, De-Hass-van Alphen Effect, extremal orbits, Fermi surface of Copper. Fermi surface of gold, Magnetic breakdown.	12
V	**Band Theory of Solids** Failure of free electron theory of metals, Nearly free electron model-Origin of the energy gap- The Bloch theorem- Kronig-Penney Model, wave equation of electron in a periodic potential distinction between metals, insulators and intrinsic semiconductors, Effective mass of electron-Crystal momentum of an electron-Approximate solution near a zone boundary.	12

Reference Books:

1. A.J. DEKKER , Solid State Physics, (Macmillan).
2. CHARLES KITTEL , Introduction to Solid State Physics, (John Wiley & Sons).
3. M.A Wahab, Solid state physics, structure and properties of the Materials
4. GUPTA and KUMAR, Solid State Physics, (K. Nath & Co.)
5. S. O Pillai, Solid state physics, (NEW AGE.)

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Paper – 5: INTRODUCTION TO NANOMATERIALS SCIENCE (Open Elective)

Offered to : M.Sc.(PHYSICS)	Course Code: 20PH2T5
Course Type : Core	Course: Introduction to nanomaterials science (Open elective)
Year of Introduction : 2020	Year of offering : 2020
Year of Revision : 2020	Percentage of Revision : Nil
Semester : II	Credits : 4
Hours Taught: 60 hrs. per Semester	Max.Time : 3 Hours

Course Description : Introduction to Nanomaterials course is a broad and interdisciplinary one, which describes the different physical and chemical methods for synthesis of different nanostructures and their characterization through various tools and their applications in diverse fields.

Course Objectives:
1. To understand the structure of nanomaterials.
2. To understand the chemical synthesis of nanomaterials
3. To learn the physical methods of preparation of nanomaterials.
4. To Understand the applications of nano carbons.
5. To learn the thenano device fabrication.

Course Outcomes: At the end of this course, students should be able to:
CO1: Explain the size and shape dependent properties of nano particles and change in their functional properties.
CO2:Synthesizenano particles by some physical methods
CO3:Synthesizenano particles by some chemical methods
CO4:Fabricate the nanodevice structures using nanocarbon and use them for different applications
CO5: Fabricate the device structures using lithographic techniques

CO - PO MATRIX								
	CO-PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
20PH2T5	CO1	H					M	L
	CO2	H					M	L
	CO3	H					M	L
	CO4	H					H	L
	CO5	H					H	L

Syllabus		
Unit	**Learning Units**	**Lecture Hours**
I	**Introduction to Nanomaterials** Introduction and origin of Nanomaterials – Zero, One and Two dimensional Nanomaterials Quantum confinement, Density of states, Dependence of dimensionality - Physical and chemical properties. (CO1)	12
II	**Synthesis of Nanomaterials - Chemical Methods** Introduction to Bottom-up and Top-down approaches Sol-Gel Process– Self-assembly – Electrodeposition – Spray Pyrolysis– Flame Pyrolysis–Metal Nanocrystals by Reduction–Solvothermal Synthesis– Photochemical Synthesis–Combustion Method–Chemical Vapor Deposition(CVD) (CO2)	12
III	**Synthesis of Nanomaterials- Physical Methods** Ball Milling – Inert Gas Condensation Technique (IGCT)–Thermal evaporation–Pulsed Laser Deposition (PLD) – Sputtering – Molecular Beam Epitaxy (MBE) Microlithography– Etching. (CO3)	12
IV	**Nano-Carbon** Carbon molecules and carbon bond - C60: Discovery, Synthesis and structure of C60 - Superconductivity in C60 - Carbon nanotubes: Fabrication – Structure – Electrical properties – Vibrational properties – Mechanical properties – Applications (fuel cells, chemical sensors, catalysts). (CO4)	12
V	**Nano Devices** Introduction – Nanofabrication – Photo-Lithography – Pattern transfer –Introduction to MEMS - Single Electron Transistor – Solar Cells –Dye sensitized solar cells - Light Emitting diodes – Gas Sensors – Microbatteries- Field emission display devices – Fuel Cells. (CO5)	12

Reference Books:

1. A.S.Edelstein and R.C.Cammarata ,Nanomaterials: Synthesis, Properties and Applications, Institute of Physics Publishing, 2002.
2. Charles P.Poole Jr and FrantJ.Owens , Introudction to Nanotechnology –, Wiley Interscience, 2003.
3. Gunter SchmidNanopracticles from Theory to Applications, Wiley VCH, 2004.
4. T.Pradeep et al.,. ,Nanoscience and Nanotechnology (Tata McGraw Hill, New Delhi, 2012)

ADVANCEDPHYSICS&OPTICS LAB

Offered to : M.Sc.(PHYSICS)	Course Code : 20PH3L1
Course Type: Core	Course: ADVANCEDPHYSICS&OPTICS LAB
Year of Introduction : 2004	Year of offering : 2020
Year of Revision : 2020	Percentage of Revision : 50%
Semester : III	Credits : 3
Hours Taught: 60 hrs. per Semester	Max.Time : 3 Hours

Course Description:
In this course student do different experiments based on optical phenomena and some advanced concepts.

CourseObjectives:
1. Tounderstandthevariousmagneticmaterialproperties.
2. Tolearntheelectricaland opticalpropertiesofthesemiconductormaterials.
3. Toobservetheprocessofnucleardisintegrationofradioactivematerials.
4. Tounderstandthethermalpropertiesofdifferentmaterials.
5. Tolearnthethe formationofdifferent spectra.

Course Outcomes: At the end of this course, students should be able to:

CO1: Understand the different concepts of physics through experiments.
CO2: To apply the concepts of condensed mater physics to understand the properties of different materials
CO3: Determine the value of g using the concept of ESR
CO4: Determine the operating voltage of GM counter and dead time of a nuclear sample.
CO5: To analyse the results obtained from different experiments through graphical analysis.

CO-POMATRIX								
	CO-PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
20PH3L1	**CO1**	H					L	M
	CO2		H				L	M
	CO3			H	L		L	M
	CO4			H	L		L	M
	CO5			H	L		L	M

Syllabus

PRACTICAL–V

ADVANCEDPHYSICS&OPTICS(20PH3L1)

(Minimum10experimentsaretobedone)

1. DeterminationofRydbergconstantusingmercuryspectrum.
2. Determinationofwavelengthsofthespectrallinesofmercury spectrum usingHartmann'sdispersionformula-Prism.
3. Electronsspinresonances.
4. DeterminationofCauchy'sconstantsusingPrism.
5. Viscosity ofaliquidby oscillatingdiscmethod.
6. CharacteristiccurveofGMcounter.
7. DeterminationofCurietemperature.
8. StudyofLaserdiffraction.
9. Coefficientoflinearexpansions
10. Fourieranalysis.
11. Non-DestructiveTesting–Ultrasonic
12. Comparison ofthe experimental and Theoretical frequencies of band gaps of mono-atomicand diatomiclattices.
13. Opticalabsorptioncoefficientofsolutions
14. AnalysisofRamanspectrum.
15. Studyofinterferenceoflight(biprismorwedgefilm)
16. Anytwoonlinevirtuallabexperimentswithinthesyllabushavetobecarriedout(usingMHRDwebresource).

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ELECTRONICSIC –VERSION LAB

Offered to : M.Sc.(PHYSICS)	Course Code : 20PH3L2
Course Type: Core(P)	Course: ElectronicsIC–Version Lab
Year of Introduction : 2004	Year of offering : 2020
Year of Revision : 2020	Percentage of Revision : 60%
Semester : III	Credits : 4
Hours Taught: 60 hrs. per Semester	Max.Time : 3 Hours

Course Description:
In this course, students design different circuits learnt in the theory using IC741 op amp and basic gates

CourseObjectives:
1. TounderstandtheconstructionofvariouscircuitsusingIC's.
2. TolearntheconstructionandworkingofIC-741indifferentcircuits.
3. TolearntheconstructionandworkingofIC-5551in variouscircuits.
4. Tounderstandthefrequencyresponseofvariousfilters.
5. Tounderstandtheworking ofwave formgenerators.

CourseOutcomes: Attheendofthiscourse,studentsshouldbeableto:
CO1: Design integrator, differentiator circuits using op amp.
CO2: Design different oscillators using op amp.
CO3: Construct filters using opamp
CO4: Apply the concepts of different circuits in various devices
CO5: Analyse different characteristic graphs and frequency responses of different circuits

CO-POMATRIX								
	CO-PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
20PH3L2	**CO1**			H	M		L	M
	CO2			H	M		L	M
	CO3			H	M		L	M
	CO4		H				L	M
	CO5			H			L	M

Syllabus
PRACTICAL – VI:(22PH3L2) **ELECTRONICSIC–Version** **(Minimum10experimentsaretobedone)** 1. RectangularwavegeneratorusingIC555 2. AstablemultivibratorusingIC555 3. IC555timer–SchmittTrigger 4. IC741timer–SchmittTrigger 5. Twin-Toscillator 6. Colpittsoscillator 7. IntegratorusingIC741 8. Differentiatorusing IC741 9. Wien bridge oscillator using IC741 10. 10.Voltagefollower 11. LowPassFilter 12. HighPassFilter 13. Bandpass filter usingIC74114.TriangularwavegeneratorusingIC741 15.Anytwoonlinevirtuallabexperimentswithinthesyllabushave tobecarrieout(using MHRDwebresource).

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QUANTUMMECHANICS–II

Offered to : M.Sc.(PHYSICS)	Course Code : 20PH3T1
Course Type : Core	Course : QUANTUMMECHANICS-II
Year of Introduction : 2004	Year of offering : 2020
Year of Revision : 2020	Percentage of Revision : 100%
Semester : III	Credits : 4
Hours Taught: 60 hrs. per Semester	Max.Time : 3 Hours

CourseDescription: Quantum Mechanics - II is a second course in quantum theory leads from quantum basics to basic quantum field theory, and lays the foundation for research-oriented concepts. This course is aimed to give insights on angular momentum, basic concepts of scattering cross-section & amplitude and to solve simple problems on scattering besides relativistic quantum physics

CourseObjectives:

1. Toapplytheformalismtostudytheorbitalangularmomentumconcept
2. Toapplytheformalismtostudythespinandtotalangularmomentumconcept
3. Tolearnthescattering processesofdifferent problems
4. Tolearntheformalismofrelativisticquantummechanics
5. TolearncovaianceofDirac'sequationunderdifferenttransformations

Course Outcomes : At the end of this course, students should be able to:

CO1: Analyze the problems related to orbital angular momentum
CO2: Analyze the problems related to spin and total angular momentum
CO3: Understand different scattering problems
CO4: Analyze and compare Klein Gordan theory and Dirac's theory
CO5: Understand the concept of covariance under different transformations.

CO-POMATRIX								
	CO-PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
20PH3T1	**CO1**	H					L	M
	CO2	H					L	M
	CO3		H				L	M
	CO4	H	M				L	M
	CO5		H	M			L	M

Syllabus		
Unit	**LearningUnits**	**Lecture Hours**
I	**Orbitalangularmomentum** Introduction, Orbital Angular momentum, commutation relations for angularmomentum operator. Ladder operators, Angular Momentum in spherical polarcoordinates, Eigen valueproblem for L^2 and L_Z, Eigen value problem for L+andL- operators,EigenvaluesandEigenfunctionsofRigidrotatorand Hydrogenatom.	12
II	**SpinandTotalAngularMomentum** Spinangularmomentum,Pauli'sexclusionprincipleandconnectionwithstatistical mechanics, Pauli spin matrices for electron, Commutation relations,Paulioperators,Paulieigenvaluesandeigenfunctions,TotalangularmomentumJ,Commutationrelationsoftotalangularmomentumwithcomponents.EigenvaluesofJ^{2}andJ$_Z$,EigenvaluesofJ$_+$andJ-,Explicit matricesforJ,J$_X$,Jy&J$_Z$.	12
III	**ScatteringTheory** Scattering cross section, scattering amplitude, Partial waves, Scattering by acentral potential: Partial wave analysis, significant number of partial waves,Scatteringbyanattractivesquarewellpotential,scatteringlength,Bornapproximation–Criteria for the validityofBornapproximation. Scatteringduetoscreenedcoulombpotential,Formfactor,Opticaltheorem, Lowenergylimit.	12
IV	**Relativisticquantummechanics** Klein-Gordonequation-continuityequation(probabilityandcurrentdensity), Klein-Gordonequation in the presence of electromagnetic field, Diracequation for a free particle,Diracmatrices-properties probability and currentdensity,Diracequationinpresenceofelectromagneticfield,Constantsofmotion–Linearmomentum–Totalangularmomentum (existenceofelectronspin), Velocityoperator, Helicityoperator, Zitterbewegungoperator.	12
V	**Covariantnotation** Covariantnotation,covarianceofDiracequation,InvarianceofDiracequationunder Lorentztransformation,PurerotationandLorentztransformation,Chargeconjugation,Holetheory,Projectionoperatorsforenergyandspin, Diracequationfor Zeromassandspinhalfparticles.	12

ReferenceBooks:

1 N.ZETTILI,Quantummechanics:ConceptsandApplications,(JohnWiley&Sons).
2 S.L. KAKANI and H. MCHANDALIA, Quantum Mechanics: Theory & Problems,SultanChand&Sons.2004
3 R.K.PRASAD,QuantumChemistry,NewAgeInternational(P)Limited,PublishersSecondedition,2002
4 G.ARULDHAS,QuantumMechanics,PrenticeHallof IndiaPrivateLimited,2002

ELECTROMAGNETIC THEORY, LASERS & MODERN OPTICS

Offered to : M.Sc.(PHYSICS)	Course Code : 20PH3T2
Course Type : Core	Course : Electro magnetic theory, Lasers & modern optics
Year of Introduction : 2004	Year of offering : 2020
Year of Revision : 2020	Percentage of Revision : 40%
Semester : III	Credits : 4
Hours Taught: 60 hrs. per Semester	Max.Time : 3 Hours

CourseDescription: Electromagnetic Theory, Lasers and Modern Optics course is designed to review the fundamentals and applications of electromagnetic field theory, understand all Maxwell's equation in time varying field and their role in solving the problems related to electromagnetics, provides an insight on the principles of lasers, modern optics and their applications in various areas of science and industry.

CourseObjectives:

1. Understanding of the importance of Maxwell's equations in solving practicalelectromagneticfieldproblems.
2. Learn about the fields produced by stationary and moving charge charged systems and propagation of electromagneticfields.
3. To understand the fundamentals of lasers, different types of lasers and applications.
4. To introduce the students to the basics of holography and non linear optics
5. To introduce the students the concept of optical fibre

Course Outcomes : At the end of this course, students should be able to:
CO1: Remember the concepts of Maxwell's equations.
CO2: Understand the concept of retarded potentials in electromagnetic fields..
CO3: Analyse the different LASER systems.
CO4: Understand the fundamentals of non linear optics and holography.
CO5: Understand the applications of various optical fibers.

CO-POMATRIX								
	CO-PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
20PH3T2	**CO1**	H					L	M
	CO2	H					L	M
	CO3	H					L	M
	CO4	H					L	M
	CO5	H					L	M

Syllabus		
Unit	**LearningUnits**	**Lecture Hours**
I	Electromagnetic waves Maxwell's equations in differential and integral forms, Electromagnetic waves in vacuum, Plane waves in non-conducting media: Energy flux in a plane wave, radiation pressure and momentum, plane waves in conducting media, the skin effect, Reflection and refraction of plane waves at a plane interface- Fresnel's laws; Reflection from the surface of a metal.	12
II	Electromagnetic radiation Retarded potentials, Radiation from an Oscillating Dipole, Linear Antenna, Lienard-Wiechert potentials, Potentials for a charge in uniform motion-Lorentz formula, radiation from an acceleration charged particle at low velocity- Larmor formula, radiation from a charged particle moving in a circular orbit, Electric quadrupole radiation	12
III	Principles of Lasers Introduction, Laser beam properties, Einstein coefficients, population inversion, Laser pumping- rate equations for two and three level systems, Threshold condition, laser systems –Argon ion gas laser, Dye laser, Nd: YAG laser, Semiconductor laser, Applications oflasers.	12
IV	Nonlinear Optics and Holography Basic Principles- Harmonic generation – Second harmonic generation- Phase matching – Third Harmonic generation-Optical mixing –Parametric generation of light –Parametric light oscillator-Frequency up conversion-Self focusing of light. Introduction to Holography-Basic theory of Holography-Recording and reconstruction of Hologram-Distinguish between Holography and Photography-Diffuse object illumination- Speckle pattern – Applications of Holography.	12
V	FiberOptics Fiber Optics : Introduction – total internal refraction –optical fiber modes and configurations - fiber types – rays and modes- Step index fiber structures – ray optics representation - wave equations for step indexed fibers – modal equation – modes in step indexed fibers – power flow in step indexedfibers. Graded indexed fiber structure: Structure – Numerical aperture and modes in graded index fibers-Signal degradation in optical fibers.	12

Text and Reference Books:

1. Electromagnetics, B.B. LAUD (New AgeInternationalPublishers)
2. Introduction to Electrodynamics, D.J. Griffiths (PearsonAddisonWesley)
3. Electromagnetic theory and Electrodynamics, SATYAPRAKASH (KNRNEd.Pub.)
4. Laser and Non-Linear Optics, B.B. LAUD (New AgeInternationalPublishers)
5. Introduction to Modern Optics, GRANT R. FOWLES (Dover PubInc.).
6. Lasers and their Applications, M.J. BEESLEY (TaylorandFrancis).
7. Optical Fiber Communications, GERD KEISER (TataMcGraw-HillBook).

NUCLEAR AND PARTICLE PHYSICS

Offered to : M.Sc.(PHYSICS)	Course Code : 20PH3T3
Course Type : Core	Course : Nuclear and particle physics
Year of Introduction : 2004	Year of offering : 2020
Year of Revision : 2020	Percentage of Revision : 100%
Semester : III	Credits : 4
Hours Taught: 60 hrs. per Semester	Max.Time : 3 Hours

CourseDescription:
Nuclearand Particle Physics course describesthe structure ofnuclei—theirformation,stability, and decay. It aims to understand the fundamental nuclear forces in nature, their symmetries, andthe resulting complex interactions between protons and neutrons in nuclei and among quarks insidehadrons, including the proton

Course Objectives:

1. To know the basic properties of nucleus and their properties.
2. To visualize the nuclear characteristics through different nuclearmodels.
3. To understand nuclear reactions in nuclear reactors for generation of nuclearenergy.
4. To learn classification of elementary particles and gain knowledge on basic concepts of particle physics.
5. To demonstrate the mechanism of particle accelerators and creation of novelparticles.

Course Outcomes: At the end of this course, students should be able to:

CO1: Remember the concepts of fundamentals of nuclear physics including nuclear forces, nuclear models,nuclear reactions and reactors, fundamentals of particle physics and Particle Accelerators.
CO2: Understand the characteristics of nuclear forces and the different nuclear model tocalculate the radioactivity decayprocess.
CO3: Understand the process in nuclear reactors for generation of energy.
CO4: Understand the fundamentals of particle physics.
CO5: Analyze the particle accelerators technologies and their role as nuclear medicine and Detectortechnologies.

CO-POMATRIX								
	CO-PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
20PH3T3	**CO1**	M					L	M
	CO2	H					L	M
	CO3	H					L	M
	CO4	H					L	M
	CO5		H	M			L	M

Syllabus		
Unit	**LearningUnits**	**Lectur eHour s**
I	**Introduction and Nuclear Forces** **Introduction**: Objective of studying Nuclear Physics, Nomenclature, nuclear radius, Mass & Binding energy, Angular momentum, Magnetic dipole moment, Electric quadrupole moment, parity and symmetry, Domains of instability, Energy levels, Mirror nuclei. **Nuclear Forces:** Characteristics of Nuclear Forces- Ground state of deuteron, scattering cross - sections, qualitative discussion of neutron-proton scattering at low energies – charge independence, spin dependence and charge symmetry of nuclear forces – exchange forces and tensor forces – Meson theory of nuclear forces (Yukawa's Potential).	12
II	**Nuclear Models and Nuclear Decay** **Nuclear Models:** Weizsacker's semi-empirical mass formula - mass parabolas- Liquid drop model - Bohr–Wheeler theory of nuclear fission – Nuclear shell model: magic numbers, spin-orbit interaction, prediction of angular momenta and parities for ground states. **Nuclear Decay:** Alpha decay process, Energy release in Beta-decay, Fermi's theory of Beta- decay, selection rules, parity violation in Beta-decay, Detection and properties of neutrino, selection rules, angular correlation.	12
III	**Nuclear Reactions and Nuclear Energy** **Nuclear Reactions:** Types of reactions and conservation laws, nuclear kinematics – the Q–equation, threshold energy - Nuclear cross section **Nuclear Energy:** Nuclear fission- energy release in fission- Stability limit against spontaneous fission, Characteristics of fission, delayed neutrons, nuclear fusion, prospects of continued fusion energy. Four factor formula for controlled fission (nuclear chain reaction) - nuclear reactor- types of reactors.	12
IV	**Elementary Particle Physics** Classification - Particle interactions and families, symmetries and conservation laws (energy and momentum, angular momentum, parity, Baryon number, Lepton number, isospin, strangeness quantum number) Discovery of K-mesons and hyperons (Gell-Mann and Nishijima formula) and charm, Elementary ideas of CP and CPT invariance, SU(2), SU(3) multiplets, Quark model.	12
V	**Accelerators and Applications** **Accelerators:** Electrostatic accelerators, cyclotron accelerators, synchrotrons **Applications:** Trace Element Analysis, Rutherford Back-scattering, Mass spectrometry with accelerators, Concepts of Diagnostic Nuclear Medicine and Therapeutic Nuclear Medicine.	12

TextandReferenceBooks:

1. NuclearPhysics,D.C.TAYAL(HimalayapublishingCo.).
2. IntroductoryNuclearPhysics,KENNETHS.KRANE(JohnWiley&Sons).
3. IntroductiontoNuclear Physics, HARALD A.ENGE(AddisonWesley).
4. ConceptsofNuclear Physics, BERNARDL.COHEN(McGraw-Hill).
5. IntroductiontoHighEnergyPhysics, D.H.PERKINS(CambridgeUniversityPress).
6. IntroductiontoElementaryParticles,D.GRIFFITHS(Wiley-VCH).
7. NuclearPhysics,S.B.PATEL(WileyEasternLtd.).
8. FundamentalsofNuclearPhysics,B.B.SRIVASTAVA(RastogiPublications).

CONDENSEDMATTERPHYSICS-I(Special)

Offered to : M.Sc.(PHYSICS)	Course Code : 20PH3T4
Course Type : Core	Course : CONDENSEDMATTERPHYSICS-I(Special)
Year of Introduction : 2004	Year of offering : 2020
Year of Revision : 2020	Percentage of Revision:Nil
Semester : III	Credits : 4
Hours Taught: 60 hrs. per Semester	Max.Time : 3 Hours

Course Description: Condensed Matter Physics -I is the field of physics that deals with the macroscopic and microscopic physical properties of matter, especially the solid and liquid phases which arise from electromagnetic forces between atoms. More generally, the subject deals with "condensed" phases of matter: systems of many constituents with strong interactions between them.

CourseObjectives:

1. Tounderstandthelatticedefectsindifferentcrystals
2. Tounderstandthethermalandopticalpropertiesofcrystalsduetolatticedefects.
3. Tolearntheconceptsofluminescenceand phosphorescence
4. ToUnderstandtheSpecificheat ofsolidsindifferentcrystals
5. ToUnderstandthemagneticpropertiesanddifferenttheoriesofmagnetism

CourseOutcomes: Atthe endofthiscourse, studentsshould beable to:
CO1: Remember the concepts of crystal structures and their properties
CO2: Understand the importance of crystal defects
CO3: Analyze the process involved in the Luminescence.
CO4: Understand the importance of specific heat of solids.
CO5: Analyze the theories involved in different magnetic domains.

CO-POMATRIX								
	CO-PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
20PH3T4	**CO1**	H					L	M
	CO2	H					L	M
	CO3			H			L	M
	CO4	H					L	M
	CO5			H			L	M

Syllabus		
Unit	**LearningUnits**	**Lecture Hours**
I	**CrystalDefects** The structure of metals, lattice defects and configurational entropy – The number ofvacanciesandinterstitialasfunctionoftemperature,theformationoflatticedefectsin metals, interstitial diffusion in metals, chemical diffusion in metals-Kirkendallleffect, Edge and screw dislocation, Estimates of dislocations densities, The Frank - Readmechanismof dislocationmultiplication.	12
II	**OpticalProperties** Optical and thermal electronic excitation in ionic crystals. The ultraviolet spectrum ofthe alkali halides; excitons, Illustration of electron-hole interaction in single ions,Qualitative discussion of the influence of lattice defects on the electronic levels, Nonstoichiometric crystals containing excess metal. The transformation of F centers intoF'-centers and vice- versa, Photoconductivity in crystals containing excess metal,Color centers resulting from excess halogen, Color centers produced by irradiationwithX-rays.	12
III	**Luminescence** Introduction,KindsofLuminescence,Excitationandemission,EfficiencyofPhosphor, Decay mechanisms, Thermo luminescence and glow, Thallium-activatedalkalihalides, thesulfide phosphors, Electroluminescence.	12
IV	**LatticeVibrationsandThermalProperties** Elastic waves in one dimensional array of identical atoms. Vibrational modes of adiatomic linear lattice and dispersion relations. Acoustic and optical modes. Infraredabsorption in ionic crystals. Phonons and verification of dispersion relation in crystallattices.Latticeheatcapacity–EinsteinandDebyetheories.Latticethermalconductivity-Phononmeanfreepath.OriginofthermalexpansionandGruneisenrelation.	12
V	**MagneticPropertiesof Solids** QuantumtheoryofParamagnetism,CrystalFieldSplitting,QuenchingoftheorbitalAngular MomentumFerromagnetism Curie point andtheExchange integral,SaturationMagnetizationatAbsoluteZero,Magnons,Bloch'sT$^{3/2}$law. FerromagneticDomains.Ferrimagnetism.Thestructureofferrites,Thesaturationmagnetization,Elements ofNeel's theory.	12

ReferenceBooks:

1. A.J.DEKKER,SolidStatePhysics,Macmillan,2002
2. CHARLESKITTEL,IntroductiontoSolidStatePhysics,JohnWiley&Sons,2007
3. GUPTAand KUMAR,Solid StatePhysics,K. Nath&Co.,2000
4. S.O. PILLAI,SolidStatePhysicsNewAgeInternational, 2006
5. M.A.Wahab,Solid StatePhysics,Narosa, 2019,3rdedition

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FUNDAMENTALS OF ANALYTICAL INSTRUMENTS

Offered to : M.Sc.(PHYSICS)	Course Code : 20PH3T5
Course Type : Open Elective	Course : Fundamentals of Analytical Instruments
Year of Introduction : 2020	Year of offering : 2020
Year of Revision : xxxx	Percentage of Revision : xxxx
Semester : III	Credits : 4
Hours Taught: 60 hrs. per Semester	Max.Time : 3 Hours

Course Description: The Fundamentals of Analytical Instruments course is aimed to give fundamentals of selective instruments and their applications in chemical, pharmaceutical, clinical, food-processing laboratories, and oil refineries. They are employed to obtain qualitative and quantitative information about the presence or absence of one or more components of the sample.

CourseObjectives:

1. Tounderstandtheworkingofdifferentspectroscopictechniques
2. Tounderstandthebasicprinciplesofchromatography
3. Tolearnthe workingofdifferentlaserssystemsandtheprocessofholography
4. ToUnderstandthebasicprinciplesofnuclearmagneticresonance
5. TolearnthebasicprincipleofX-Raydiffractionanditsapplicationsincryptography

CourseOutcomes: Atthe endofthiscourse, studentsshould beable to:
CO1: Remember the concepts of spectroscopy
CO2: Understand the importance of chromatography
CO3: Analyze the process involved in the generation of different lasers
CO4: Understand the importance of mass spectrometry
CO5: Understand the microscopic techniques involved in determing the strucure of materials.

CO-POMATRIX								
	CO-PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
20PH3T5	**CO1**	H					M	M
	CO2	H					M	M
	CO3	H					M	M
	CO4	H					M	M
	CO5	H					M	M

Syllabus		
Unit	**LearningUnits**	**Lecture Hours**
I	**SPECTROPHOTOMETRY** **Spectrophotometry** Introduction-Beer-Lambertlaw–UV-Visiblespectroscopy–Instrumentation,Essentialpartsofspectrophotometer- Gratings and prisms – Radiant energy sources – filters – Photosensitive detectors-Photomultiplier tubes -Atomic absorption spectrophotometry – Flame emission and atomic emissionphotometry–Construction,workingprinciple,instrumentationandapplications.	8
II	**CHROMATOGRAPHY** General principles –classification –chromatographic behavior of solutes–quantitative determination –Gas chromatography– Liquidchromatography–High-pressureliquidchromatography– Applications.	8
III	**LASERSANDHOLOGRAPHY** Basic principles of lasers - Spontaneous and stimulated emission – Laser beam properties Typesof lasers- Ruby laser-He-Ne laser - GaAs laser - Dye laser – Applications of Lasers. IntroductiontoHolography–RecordingandreconstructionofHologram–ApplicationsofHolography	8
IV	**NUCLEARMAGNETICRESONANCEANDMASSSPECTROMETRY** NMR–Basicprinciples–ContinuousandPulsedFourierTransformNMRspectrometer–MassSpectrometry–Samplesystem–Ionization methods– Massanalyzers–Types ofmassspectrometry.	8
V	**STRUCTUREANDMICROSCOPICTECHNIQUES** X- ray diffraction, Bragg's law, Powder X-ray Diffractometer - Basic principles, Instrumentation andapplicationsofScanningelectronmicroscopy,Transmissionelectronmicroscopy,Atomicforcemicroscopy,DifferentialscanningcalorimetryandThermogravimetric analysis	8

ReferenceBooks:

1. Willard,H.H.,Merritt,L.L.,Dean,J.A., Settle, Instrumentalmethodsofanalysis, ,7thEdition,2012.
2. RobertE.Sherman.,"AnalyticalInstrumentation",
3. GUPTAand KUMAR,Solid StatePhysics,K. Nath&Co.,2000
4. Khandpur,R.S.,"HandbookofAnalyticalInstruments",TataMcGraw-Hill,2ndEdition2007
5. NPTELlecturenoteson, "ModernInstrumentalmethodsofAnalysis"byDr.J.R.Mudakavi,IISC, Bangalore.

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CONDENSED MATTER PHYSICS LAB

Offered to : M.Sc.(PHYSICS)	Course Code: 20PH4L1
Course Type : Core	Course: Condensed Matter Physics Lab
Year of Introduction : 2004	Year of offering : 2020
Year of Revision : 2020	Percentage of Revision : 30%
Semester : IV	Credits : 4
Hours Taught : 60 hrs. per Semester	Max.Time : 3 Hours

Course Description: The main objective of the course is to make the students understand the experiments based on some physical concepts in material science courses.

Course Objectives:

1. To experimentally study some of the fundamental concepts in condensed matter physics
2. To teach some experiments of dielectric constants
3. To understand the different phenomena involved in experiments.
4. To teach experiments of susceptibilty
5. To teach error analysis

Course Outcomes: At the end of this course, students should be able to:
CO1: Conduct experiments on the phenomena learnt in condensed matter physics.
CO2: Explain physical phenomena in the experiments performed.
CO3: Explain the connection between physical laws and their application.
CO4: Do the statistical analysis of the results obtained by the experiment and interpretation of results.
CO5: Understand the physics behind the results and make detailed, full report of the experiment.

CO - PO MATRIX								
	CO-PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
20PH4L1	CO1				H		L	M
	CO2				H		L	M
	CO3		H	M			L	M
	CO4				H		L	M
	CO5				H		L	M

Syllabus

PRACTICAL – VII: (20PH4L1):

Condensed Matter Physics Lab

(Minimum 10 experiments are to be done)

1. Linear expansion of solids
2. Curie temperature of ferroelectric materials
3. Dielectric constant of PZT
4. Verification of law of addition of capacitances
5. Determination of k/e using transistor
6. Susceptibility of liquids
7. Susceptibility of solids
8. Dielectric Constant of liquids
9. Dipole moment of acetone
10. Polarisability of Benzene
11. Energy gap of a thermistor.
12. Characteristics of Photo diode
13. Synthesis and estimation of band gap energy of amorphous materials
14. Composite Piezoelectric Oscillator
15. Any two online virtual lab experiments within the syllabus have to be carried out (using MHRD web resource).

Reference Books:

1. Advanced practical physics Vol – I Dr. S. P. Singh
2. Advanced practical physics Vol II : DR. S.P. Singh
3. Practical Physics : Gupta, Kumar, Sharma
4. Practical Physics: P. R. Sasi Kumar
5. University Practical physics by D. C. Tayal
6. Viva – Voce in advanced physics : Gupta , Kumar, Sharma

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THERMAL PHYSICS
Electives (through MOOCs)

Offered to : M.Sc.(PHYSICS)	Course Code: 20PH4M1
Course Type : MOOCS	Course: Thermal Physics
Year of Introduction : 2020	Year of offering : 2020
Year of Revision : xxxx	Percentage of Revision : xxx
Semester : IV	Credits : 4
Hours Taught : 60 hrs. per Semester	Max.Time : 3 Hours

Course Description: Students understand the basic concepts of thermodynamics, fundamental laws and different theories related to thermal phenomena.

Course Objectives:

1. To understand thefundamental aspects of thermodynamics.
2. To understand the concept of specific heat of solids.
3. To apply the thermodynamics laws for thermo dynamical systems.
4. To understand the Maxwell's thermodynamics relations.
5. To understand the concept of thermodynamics phase transitions.

Course Outcomes: At the end of this course, students should be able to:
CO1: Remember the fundamental concepts of kinetic theory of gases.
CO2: Understand the theory of specific heat of solids.
CO3: Analyze the fundamental laws of thermodynamics and applications.
CO4: Understand the chemical energy and thermodynamics of chemical reactions.
CO5: Understand the thermodynamics phase transitions in Black body radiation.

CO - PO MATRIX								
	CO-PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
20PH4M1	CO1	H						M
	CO2	H						M
	CO3	H						M
	CO4	H						M
	CO5	H						M

Syllabus		
Unit	**Learning Units**	**Lecture Hours**
I	**Kinetic theory of gasses** Maxwell-Boltzmann speed distribution law, average speed, RMS speed, most probable speed, pressure expression from kinetic theory Mean free path, collision probability, Fundamentals of transport phenomena, Viscosity, diffusion, effusion, and thermal conductivity in gasses. Brownian motion and its significance, Einstein's theory of molecular diffusion, Perrin's experiment, random walk (concept only)	12
II	**Specific heat of solids** Principle of equipartition of energy, degrees of freedom, Specific heat of monoatomic, diatomic and polyatomic gasses, Specific heat of solids, Dulong-petit law, Einstein and Debye theory of specific heat of solids Real gasses, deviation from ideal gas equation, The Van-der Walls equation of state, the virial coefficients, other equation of state (elementary discussion)	12
III	**Thermodynamics** Zeroth and 1 st law of thermodynamics, quasi static processes, work and internal energy, isothermal and adiabatic processes, elastic coefficients of matter Cyclic process, heat engines and refrigerators, Carnot's theorem and Carnot's cycle, 2 nd law of thermodynamics, Clausius' theorem, Entropy.	12
IV	**Free Energy and Chemical Thermodynamics** The entropy principle, The T-S diagram, Otto and diesel cycles, entropy and unavailable energy, physical interpretation of entropy. Maxwell's thermodynamics relations, the TdS, Gibbs- Helmholtz and energy equations, Enthalpy, Helmholtz and Gibbs free energies, general condition for thermodynamic equilibrium, thermodynamics of chemical reactions	12
V	**Thermodynamic Phase transitions** Equilibrium between phases, 1 st order phase transitions, 1 st and 2nd latent heat equations, Phase diagram and Triple point, 2 nd order phase transition and Ehrenfest equations, Gibbs phase rule and simple applications. Radiation: Energy density and pressure of radiation, Blackbody radiation and Kirchhoff's law, Blackbody (Cavity) radiation as a thermodynamic system, 3 rd law of thermodynamics, entropy at absolute zero temperature	12

Text and Reference Books:

1. E.R. ANDREW , Nuclear Magnetic Resonance (Cambridge UniversityPress).
2. E. BALAGURUSAMY , Molecular Structure and Spectroscopy, (Prentice Hall ofIndia).
3. RAYMOND CHANG , Basic Principles of Spectroscopy, (McGrawHill).
4. V.G. BHIDE , Mossbauer Effect and Its Applications, (McGrawHill).

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PRACTICAL – VIII: Project Work (20PH4P1)

Offered to : M.Sc.(PHYSICS)	Course Code: 20PH4P1
Course Type : Core	Course: **Project Work**
Year of Introduction : 2016	Year of offering : 2020
Year of Revision : 2020	Percentage of Revision : Nil
Semester : IV	Credits : 8
Hours Taught : xxxxxx	Max.Time : xxxxxxx

Course Description: A short research activity on any significant or interesting aspects of the works (preferably relevant to the students' field of study/specialization) has to be performed or observed by a student in the organization. As part of curriculum students are required to write a short report generally named as a Research activity under the guidance of supervisor.

Course Objectives:

1. To promote independence, creativity and communication skills of the students
2. To enable the practical application of theoritical knowledge
3. To develop proper planning, organization and execution
4. To apply and adapt a variety of problem solving strategies to solve problems.
5. To develop positive attitude towards problems in career and life.

Course Outcomes: At the end of this course, students should be able to:

CO1: Get the ability to connect different areas of knowledge and develop ideas to do a project.
CO2: Will be able to learn on his own and take steps to improve it.
CO3: Will acquire collaborative skills through working in a team.
CO4: Demonstrate a strong working knowledge of ethics and professional responsibility.
CO5: Acquire skills to communicate his work effectively and present ideas clearly in both written and oral forms.

CO - PO MATRIX								
	CO-PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
20PH4P1	CO1	H					L	M
	CO2	H					L	M
	CO3			H	H		L	M
	CO4	H				H	L	M

	CO5	H	M				L	M

Procedure for Conduct and Evaluation of Project Midterm review:

After selecting the specific project topic, the student shall collect the information and prepare an abstract, showing his/her understanding of the proposed project topic as a summary and submit the same to the department before implementation of the project in the beginning of the IV Semester. The status of the project work will be reviewed and the presentation shall be evaluated by the departmental committee consisting of Head of the Department, Project supervisor and a senior faculty member after two months of the project. It shall be evaluated for 50 marks. A student shall acquire 2 credits assigned to the Project midterm review, when he/she secures 40% or more marks for the total of 50 marks. There shall be no external evaluation for Project midterm review. In case, if a student fails in Project midterm review, a re-review shall be conducted within a month. In case if he/she fails in the re-review also, he/she shall not be permitted for Project Evaluation. Further, such students shall reappear as and when IV semester supplementary examinations are conducted.

Project midterm review- 50 marks
Project evaluation- 150 marks

Procedure for Conduct and Evaluation of Project Evaluation:

Out of a total of 200 marks, 50 marks for Project Review and for the Project Evaluation, 100 marks shall be for Project report/thesis/record and 50 marks for the End Semester Examination (Viva-voce). The Viva- Voce shall be conducted by a committee consisting of HOD, Project Supervisor and an External Examiner nominated by the University. The Internal Evaluation shall be made by the departmental committee (Head of the Department, two senior faculty members of the department and Supervisor), on the basis of review presentation given by each student on the topic of his/her project.

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ANALYTICAL TECHNIQUES

Offered to : M.Sc.(PHYSICS)	Course Code: 20PH4T1
Course Type : Core	Course: Analytical Techniques
Year of Introduction : 2004	Year of offering : 2020
Year of Revision : 2020	Percentage of Revision : Nil
Semester : IV	Credits : 4
Hours Taught : 60 hrs. per Semester	Max.Time : 3 Hours

Course Description: Analytical Techniques course is aimed to train the students the principles, basic theory,instrumentation, and applications of selected analytical instruments. Analytical technique is a method thatis used to determine a chemical or physical property of a material.

Course Objectives:

1. To understand the theory of different analytical techniques.
2. To develop the skills to practice of analytical techniques.
3. To establish an appreciation of the role of Physics in quantitative analysis.
4. To provide scientific understanding of analytical techniques.
5. To provide the detail interpretation of results.

Course Outcomes: At the end of this course, students should be able to:
CO1: Understand the basic concept of theory and experimental methods of Nuclear Magnetic Resonance.
CO2: Analyse the fundamental of Electron Spin Resonance (ESR).
CO3: Analyse the process of Nuclear Quadrupole Resonance (NQR) spectrometer.
CO4: Apply the concepts of Electron spectroscopy to analyse the properties of materials.
CO5: Understand the concepts of Mossbauer Effect and applications.

CO - PO MATRIX								
	CO-PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
20PH4T1	CO1	H					L	M
	CO2		M				L	M
	CO3		M				L	M
	CO4		H				L	M
	CO5	H	M				L	M

Syllabus		
Unit	**Learning Units**	**Lecture Hours**
I	**Nuclear Magnetic Resonance** Nuclear spin and magnetic moment, theory of NMR, chemical shift, Relaxation mechanisms, Spin-lattice (T1), spin-spin (T2) relaxation times by pulse methods, Bloch equations, Theory of relaxation mechanisms for spin ½ nuclei, Proton NMR, Carbon-13 NMR and Experimental methods, CW NMR spectrometer and applications.	12
II	**Electron Spin Resonance** Magnetic moment of an electron, two states of an electron in a magnetic field, ESR theory- Spin-spin interaction, Spin-lattice interaction - Hyperfine interaction-g factor, Characteristics of g and A values, Line widths and Intensities, Relaxation effects, Experimental methods –ESR Spectrometer and applications.	12
III	**Nuclear Quadrupole Resonance** Nuclear Quadrupole Resonance spectroscopy, fundamental requirements of NQR spectroscopy, General principles, Integral spins and Half integral spins, Experimental detection of NQR frequencies, Block diagram of NQR spectrometer – Experimental methods of SR oscillator, CW oscillator, pulse methods.	12
IV	**Electron Spectroscopy** Photo electron spectroscopy- theory- Instrumentation- Applications, Energy Dispersive Spectra (EDS), Auger Electron Spectroscopy (AES), Scanning Electron Microscope, Transmission Electron Spectroscope, Differential Scanning Calorimeter, Differential Thermal Analysis and Thermal Gravimetric Analysis.	12
V	**Mossbauer Spectroscopy** The Mossbauer Effect, Recoilless Emission and Absorption, The Mossbauer Spectrometer, Experimental methods, Chemical shift, Quadrupole interaction, Magnetic Hyperfine interactions and applications.	12

Text and Reference Books:

1. E.R. ANDREW , Nuclear Magnetic Resonance (Cambridge UniversityPress).
2. E. BALAGURUSAMY , Molecular Structure and Spectroscopy, (Prentice Hall ofIndia).
3. RAYMOND CHANG , Basic Principles of Spectroscopy, (McGrawHill).
4. V.G. BHIDE , Mossbauer Effect and Its Applications, (McGrawHill).

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ADVANCES IN MATERIALS SCIENCE

Offered to : M.Sc.(PHYSICS)	Course Code: 20PH4T2
Course Type : Core	Course: Advances in materials science
Year of Introduction : 2004	Year of offering : 2020
Year of Revision : 2020	Percentage of Revision :30%
Semester : IV	Credits : 4
Hours Taught : 60 hrs. per Semester	Max.Time : 3 Hours

Course Description: The Course Advances in Materials Science isfocussed to equip the students with knowledgeand understanding of the key structural properties of different classes of materials. Students will gainskills in characterization of materials.

Course Objectives:
1. To understand the properties of different materials.
2. To understand the formation and applications of glass materials.
3. To understand the importance of bio materials.
4. To understand the importance of nano materials.
5. To provide the detailed information of carbon nano tubes.

Course Outcomes: At the end of this course, students should be able to:
CO1: Understand the basic concept of properties of materials
CO2: Understand the preparation of glass materials and their applications.
CO3: Analyse the process of preparation and applications of glass materials.
CO4: Apply the concepts of synthesis of nano materials.
CO5: Understand the concepts of applications of carbon nano tubes.

CO - PO MATRIX								
	CO-PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
20PH4T2	CO1	H					L	M
	CO2	H	M				L	M
	CO3		H				L	M
	CO4		H				L	M
	CO5	H	M				L	M

Syllabus		
Unit	**Learning Units**	**Lecture Hours**
I	**Unit-I: Classification of Materials-** Introduction, structure of materials, bonding in solids, Types of materials, Metals, Ceramics (and glasses) polymers, composites, semiconductors. Metals and alloys: Phase diagrams of single component, binary and ternary systems, diffusion, nucleation and growth-Mechanical Properties. Metallic Glasses. Preparation, structure andproperties like electrical, magnetic, thermal and mechanical, applications	12
II	**Unit-II Glasses: the glass transition** - Glass formation, Types of glasses. Theories of glass transition-Factors that determine the glass transition temperature - Glass forming systems and ease of glass formation - Preparation of glass materials-Applications of Glasses: Electronic applications, electrochemical applications, optical applications, and Magnetic applications.	12
III	**Unit-III: Biomaterials - Implant materials**: Introduction to biomaterials for biomedical applications, Chemical structure and property of biomaterials, Preparation. Stainless steels and its alloys, Ti and Ti based alloys, Ceramic implant materials; Hydroxyapatite glass ceramics, Carbon Implant materials, Polymeric Implant materials, Soft tissue replacement implants :Sutures, Surgical tapes and adhesives, heart valve implants, artificial organs, Hard Tissue replacement Implants	12
IV	**Unit-IV: Nano Structured Materials**: Origin of Nanomaterials – Zero, One and Two dimensional Nanomaterials Quantum confinement, Density of states, physical and chemical properties, Synthesis of Nanomaterials -Bottom-up and Top-down approaches, Chemical methods: Sol-Gel Process–Spray Pyrolysis –Solvothermal Synthesis– Chemical Vapor Deposition(CVD), Physical methods: Ball Milling –Inert Gas Condensation Technique–Thermal evaporation–Pulsed Laser Deposition (PLD) –Sputtering.	12
V	**Unit-V: Carbon based nanomaterials:** Carbon based molecules and carbon bond - C60: Discovery, Synthesis and structure of C60 -Superconductivity in C60 - Carbon nanotubes: Fabrication – Structure – Electrical properties –Vibrational properties – Mechanical properties – Applications (fuel cells, chemical sensors,catalysts).	12

Text and Reference Books:

1.S.R.ELLIOTT ,Physics of Amorphous Materials, (Longman).
2.SL KAKANI,AMIT KAKANI , Material Science (Science and Engineering of Materials)
3. H. GLEITER ,Nanocrystalline materials, (Review article from "Progress in Materials Science, Volume 33, Issue 4, 1989, Pages 223-315").
4. J.B. PARK ,Biomaterials: Principles and Applications, (CRC Press).
5. C.M. SRIVASTAVA and C.SRINIVASAN Material Science Science and Engineering Materials and Carbon Nanotubes, (New Age Int)

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CONDENSED MATTER PHYSICS –II (SPECIAL)

Offered to : M.Sc.(PHYSICS)	Course Code: 20PH4T3
Course Type : Core	**Course:** Condensed Matter Physics - II(Special)
Year of Introduction : 2004	Year of offering : 2020
Year of Revision : 2020	Percentage of Revision : 20%
Semester : IV	Credits : 4
Hours Taught : 60 hrs. per Semester	Max.Time : 3 Hours

Course Description: Condensed Matter Physics–II course will obtain a basic knowledge of the theory ofsuperconductors and the Josephson effect and their applications in cryoelectronics. The study of dielectricproperties concerns storage and dissipation of electric and magnetic energy in materials.

Course Objectives:

1. To understand the principles of some crystal growth techniques.
2. To understand the basic concepts of superconductivity
3. To understand the different phenomena where superconductivity is applied.
4. To understand the basic concepts of dielectrics
5. To understand the basic concepts of ferroelectrics.

Course Outcomes: At the end of this course, students should be able to:
CO1: Apply some crystal growth techniques to form crystals
CO2: Analyse the basic concepts of superconductivity
CO3: Analyse different phenomena involving superconductivity and their applications
CO4: Analyse the basics of dielectrics and their applications
CO5: Analyse the basics of ferroelectrics and their applications

CO - PO MATRIX								
	CO-PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
20PH4T3	CO1	H					L	M
	CO2	H	M				L	M
	CO3		H				L	M
	CO4		H				L	M
	CO5	H	M				L	M

Syllabus		
Unit	**Learning Units**	**Lecture Hours**
I	**Crystal Growth Techniques** Bridgeman - Czochralski - Liquid Encapsulated Czochralski (LEC) growth techniques – zone refining and floating zone growth - chemical vapour deposition (CVD) - Molecular beam epitaxy - vapour phase epitaxy - hydrothermal growth - Growth from melt solutions - Flame fusion method	12
II	**Superconductivity-Introduction** Meissner effect, Isotope effect, specific heat, thermal conductivity and manifestation of energy gap, London equations, type I and type II superconductors, Quantum tunneling, Cooper pairing due to phonons, BCS theory of superconductivity.	12
III	**Applications of Superconductivity** Ginzburg - Landau theory and application to Josephson effect - dc Josephson effect, ac Josephson effect, macroscopic quantum interference, applications of superconductivity, high temperature superconductivity.	12
IV	**Dielectrics** Introduction, Dipole moment, Various types of polarization – Electronic, ionic, and orientation polarization, Macroscopic description of the static dielectric constant, The internal field according to Lorentz, Clausius - Mossotti equation, The static dielectric constant of solids,Complex dielectric constant, Frequency dependence of dielectric constant, Dielectric loss, Effect of temperature on dielectric constant, Applications of dielectrics.	12
V	**Ferroelectrics** General properties of ferroelectric materials. Classification and properties of representative ferroelectrics - Dipole theory of ferroelectricity, objections against the dipole theory, Ionic displacements and the behaviour of $BaTiO_3$ above Curie temperature, theory of spontaneous polarization of $BaTiO_3$, Ferroelectric domains.	12

Text and Reference Books:

1. A.J. DEKKER , Solid State Physics, (Macmillan).
2.CHARLES KITTEL, Introduction to Solid State Physics, (John Wiley &Sons).
3. GUPTA and KUMAR , Solid State Physics, (K. Nath &Co.).
4. S.O. Pillai**,** Solid state Physics