Atal Bihari Vajpayee Vishwavidyalaya, Bilaspur (C.G.)

Scheme and Syllabus

of

M. Sc. (Physics)

Program Code: MSCPHYR121

Semester system for affiliated college
(As per LOCF and credit system)

w.e.f. 2024-2025

(As approved by AC and EC meetings held on 16.08.2023 and 18.04.2023 respectively)

Scheme of M.Sc. Physics under Semester

SystemProgram Code: MSCPHY121

Semester	Course Code	Subject Name	Credit			Total Credit	Marks			
			L	P	T		ESE	IA	Total	
									Max	Min
Third	PHYT 301	Quantum Mechanics - II	3	0	1	4	80	20	100	36
	PHYT 302	Statistical Mechanics	3	0	1	4	80	20	100	36
	PHYT 303	Condensed matter physics - I	3	0	1	4	80	20	100	36
	PHYT 304	Electronics - III	3	0	1	4	80	20	100	36
	PHYP 305	Lab-I Electronics	0	2	0	2	100	-	100	36
	PHYP 306	Lab-II General Physics	0	2	0	2	100	-	100	36
		Subtotal	**12**	**4**	**4**	**20**	-	-	**600**	-
Fourth	PHYT 401	Condensed matter physics - II	3	0	1	4	80	20	100	36
	PHYT 402	Nuclear Physics	3	0	1	4	80	20	100	36
	PHYT 403	Atomic and Molecular Physics	3	0	1	4	80	20	100	36
	PHYT 404	Electronics - IV	3	0	1	4	80	20	100	36
	PHYP 405	Project	0	4	0	4	200	-	200	72
		Subtotal	**12**	**4**	**4**	**20**	-	-	**600**	-
		Total	**48**	**16**	**16**	**80**	-	-	**2400**	

Abbreviation used:

ESE: End Semester Exam

IA: Internal Assessment

Atal Bihari Vajpayee Vishwavidyalaya, Bilaspur (C.G.)

Semester Syllabus

M.Sc. Physics

Part A: Introduction			
Program: M.Sc. (Physics)	Semester: III	Year: Second	w.e.f. 2024-2025
1. Course Code	PHYT 301		
2. Course Title	Quantum Mechanics - II		
3. Course Type	Theory		
4. Pre- requisite	Nil		
5. Course Learning Outcomes (CLO)	At the end of this course , the student will be able to : • Understand time independent perturbation theory. • Master the applications of perturbation theory and approximations. • Understand the concept of scattering and its applications. • Explain Fermi's golden rule, Born approximation, Klein Gordon and Dirac equations. • Understand relativistic quantum mechanics.		
6. Credit Value	4		
7. Total Marks	IA: 20 Marks ESE: 80 Marks	Max. marks : 100 Min. Marks: 36	

Part B: Contents of the Course		
Total No. of the Lecture/ Hour: 60		
Unit	Topic	No. of Hour
I.	**Identical particles:** Interchange symmetry ,system of identical particles, symmetric and antisymmetric wavefunction, construction of symmetric and antisymmetric wavefunction , slater determinant, Pauli exclusion principle.	12
II.	**Approximation Methods for Stationary Systems:** Time-independent perturbation theory - (a) non- degenerate and (b) degenerate, variational method and its applications. WKB method and its applications.	12
III.	**Approximation Methods for time-dependent perturbations:** Interaction picture. Time-dependent perturbation theory. Transition to a continuum of final states – Fermi's Golden Rule. Application to constant and harmonic perturbations. Sudden and adiabatic approximations.	12
IV.	**Scattering:** Scattering amplitude, Scattering Cross section Wave packet description of scattering. Born approximation and applications. Definition and properties of S-Matrix Partial wave analysis. Optical theorem.	12

V.	**Relativistic Quantum Mechanics**: Klein-Gordon and Dirac equations. Properties of Dirac matrices. Plane wave solutions of Dirac equation. Spin and magnetic moment of the electron, non-relativistic reduction of the Dirac equation.	12

Part C - Learning Resources

Text Books, Reference Books, E -Resources

Text Books:

1. Quantum Mechanics by Davydov (2nd Ed., Pegamon,1991)
2. Ajoy Ghatak and S Lokanathan, Quantum Mechanics: Theory and Applications, 5th edition, Macmillan India Ltd
3. Quantum Mechanics by L.I. Schiff, McGraw-Hill

Reference Books:

1. N. Zettili, (2009). Quantum Mechanics-Concepts and Applications
2. E. Merzbacher, (2011). Quantum Mechanics Wiley India Pvt. Ltd., New Delhi, India.
3. J. J. Sakurai, (2009). Modern Quantum Mechanics Pearson Education
4. L D Landau, E. M. Lifshitz , Quantum Mechanics – Nonrelitavistic Theory: Course Of Theoretical Physics - Vol. 3
5. Lewis H. Ryder , Quantum Field Theory, Cambridge University Press, (2nd Ed.,1996)

E -Resources:

1. https://nptel.ac.in/courses/115103104
2. https://nptel.ac.in/courses/115108074
3. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=+4mIqRALksfwQH9v8YSMrw==
4. https://ocw.mit.edu/courses/8-04-quantum-physics-i-spring-2016/

Dr. A. P. Goswami

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Semester Syllabus

M.Sc. Physics

Part A: Introduction				
Program: M.Sc. (Physics)		Semester: III	Year: Second	w.e.f. : 2024-2025
1.	Course Code	PHYT 302		
2.	Course Title	Statistical Mechanics		
3.	Course Type	Theory		
4.	Pre- requisite	Nil		
5.	Course Learning Outcomes (CLO)	After successfully completion of this course, the student will achieve the ability to: • Find connection between statistics and thermodynamics. • Solve the problem of macroscopic and microscopic systems. • Differentiate between different ensembles and explain the behaviour of the systems. • Differentiate between classical and quantum statistics. • Explain the statistical behaviour of bosons and fermions.		
6.	Credit Value	4		
7.	Total Marks	IA: 20 Marks ESE: 80 Marks	Max. marks : 100 Min. Marks: 36	

Part B: Contents of the Course		
Total No. of the Lecture/ Hour: 60		
Unit	Topic	No. of Hour
I.	**Review of concepts:** Basics of thermodynamics, laws of thermodynamics, thermodynamic processes, concept of entropy, kinetic theory of gases, phase diagram and concept of triple point. Thermodynamic potentials and maxwell's relation. Specific heat capacities of gases, law of equipartition of energy. Black body radiation , Kirchhoff's law, Stephan-Boltzmann law.	12
II.	**Basics of statistical mechanics:** Statistical basis of thermodynamics, probability and equilibrium, probability distribution, statistical description of entropy, Ensembles, partition functions and its relation with thermodynamics quantities. Phase space, Density of states for relativistic and non- relativistic particles.	12
III.	**Classical statistical mechanics:** Maxwell-Boltzmann statistics and its application. Distinguishable and indistinguishable particles.	12

IV.	**Quantum statistical mechanics:** Bose-Einstein statistics, derivation of Planck's law, application to liquid helium, Bose-Einstein condensation. Fermi-Dirac statistics, fermi energy, fermi theory of free electron gas, Ising model.	12
V.	**Fluctuation:** Fluctuation in energy, pressure, volume and enthalpy. One dimensional random walk, Brownian movement, Fokker Planck equation, Wiener - khintchine theorem, electrical noise, Nyquist theorem.	12

Part C - Learning Resources

Text Books, Reference Books, E -Resources

Text Books:

1. Thermal Physics: with Kinetic Theory, Thermodynamics and Statistical Mechanics" by S C Garg and R M Bansal, McGraw Hill Education
2. Statistical and Thermal Physics: An Introduction by Lokanathan, Prentice Hall India Learning Private Limited
3. Thermodynamics, Kinetic Theory, and Statistical Thermodynamics by Addison Wesley, Pearson.

Reference Books:

1. Heat Thermodynamics and Statistical Physics by Brij Lal , N Subrahmanyam , PS Hemne, S. Chand
2. Statistical Mechanics by R K Pathria, Academic Press Inc.(London) Ltd
3. Statistical physics by L D Landau, Statistical Physics, Third Edition, Part 1: Volume 5 (Course of Theoretical Physics, Volume 5) , Butterworth-Heinemann
4. Statistical Mechanics: Entropy, Order Parameters and Complexity by James P Sethna, Oxford University Press

E -Resources:

1. https://youtu.be/fXfBGVfH140
2. https://nptel.ac.in/courses/115106111
3. https://nptel.ac.in/courses/115106126
4. https://nptel.ac.in/courses/115103113

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Semester Syllabus

M.Sc. Physics

Part A: Introduction				
Program: M.Sc. (Physics)		Semester: III	Year: Second	w.e.f. : 2024-2025
1.	Course Code	PHYT 303		
2.	Course Title	Condensed matter physics – I		
3.	Course Type	Theory		
4.	Pre- requisite	Nil		
5.	Course Learning Outcomes (CLO)	At the end of this course, the student will be able to : • Understand about crystal lattice and diffraction reciprocal lattice and properties. • Students know about crystal defects and its classification , knowledge about how to a crystal growth. • Knowledge about how specific heat depend on temperature. • Understand Fermi surface, Block wall energy, spin waves, and magnons. • Understand magnetic properties of solids.		
6.	Credit Value	4		
7.	Total Marks	IA: 20 Marks ESE: 80 Marks	Max. marks : 100 Min. Marks: 36	

Part B: Contents of the Course		
Total No. of the Lecture/ Hour: 60		
Unit	Topic	No. of Hour
I.	**Crystal lattice and diffraction:** Crystalline and amorphous solids Unit cells and direct lattice, Two and three-dimensional Bravais lattices, Fundamental elements of symmetry, Concept of point group and space groups, Crystal plans and Miller indices, Closed packed structure, X-ray diffraction and methods, Reciprocal lattice and its properties Brags law in a reciprocal lattice, Brillouin zones, Structure factor.	12
II.	**Defects or imperfections in crystals and their classification:** Point defects, Schottky and Frenkel defects, Vacancies, interstitial and colour centers in ionic crystals, their types and production, line defects , dislocations, Edge and screw dislocations, Burger vectors, the role of dislocation in plastic deformation and crystal growth.	12
III.	**Lattice dynamics and metals:** Quantization of lattice vibration, Einstein and Debye theories of specific heat, Phonon density of states, Drude theory, DC conductivity, Magneto resistance, Thermal properties of an electron gas, Wiedemann Franz law.	12

IV.	**Band theory of solids:** Electron in a periodic lattice, block theorem, Kroning Panny model, band theory, classification of solids, Effective mass of electron, Tight bonding, Cellular and pseudo potential methods, Fermi surface and its construction, De Hass Von Alfen effect, Cyclotron resonance, Quantum Hall effect.	12
V.	**Magnetism in solid:** Weiss theory of ferromagnetism, Heisenberg model and molecular field theory, Curie-Weiss law for susceptibility, Ferri and Antiferromagnetic order, Domains and Bloch wall energy, spin waves and magnons, susceptibility below Neel temperature.	12

Part C - Learning Resources

Text Books, Reference Books, E -Resources

Text Books:

1. Kittel: solid state physics, Wiley
2. A.J. Dekker: Solid state physics, Pan Macmillan
3. R.K. Puri and V.K. Babber: solid state physics, S. Chand

Reference Books:

1. Verma and Shrivastava: crystallography for solid-state physics 2000 , Wiley
2. Azroff: Introduction to solids, McGraw-Hill
3. Ziman: Principal of theory of solids, Cambridge University Press
4. Kittel: Quantum theory of solids, Wiley

E -Resources:

1. https://youtube.com/playlist?list=PLbMVogVj5nJRjLrXp3kMtrlO8kZHD1Jp
2. https://youtube.com/playlist?list=PLFW6lRTa1g83HGFihgwcy7KeTLUuBu3WF
3. https://youtube.com/playlist?list=PLaNkJORnlhZnC6F3z1-i7WFRkferhQDzq
4. http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html

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Semester Syllabus

M.Sc. Physics

Part A: Introduction				
Program: M.Sc. (Physics)		Semester: III	Year: Second	w.e.f. : 2024-2025
1.	Course Code	PHYT 304		
2.	Course Title	Electronics – III		
3.	Course Type	Theory		
4.	Pre- requisite	Nil		
5.	Course Learning Outcomes (CLO)	At the end of this course, the student will be able to: • Master number systems, perform arithmetic operations, and apply BCD and complement operations. • Design and analyze logic circuits, including gates, decoders, encoders, multiplexers, and flip-flops. • Learn about digital-to-analog and analog-to-digital converters, their principles, and applications. • Compare logic families, simplify Boolean expressions, and design logic components. • Understand integrated circuit technology, fabrication processes, advantages, and packaging.		
6.	Credit Value	4		
7.	Total Marks	IA: 20 Marks ESE: 80 Marks	Max. marks : 100 Min. Marks: 36	

Part B: Contents of the Course

Total No. of the Lecture/ Hour: 60

Unit	Topic	No. of Hour
I.	**Number system and Logic Gate**: Decimal, Binary, Octal and Hexadecimal Number System with mutual conversion, BCD addition and subtraction, 1's and 2's compliments, multiplication & division BCD code (8421), Excess -3 code, gray code, binary to gray code and gray code to binary code conversion. Logic gates: Positive and negative logic, Basic gates, Universal building block. Basic laws of Boolean Algebra, De-Morgan's Theorem, two, three and four variable K-Map, mapping and minimization of SOP and POS expressions, pairs, quads, octel , overlapping, Rolling, concepts of Don't care condition.	12

II.	**Combinational Logic Circuits:** X- OR gate, Ex-NOR gate circuitry, Half adder, Full adder, binary parallel adder, Serial adder, Half subtractor, Full Subtractor, 1's complements subtractor circuit and 2's complements subtractor circuit. Digital logic Families: Introduction, Basic concepts of RTL, DTL, TTL, ECL and CMOS logic. Decoder: 2 line to 4 line decoder, 1 of 16 decoder, BCD to decimal decoder, BCD to seven segment decoder, Encoder: decimal to BCD encoder.	12
III.	**Multiplexer and Flip-Flops:** Multiplexer, 2-input, 4-input, 16 input Multiplexer, Demultiplexer 1 line to 2 line, 1 line to 4 line and 1 line to 16 line Demultiplexer. Flip-flop and timing diagram, RS flip-flop using NOR gate, RS flip-flop using NAND gate, Clocked RS flip-flop, D- latch flip-flop, Pre-set and Clear, JK flip-flop, Positive and negative edge triggered flip-flops, JK Master Slave flip-flop.	12
IV.	**Counters and Registers :** Binary ripple counter, up counter, down counter, decade counter and Ring counter and time diagram Registers: Parallel and shift Register, Scaling, PIPO, SIPO, PISO, SCSI Bi-directional shift Register, Application of shift register.	12
V.	**A/D and D/A Converter and Integrated circuit:** Digital to Analog converters using binary weighted resistor network and R-2R ladder Network; Counter type A/D converter, Successive approximation Analog to Digital converter and dual slope converters, Applications of DACS and ADCs. Intergraded Circuit: Introduction, Technology, Advantages and disadvantages, Basic technology of monolithic IC, Basic processes used in monolithic technology, Fabrication of components on monolithic 1C, 1C packing, symbol and scale of Integration.	12

Part C - Learning Resources

Text Books, Reference Books, E -Resources

Text Books:

1. Hand Book of Electronics - Gupta and Kumar ,Pragati Prakashan
2. Digital Principles and applications - Malvino and Leach, Tata McGraw Hills

Reference Books:

1. Digital and Analogue Technique- Navneet Gokhale and Kale, Kitab Mahal
2. Digital integrated Electronics , Taub and Schilling, McGraw International Edition
3. Fundamentals of Digital Circuits - A. Anand Kumar, Prentice Hall of India

E -Resources:

1. https://nptel.ac.in/courses/117106114
2. https://nptel.ac.in/courses/108105113
3. https://www.allaboutcircuits.com/video-lectures/

4. https://electronics.stackexchange.com/
5. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=+4mlqRALksfwOH9v8YSMrw

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Dr. S. S. Upadhyay

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Part A: Introduction				
Program: M.Sc. (Physics)		Semester: III	Year: Second	w.e.f. : 2024-2025
1.	Course Code	PHYP 105		
2.	Course Title	LAB - I Electronics		
3.	Course Type	Practical		
4.	Pre- requisite	Nil		
5.	Course Learning Outcomes (CLO)	At the end of this course, the student will be able to: • Learn about different logic gates and how they process information. • Verify the rules of Boolean algebra, a way to manipulate logical expressions. • Study half and full adders, circuits used to perform addition in binary arithmetic. • Experimentally confirm the truth table of the R-S flip flop, a basic memory circuit. • Experimentally confirm the truth table of the J-K flip flop, another type of memory circuit. • Experimentally confirm the truth table of the D flip flop, used in data storage. • Experimentally confirm the truth table of the T flip flop, a type of toggle circuit. • Study the operation of Shift registers, circuits used to store and move data in sequence. • Study the operation of Up-Down counters, circuits that can count both up and down. • Study the operation of a 4-bit ripple counter, a circuit that counts in binary. • Study R to R ladder type D/A converter, a circuit that converts digital signals to analog. • Design an astable multivibrator using a 555 Timer with specific requirements, a circuit that generates oscillating output without external triggering. • Now, let's move on to the 8085 Microprocessor programs: • • Write a program to add and subtract two 8-bit numbers using the 8085 Microprocessor. • Write a program to arrange a series of numbers in descending order using the 8085 Microprocessor. • Write a program to find the largest number in a data array using the 8085 Microprocessor. • These practicals introduce students to the world of digital circuits, logic gates, and microprocessors, giving them hands-on experience in working with these fundamental components of computer systems.		
6.	Credit Value	4		
7.	Total Marks	IA: Na ESE: 100 Marks	Max. marks : 100 Min. Marks: 36	

Part B: Contents of the Course	
List of experiments	
S.N.	Title
1.	To study the various logic gate.
2.	Verification of Boolean algebra
3.	To study half and full adder.
4.	To study and experimentally verify the truth table of R-S flip flop.
5.	To study and experimentally verify the truth table of J-K flip flop.
6.	To study and experimentally verify the truth table of D flip flop.
7.	To study and experimentally verify the truth table of T flip flop.
8.	To study the operation of Shift resister.
9.	To study the operation of Up-Down counter.
10.	To study the operation of 4-bit ripple counter
11.	To study R to R ladder type D/A converter
12.	To design an astable multivibrator of given specifications using 555 Timer.
(Write the following programs using 8085 Microprocessor)	
13.	Addition and Subtraction of two 8- bit number.
14.	To arrange a series of number in Descending order.
15.	To find the largest number in a data array.

Dr. A. P. Goswami

Dr. S. S. Upadhyay

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Mrs. Usha Rathore

Part A: Introduction				
Program: M.Sc. (Physics)		Semester: II	Year: First	w.e.f. : 2024-2025
1.	Course Code	PHYP 105		
2.	Course Title	LAB - II General Physics (Condensed Matter Physics, Nuclear Physics, Atomic and Molecular Physics)		
3.	Course Type	Practical		
4.	Pre- requisite	Nil		
5.	Course Learning Outcomes (CLO)	At the end of this course, the student will be able to: • Measure lattice parameter and index powder photograph to understand atomic arrangements. • Identify unknown samples using powder diffraction to determine their composition. • Measure superconductivity transition temperature and transition width of a high-temperature superconductor. • Draw B-H curve of iron using solenoid and find energy loss from hysteresis. • Determine Hall coefficient of a semiconductor sample to study its electrical behaviour in a magnetic field. • Study characteristics of GM counter, a device to detect ionizing radiation. • Explore gamma ray absorption process to understand material interactions. • Determine range and energy of alpha particles using a spark counter. • Study Solid State Nuclear Track Detector for detecting ionizing radiation in solids. • Identify particles by visual range in Nuclear Emulsion to study particle interactions. • Measure optical spectrum of alkali and alkaline earth atoms to study their light emission. • Measure band positions and vibrational constants of N2 molecule to understand its properties. • Analyze fluorescence spectrum of I2 vapor to study iodine molecules' light emission. • Measure Raman spectrum of CCl4 to study molecular vibrations.		
6.	Credit Value	4		
7.	Total Marks	IA: Na ESE: 100 Marks	Max. marks : 100 Min. Marks: 36	

Part B: Contents of the Course	
List of experiments	
S.N.	Title

1.	Measurement of lattice parameter and indexing of powder photograph.
2.	Identiffcation of unknown sample using powder diffraction method.
3.	To measure the superconductivity transition temperature and transition width of a high temperature superconductor.
4.	To draw the B-H curve of Fe using Solenoid & determine energy loss from Hysteresis.
5.	To determine the Hall coefficient of a semiconductor sample.
6.	To study the characteristics of GM counter.
7.	Study of gamma ray absorption process.
8.	Determination of the range and energy of alpha particles using spark counter.
9.	To Study the Solid State Nuclear Track Detector.
10.	Identification of particles by visual range in Nuclear Emulsion.
11.	Measurement of optical spectrum of an alkali atom.
12.	Measurement of optical spectrum of alkaline earth atoms.
13.	Measurement of Band positions and determination of vibrational constants of N2 molecule.
14.	Measurement and analysis of fluorescence spectrum of I2 vapour
15.	Measurement of Raman spectrum of CCl4.

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Semester Syllabus

M.Sc. Physics

Part A: Introduction				
Program: M.Sc. (Physics)		Semester: IV	Year: Second	w.e.f. : 2024-2025
1.	Course Code	PHYT 401		
2.	Course Title	Condensed Matter Physics -- II		
3.	Course Type	Theory		
4.	Pre- requisite	Nil		
5.	Course Learning Outcomes (CLO)	At the end of this course, the student will be able to : • Understand superconductivity and effect of magnetic field on Superconductors. • The students will have solid understandings of the topics include dielectric properties and Ferroelectricity. • Gain deep knowledge on semiconductors and its applications. • Explain phonons vibrations and thermal property . • Understand concept of phonon.		
6.	Credit Value	4		
7.	Total Marks	IA: 20 Marks ESE: 80 Marks	Max. marks: 100 Min. Marks: 36	

Part B: Contents of the Course		
Total No. of the Lecture/ Hour: 60		
Unit	Topic	No. of Hour
I.	**Super conductivity:** Experimental facts-occurrence, Effect of magnetic fields - Meissner effect, Entropy and heat capacity, Energy gap, Microwave and infrared properties. Type I and II superconductors, theoretical explanation, thermodynamics of super conducting transition, London equation, Coherence length , BCS Theory, single particle Tunnelling , Josephson tunnelling, DC and AC Josephson effects, High temperature super conductors, SQUIDS.	12
II.	**Dielectric Properties and Ferroelectricity:** Dielectrics and ferroelectrics, macroscopic electric field, local field at an atom, dielectric constant and polarizability, ferroelectricity, antiferroelectricity, piezoelectric crystals, ferroelasticity, electrostriction, Landau's theory, first order and second order transition, order parameter and critical exponents, examples of phase transition: Solid-liquid, ferroelectric, paraelectric, ferromagnetic, paramagnetic.	12

III.	**Semiconductors:** Energy bands in semiconductor, Intrinsic and Extrinsic semiconductors. Drift velocity, mobility carrier concentration and Fermi level for intrinsic and extrinsic semiconductors electrical conductivity of Semiconductors, elementary ideas of Nano structure, definition, properties different methods of preparation, applications.	12
IV.	**Lattice dynamics :**Interatomic forces and lattice dynamics of simple metals, ionic and covalent crystals, lattice dynamics of linear monoatomic and diatomic lattices, optical and acoustical modes.	12
V.	**PHONONS; vibrations and thermal property:** Quantization of elastic waves, phonons, inelastic neutron scattering by phonons , anharmonicity, thermal expansion ,lattice thermal conductivity.	12

Part C - Learning Resources

Text Books, Reference Books, E -Resources

Text Books:

1. Kittel: solid state physics, Wiley
2. Azroff: Introduction to solids, Pan Macmillan
3. Verma and Shrivastava: Crystallography for solid state Physics, S. Chand

Reference Books:

1. Solid State Physics, N. W. Ashcroft and N.D. Mermin(Ist Ed., Cengage Learning, 2003)
2. Elementary Excitations in Solids, D. Pines ,CRC press, 1999
3. The Wave Mechanics of Electrons in Metals, S. Raimes ,North-Holland ,1970
4. Lecture Notes on Electron Correlation & Magnetism, P. Fazekas ,World Scientific, 1999
5. Introduction to Superconductivity,M. Tinkham ,Dover Publications Inc.
6. Condensed Matter Physics,M. Marder,2nd Ed., John Wiley & Sons, 2010)
7. Principles of Condensed Matter Physics,P.M. Chaikin and T.C. Lubensky, Cambridge University Press, 1995

E -Resources:

1. https://youtu.be/Ofzd2ZqFvjo
2. https://archive.nptel.ac.in/courses/115/105/115105099/
3. https://nptel.ac.in/courses/115105099
4. http://www.cense.iisc.ac.in/course/applied-solid-state-physics

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Part A: Introduction				
Program: M.Sc. (Physics)		Semester: IV	Year: Second	w.e.f. : 2024-2025
1.	Course Code	PHYT 402		
2.	Course Title	Nuclear Physics		
3.	Course Type	Theory		
4.	Pre- requisite	Nil		
5.	Course Learning Outcomes (CLO)	At the end of this course, the student will be able to: • Understand nuclear physics fundamentals: atomic structure, isotopes, nuclear forces. • Comprehend nuclear models and properties: liquid drop model, semi-empirical mass formula, shell model. • Analyze nuclear decay processes: α decay, β decay, particle energy measurement, Fermi theory of decay. • Study nuclear reactions and energy: conservation laws, nuclear chain reactions, fusion. • Familiarize with counters, accelerators, and elementary particles: radiation detectors, particle accelerators, elementary particle classification.		
6.	Credit Value	4		
7.	Total Marks	IA: 20 Marks ESE: 80 Marks	Max. marks : 100 Min. Marks: 36	

Part B: Contents of the Course

Total No. of the Lecture/ Hour: 60

Unit	Topic	No. of Hour
I.	**Basic concepts:** atomic structure, isotopes, and nuclear forces, Differences between nuclear physics and atomic physics, Nuclear Structure. Nuclear constituents: Nucleons, Nuclear size and mass, nuclear density(mass density), mass defect, binding energy, binding energy per nucleon, Introduction(spin, parity quadrupole). Nuclear models: liquid drop model, semi empirical mass formula, shell model, Magic numbers, spin orbit coupling , determination of total angular momentum, Using shell model (spin, parity, magnetic moment, quadrupole moment) .	12
II.	**Nuclear Decay:** Nuclear stability, Introduction to Nuclear Decay, Overview of nuclear decay processes α decay: Measurement of particles energies, particle spectra, Geiger-Nuttal law, barrier penetration applied to a decay,	12

	β decay: shape of spectrum, neutrino hypothesis, detection of neutrino, Fermi theory of decay kurie plot, mass of neutrino, half lives, Allowed and forbidden transitions, selection rules.	
III.	**Nuclear Reactions and Energy:** Conservation laws, Q equation theories of nuclear reactions, partial wave analysis, compound nucleus formation and breakup resonance scattering and reactions. Neutrons released in fission process, cross sections, nuclear chain reactions, nuclear reactor, four factor formula critical size of reactor, General aspect of reactor design. Fusion, thermonuclear energy, prospect of controlled fusion energy.	12
IV.	**Counters and Accelerators:** Gas filled counter, solid state counter, scintillation counters, neutron detection. Accelerators: Cyclotron, linear accelerators, betatron, electron synchrotron, proton synchrotron.	12
V.	**Elementary Particles:** Classification of elementary particles, basic particle interactions, conservation laws, invariance under parity, CP, time, CPT, Electron and positron, proton and Antiproton, neutrino and antineutrino, mesons, and hyperons: (their masses, decay modes and reactions) elementary particle symmetry [SU(2),SU(3)], Quark Theory.	12

Part C - Learning Resources

Text Books , Reference Books, E -Resources

Text Books:

1. Nuclear Physics ; Ray and Nigam (Wiley Eastern ltd)
2. Nuclear Physics; I Kaplan (Narosa)
3. Introduction to nuclear Physics; H.A. Enge (Addison wesley)
4. Concepts of Nuclear Physics; B.L.Cohe, McGraw Hill Higher Education

Reference Books:

1. Introductory Nuclear Physics; Kenneth S. Krane, Wiley
2. Nuclear Physics: Principles and Applications; John Lilley,2006, Wiley
3. Nuclear and Particle Physics: An Introduction; Brian R. Martin and Graham Shaw, 3rd ed., Wiley

E -Resources:

1. https://nptel.ac.in/courses/115103101
2. https://nptel.ac.in/courses/115104043
3. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=+4mIqRALksfwQH9v8YSMrw==

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Part A: Introduction				
Program: M.Sc. (Physics)		Semester: IV	Year: Second	w.e.f. : 2024-2025
1.	Course Code	PHYT 403		
2.	Course Title	Atomic and Molecular Physics		
3.	Course Type	Theory		
4.	Pre- requisite	Nil		
5.	Course Learning Outcomes (CLO)	At the end of this course, the student will be able to: • Apply principles of quantum mechanics to the study of atoms and its behaviour. • Understand spectroscopy of the hydrogen and multi-electron atoms. • Understand of quantum behaviour of atoms in external electric and magnetic fields. • Familiar with the working principle of laser for its application purposes.		
6.	Credit Value	4		
7.	Total Marks	IA: 20 Marks ESE: 80 Marks	Max. marks : 100 Min. Marks: 36	

Part B: Contents of the Course		
Total No. of the Lecture/ Hour: 60		
Unit	Topic	No. of Hour
I.	**Atomic Structure and Spectra:** Spectra of hydrogen and hydrogen like atoms, Reduced mass of electron, Variation of Rydberg constant, Bohr-Sommerfeld model of Hydrogen Atom, Sommerfeld's Relativistic correction for energy levels of hydrogen atom, Vector atom model, spin-orbit interaction and fine structure in alkali spectra.	12
II.	**X-ray Spectroscopy and Magnetic Effects:** Spectra of Helium, Alkaline earth atoms, Singlet -Triplet series, L-S and J-J coupling Interaction energy. Continuous X-ray spectrum. Dependence on voltage, Duane and Hunt's law, Characteristics X-ray, Moseley's law, Doublet Fine structure of X-ray spectra. Effect of of magnetic field on energy levels (mono-valent atoms), Gyromagnetic ratio for orbital and spin motion, Lande g-factor, weak and strong field effect(normal and anamolous zeeman effect, Baschen-Back effect), Stark effects.	12

III.	**Molecular Energy Levels and Spectroscopy:** Line broadening mechanism, Electron spin resonance, Nuclear magnetic resonance chemical shift. Types of molecules, Diatomic linear symmetric top, asymmetric top molecules, Energy levels, selection rules, spectra of symmetric top and asymmetric top molecules. Rotational energy and spectra of diatomic-molecules as rigid rotor and non rigid rotor, selection rule, internuclear distance, isotope effect.	12
IV.	**Electronic Transitions and Vibrational-Rotational Spectra:** Vibrational energy of diatomic molecule, Energy levels, spectrum, Anharmonicity of molecular vibration, Energy levels, spectrum. Molecule as vibrating rotor, rotational, vibrational and Raman spectra of diatomic molecule, selection rules. Electronic band system sequences, progression, Frank Condon principle, Born-Oppenheimer approximation and R branches, IR spectrometer.	12
V.	**Lasers:** spontaneous and stimulated emission, Einstein A & B coefficients. Optical pumping, population inversion, rate equation. Modes of resonators and coherence length.	12

Part C - Learning Resources

Text Books, Reference Books, E -Resources

Text Books:

1. Introduction to Atomic Spectra; H.E White; Mcgraw-Hill Education.
2. Atomic Spectra and Atomic Structure; Herzberg; Dover Publications Inc.
3. Molecular Structure and Spectroscopy, G. Aruldhas; Second Edition 2007, Prentice Hall Of India, New Delhi
4. Atomic & Molecular Spectra; Raj Kumar,Kedar Nath Ram Nath, New Delhi

Reference Books:

1. Fundamentals of Molecular Spectroscopy; Banwell; Mcgraw-Hill (India) Ltd.
2. Introduction to Molecular Spectroscopy; Barrow; Mcgraw-Hill Education.
3. Modern Spectroscopy; Hollas; Wiley India Pvt Ltd.
4. Atomic and Molecular Spectroscop; Sune Svanberg; 1992, Second Edition, pringer Verlag, Berlin.

E -Resources:

1. https://nptel.ac.in/courses/115101003
2. https://nptel.ac.in/courses/115105100
3. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=4mfqRALksfwQH9v8YSMrw==

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Semester Syllabus

M.Sc. Physics

Part A: Introduction				
Program: M.Sc. (Physics)		Semester: IV	Year: Second	w.e.f. : 2024-2025
1.	Course Code	PHYT 404		
2.	Course Title	Electronics - IV		
3.	Course Type	Theory		
4.	Pre- requisite	Nil		
5.	Course Learning Outcomes (CLO)	At the end of this course , the student will be able to: • Understand the evolution and architecture of microprocessors, memory systems, and local area networking (LAN). • Master the ALU, timing and control unit, registers, data/address c configuration, and instruction set of Intel 8085 microprocessor. • Gain proficiency in addressing modes, instruction execution, and data flow in Intel 8085 programming. • Acquire knowledge of optical fiber communication, including structure, classification, refraction, and total internal reflection. • Explore types of optical fibers, cables, splicing techniques, connectors, and analyze the advantages and disadvantages of optical fiber communication.		
6.	Credit Value	4		
7.	Total Marks	IA: 20 Marks ESE: 80 Marks		Max. marks: 100 Min. Marks: 36

Part B: Contents of the Course		
Total No. of the Lecture/ Hour: 60		
Unit	Topic	No. of Hour
I.	**Microprocessors & Memory Essentials:** Microprocessor & Micro Computers:-Evolution of Microprocessor, Internal Microprocessor Architecture, Architecture of digital Computer. Memory: Semiconductor memories (RAM, ROM, PROM, EPROM, Shift register), Magnetic Memory: Floppy disks, Hard disks, Optical Disks, Magnetic Bubble Memory.	12
II.	**Intel 8085: Architecture and Instruction Execution:** Intel 8085; ALU, Timing and Control Unit, Registers, Data and Address Bus, Pin Configuration. Instruction Cycle: Op-code and Operands , Fetch Operation, Execute Operation, Machine Cycle, Instruction and Data flow. Time Diagram: Opcode Fetch Cycle, Memory read, I/O Read, Memory write, I/O Write.	12

III.	**Addressing Modes and Instruction Set:** Direct Addressing, Register addressing, Register Indirect Addressing, immediate Addressing, implicit Addressing. Instruction set of 8085: Data transfer group, Arithmetic group, Logical group.	12
IV.	**Assembly Language Programming:** Addition of Two 8-bit-number, Sum 8-bit , Addition of Two 8-bit number, sum 16-bit, 8-bit subtraction, Find the largest number in data array, To arrange a series of numbers in Descending order, Find the smallest number in a data array, To arrange a data array in ascending order, Shift of 8-bit number of left by one bit and two bit , Shift of 16-bit number by one and two bit.	12
V.	**Fundamentals of Optical Fiber and Fiber Optic Systems:** Optical Fiber: Introduction, structure, Classification, Refraction and Snell's law. Total internal refraction, Light propagations through and optical fiber, Acceptance angle for incident ray, Numerical Aperture, number of modes and cut-off parameter, single mode propagation, comparison of step and graded index fiber. Types of Optical Fiber: HPSUU, HPSIR, Halide fiber. Optical fiber cables: Multifiber cable, Splicing and connectors. Advantage and Disadvantage of optical fiber.	12

Part C - Learning Resources

Text Books, Reference Books, E -Resources

Text Books:

1. Fundamental of microprocessor and microcomputer, B. Ram, Dhanpat Rai Publication, New Delhi.
2. Microprocessor Architecture, programming and application with 8085/8086- Ramesh S. Gaonkar, Wiley Easter Ltd. 1987.

Reference Books:

1. Introduction to microprocessor, Aditya Mathur, Tata McGraw Hills New Delhi
2. Optical Fibres and Fibre Optic Communication Systems, Subir Kumar Sarkar, S. Chand & company Ltd.
3. Optical Fiber Communications (Principle and Practice) John M. Senior , Prentice Hall of India Pvt Ltd.

E -Resources:

1. https://nptel.ac.in/courses/108107029
2. http://nptel.ac.in/courses/108105102
3. https://www.allaboutcircuits.com/video-lectures/
4. https://electronics.stackexchange.com/
5. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=4mlqRALksfwQH9v8YSMrw

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