010

Syllabus

Of

M.Sc. Physics (Nanoscience)

M.S. University <u>Campus</u>
Saharanpur

Members of the Board of Studies:

S. No	Name	Signature
1.	Prof. Garima Jain, Convenor and Dean, Science faculty	Eer
2.	Prof. Ashok kumar Dimri	AV
3.	Dr. Sanjay Kumar Singh	Т
4.		•
5.	Prof. Beer Pal Singh, External Expert	Off OTHOLDSA
6.	Prof. R S Singh, External Expert	

Year	Semester	course Code	Course Title	Core Compulsory/ Elective/ Value Added	Theory/ Practical/ Project	Credits	Internal Marks	External Marks (Min Marks)	Total Marks	Minimum Marks (Int+Ext.)	Teaching Hours
		0720101	Mathematical Methods	Core Compulsory	Theory	4	25	75(25)	. 100	40	60
		0720102	Classical Mechanics	Core Compulsory	Theory	4	25	75(25)	100	40	60
ij	ss per	0720103	Quantum Mechanics I	Core Compulsory	Theory	4	25	75(25)	100	40	60
.020/Yea	Semester-VII as per	0720104	Semiconductor Physics and Devices	Core Compulsory	Theory	4	25	75(25)	100	40	60
NEP-2	Sem	0720180	PHYSICS LAB I	Core Compulsory	Practical	4	25	75(25)	100	40	. 60
-4 as per	Year-4 as per NEP-2020/Year-1 Semester-VII as	0820101	Statistical Mechanics	Core Compulsory	Theory	4	25	75(25)	100	40	60
Year		0820102	Electrodynamics Physics	Core Compulsory	Theory	4	25	75(25)	100	40	60
	III as per	0820103	Atomic and Molecular physics	Core Compulsory	Theory	4	25	75(25)	100	40	60
	Semester-VIII as	0820104	Nuclear and Particle Physics	Core Compulsory	Theory	4	25	75(25)	100	40	60
	Seme	0820180	PHYSICS LAB II	Core Compulsory	Practical	4	25	75(25)	100	40	60

my Ear Mg

	ter-III	0920101	OP-Amp Applications & Digital	Core Compulsory	Theory	4	25	75(25)	100	40	60
	0/Ѕешея	0920102	Condensed Matter Physics	Core Compulsory	Theory	4	25	75 (25)	100	40	60
	NEP-202	0920103	Introduction to Nano Science & Technology	Core Compulsory	Theory	4	25	75(25)	100	40	60
_	Semester-IXasperNEP-2020/Semester-III	0920180	Lab Work(based on the Contents of Theory Courses)	Core Compulsory	Practical	4	25	75(25)	100	40	60
)20/Year-	Semeste	0920165	Research Project	Core Compulsory	Project	4			100	40	
NEP-20	ester-	1020101	Quantum Mechanics-II	Core Compulsory		4	25	75 (25)	100	40	60
Year-5asperNEP-2020/Year-I	P-2020/Sem	1020102	Synthesis of Nano materials	Core Compulsory	Theory	4	25	75 (25)	100	40	60
\ \ \	Semester-XasperNEP-2020/Semester-IV	1020103	Characterization of Nano materials	Core Compulsory	Theory	4	25	75 (25)	100	40	60
	Semester IV	1020180	Lab Work (based on the contents of Theory Courses)	Core Compulsory	Practical	4	25	75 (25)	100	40	60
		1020165	Research Project	Core Compulsory	Project	4			100	40	

Art Eur By

Programme	e/Class: Bachelor (Research)	Year: 4 Sem	ester: 7
Subject: Pl	HYSICS	. :	
Course Cod	le: 0720101	Course Title: Mathematical Methods	
The resThe soluFourierSpecial	pleting this course students will be able to earch problems based on the complex var ation of various mathematical equations us series and transformation in some spectros	iables and integral of complex functions, sing Laplace transformation. scopic analysis. vhich may imparts skills for direct employabilit	<i>y</i> .
Credits: 4		Core Compulsory / Elective: Core compulsory	
Max. Marks	s: 75 + 25	Min. Passing Marks: 40	
Total No. of	Lectures-Tutorials-Practical (in hours pe	r week): L-T-P: 4-0-0	
Unit		Topics	No. of Lectures
ı	Special functions and polynomials		20
	Recurrence relations and special prope	polynomials and their generating function erties of $P_n(x)$ as solution of Legendre differentionality of $P_n(x)$, associated Legendre polynomia	al
		g function, recurrence relations, $J_n(x)$ as solutions of $J_n(x)$ when n is half and odd integer	
il	conditions, Complex Integration, Cauchy Taylor's and Laurent's Series (without do	ex variable, Analytic Function, Cauchy Riemann y 's integral theorem Cauchy's integral formula, erivation) Singularities, zeros and residue of orem, Evaluation of definite integrals of the adx and $\int_{-\infty}^{\infty} f(x)e^{bax}dx$	15

Ht Euroso

III	Fourier Series and Fourier Integral:	10
	Fourier series, Even and Odd function, Half range expansion, Function of arbitrary period, Physical applications of Fourier Series analysis, Fourier integral, Fourier integral for even and odd functions and its application.	
IV	Integral Transforms: Laplace Transform, First and second shifting theorems, Inverse LT by partial fractions, LT of derivative and integral of a function, Solution of initial value problems by using LT Fourier Transform, Fourier Cosine Transform, Fourier Sine Transform, two dimensional and three-dimensional Fourier transform, Fourier Transform of delta and Gaussian function	. 15

- 1. Kreyszig, E, "Advanced Engineering Mathematics" John Wiley & Sons.
- 2. Rajput, B.S., "Mathematical Physics" Pragati Prakashan, Meerut.
- 3. Das, H.K., "Mathematical Physics"

Suggestive digital platforms web links-

- 1. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
- 2. Swayam Prabha DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current-he/8
- 3. National Programme on Technology Enhanced Learning (NPTEL), https://www.voutube.com/user/nptelhrd

Suggested Continuous Evaluation Methods:

Continuous internal evaluation shall be based on allotted assignment and class tests. The marks shall be as follows:

Quiz/ Assignment	(10 marks)
Class Test	(15 marks)

At I Ser Box

ical Mechanics
icles, related conservation theorems, gian and Hamiltonian formulation. The ations of motion for conservative
on.
al problems using Lagrangian
nutual central force motion. cations.
Lations.
•
/ Elective: Core compulsory
ks: 40
0-0
No. of
Lectures
a system of particles,
Virtual work, generalized ocity-dependent potentials
n formulation, Generalized nmetries of space and time
rtin usio ic

Hamilton's principle, some techniques of the calculus of variations, Derivation of Lagrange's equation from Hamilton's principle, advantages of variational principle formulation, Principle of least action, Legendre transformations and Hamilton equations of motion, Cyclic coordinates and conservation theorems, Canonical transformation generating functions, Properties, Poisson bracket, Poisson

theorem, Relation of Poisson brackets, Hamilton Jacobi method.

Variational Principles and Hamilton Formalism:

Year: 4

Semester: 7

Programme/Class: Bachelor (Research)

IJ

At Son Color

111	Two Body Central Force Problem: Reduction to the equivalent one-body problem, Motion in a central force field, The Virial theorem, The inverse square law of force, The motion in central force in the Kepler problem.	15
IV	Rigid Body Dynamics and Small oscillations: Rotational motion, Moment of Inertia, Euler's theorem, Euler's Angles, Symmetric top, Concept of small oscillations, Expression of kinetic energy and potential energy for the problem of small oscillations, Frequencies of free vibration, and Normal coordinates.	15

- 1. Goldstein, H., "Classical Mechanics"
- 2. Rana, N.C. & Joag P.S., "Classical Mechanics"
- 3. Sommerfield A., "Physics"
- 4. Perceival & Richards D., "Introduction to Dynamics"

Suggestive digital platforms web links-

- 1. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
- 2. Swayam Prabha DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current he/8
- 3. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptellinl

Suggested Continuous Evaluation Methods:

Continuous internal evaluation shall be based on allotted assignment and class tests. The marks shall be as follows:

(10 marks)
(15 marks)

It an ag

Programme/Class: Bachelor (Research)		Year: 4	Semester: 7
Subject: PHYSICS			
Course Code: 0720103	Course	Fitle: Quantum Mechanics I	
Course Outcomes			

Course Outcomes:

After completing this course students will be able to understand

- The physical and mathematical basis of quantum mechanics for non-relativistic systems.
- The mathematical tools needed to develop the formal theory of quantum mechanics.
- The measurement process in quantum mechanics.
- The connection between measurement of results and the uncertainty relation.
- The application of wave function theory in quantum mechanics.
- The applicability of angular momenta in several branches of physics.
- The profound strength of approximate methods in problems like Stark effect, Zeeman effect, etc.

Credits: 4		Core Compulsory / Elective: Core compulsor	γ
Max. Mark	s: 75 + 25	Min. Passing Marks: 40	
Total No. o	f Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0	
Unit		Topics	No. of
	,		Lectures
ı	Probability density, Expect wave packets, Eigen value Postulates of Quantum me Hermitian operators, Dege Operators, Change of bas Commutator Algebra. Unc	Fime dependent and time independent, Operators, tation values, Principle of Superposition, Motion of es and eigen vectors, Bound and continuum states, echanics, Coordinate and momentum representation, eneracy, Orthonormality and Completeness, Unitary sis, Infinitesimal and finite unitary transformations, ertainty relation between two operators, Free particle herical well, Cylindrical well, Charge particle in a gen atom.	20
II	Kets, Bras and Operators, I harmonic oscillator in m Rotation generators, Sym	sformations: Id Bases, Dirac notation, Matrix representations of Matrix representation of Eigen value problem, Linear atrix formulation, Space and time displacements, metry and conservation laws. Symmetric and antiand Pauli Exclusion Principle.	12

Att En Or

111	Approximate Methods:	14
	Time independent first and second order perturbation theory for non-degenerate and degenerate levels, Variational method, and its application for Helium atom, WKB Approximation. Application of electric field (Stark effect), normal and anomalous Zeeman Effect.	
IV	Theory of Angular momentum:	14
	Commutation relations involving angular momentum operators, the eigenvalue spectrum, Infinitesimal and finite rotations, Matrix representation of J, Addition of angular momentum, Clebsch-Gordon coefficients, Spin angular momentum, Spin wave functions, Pauli matrices, Precession of an electron in magnetic field, Addition of spin and orbital angular momentum.	

- 1. Liboff, R.L., "Introductory Quantum Mechanics".
- 2. Tyagi, I.S., "Principle of Quantum Mechanics".
- 3. Khare, S.P., "Quantum Mechanics and Atomic Physics".
- 4. Schiff, L.I., "Quantum Mechanics".
- 5. Zettili, N., "Quantum Mechanics: Concepts and Applications".
- 6. Griffiths, D.J., "Introduction to Quantum Mechanics".

Suggestive digital platforms web links-

- 1. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
- 2. Swayam Prabha DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8
- 3. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/uptelhrd

Suggested Continuous Evaluation Methods:

Continuous internal evaluation shall be based on allotted assignment and class tests. The marks shall be as follows:

Quiz/ Assignment	(10 marks)
Class Test	(15 marks)

At Ear Pag

Subject: PHYS	SICS		
Course Code: 0720104		Course Title: Semiconductor Physics and Device	ces
The c compBasicHavin& Op unde	ting this course students will be able onduction mechanism of elemental conents and circuits. phenomenon of semiconductors, it of ng the knowledge of semiconductors perational amplifier, students ma	can be used for the fabrication of modern devices, junction diodes, transistor biasing, feedback y perform better in competitive exams as roelectronic Industries and find job opportunity	s. in amplifiers well as may
Credits: 4		Core Compulsory / Elective: Core compulsory	
Max. Marks:	75 + 25	Min. Passing Marks: 40	
Total No. of L	ectures-Tutorials-Practical (in hours	s per week): L-T-P: 4-0-0	
Unit		Topics	No. of Lectures
ı	Direct band and indirect band go concentrations; electron and hole dependence of carrier concentral carriers in electric and magnet mobility, effect of temperature and	enductors: -Elemental and compound semiconductors, ap semiconductors, The Fermi Level, Carrier e concentrations at equilibrium, temperature ations, degenerate semiconductors, drift of ic fields; The Hall effect, conductivity and and doping on mobility,, Diffusion of carriers in recombination, The continuity equation.	10
II	Reverse bias breakdown, Zener junction, Schottky diode. Transistor current components configurations, Input output cl modulation, Transistor load lines	charge region, Band diagram of P-N junction, diode, Tunnel diode. Metal semiconductor and parameters, Transistor CB, CE, CC paracteristics, Early Effect and base width, Transistor as an amplifier, Graphical analysis or biasing and thermal stabilization.	15

Year: 4

Semester: 7

Programme/Class: Bachelor (Research)

At Com Org

111	Field Effect Transistors: Construction and characteristics of JFET, transfer characteristics, The FET small signal model, Measurement of gm and rd, JFET fixed-bias, Self-bias and voltage divider configurations, JFET source follower (common-Drain configuration), JFET Common-Gate configuration, Depletion and enhancement type MOSFETs. Idea of NMOS, PMOS and CMOS.	15
IV	Feedback in Amplifiers and Basics of Operational Amplifiers: Feedback concept, Effect of negative feedback, Voltage-series feedback, Current-series feedback, Voltage-shunt feedback, Current-shunt feedback. Differential amplifier and its configurations, Op-Amp Block diagram, Schematic symbol and terminals of 741, D.C. power supplies for an Op-Amp, Ideal Op-Amp, Equivalent circuit of an Op-Amp, Important characteristics of an ideal Op-Amp, Practical Op-Amp characteristics, Ideal voltage transfer curve, Open loop operation of an Op-Amp. Op-Amp with negative feedback (closed loop configuration), concept of virtual short and virtual ground. Inverting and non-inverting amplifiers.	

- 1. Sze, S.M. & Kwok, K. Ng, "Physics of Semiconductor Devices".
- 2. Streetman, B.G., "Solid State Electronic Devices".
- 3. Boylestad, R.L. & Nashelsky, L., "Electronic Devices and Circuit Theory".
- 4. Millman, J. & Halkias, C.C., "Integrated Electronics".
- 5. Chattopadhyay, D & Rakshit, P. C., "Electronics Fundamental and Application".
- 6. Kumar, Balbir & Jain, S.B., "Electronic Devices and Circuits".

Suggestive digital platforms web links-

- 1. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
- 2. Swayam Prabha DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current he/&
- 3. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user-optelbrd

Suggested Continuous Evaluation Methods:

Continuous internal evaluation shall be based on allotted assignment and class tests. The marks shall be as follows:

Quiz/ Assignment	(10 marks)
Class Test	(15 marks)

All on los

Subject: PHYSICS	
Course Code: 0720180	Course Title: PHYSICS LAB I
 The student will gain practical knowledge well as understanding troubleshooting. 	
Credits: 4	Core Compulsory / Elective: Core Compulsory
Max. Marks: 75 + 25	Min. Passing Marks: 40
Total No. of Lectures-Tutorials-Practical (in hours p	per week): L-T-P: 0-0-18

Year: 4

Programme/Class: Bachelor (Research)

Hot for and

Semester: 7

List of Experiments-

Choose any six experiments from the given list.

- 1. To study the frequency response and to calculate the various parameters such as input Impedance, output impedance, current gain and voltage gain of the emitter follower.
- 2. To study the Drain characteristics and Mutual characteristics of a N/P channel MOSFET
- 3. To study the characteristics of a junction field effect transistor and to calculate the various parameters as
 - (a) drain dynamic resistance
- (b) mutual conductance
- (c) amplification factor
- To study and compare the following transistor biasing techniques and calculate the Bias voltage and transistor currents in-
 - (a) Single battery biasing (b) Two battery biasing (c) Voltage divider bias (d) Collector to base bias
- To study the forward and reverse bias characteristics of the following diodes-
 - (a) Germanium diode
- (b) Silicon diode (c) Zener diode
- (d) Light emitting diode
- 6. To study the characteristics of a P-N junction and determine -
 - (a) Reverse saturation current
- (b) Material constant
- (C) Determination of temperature coefficient of the Junction (d) Junction voltage and energy band gap.
- 7. To study the diffraction pattern of a semiconductor laser and
 - Determine the width of the single slit from the diffraction pattern. (a)
 - Measure the thickness of the wire/obstacle. (b)
 - Determine the wavelength of the laser light using diffraction grating. (c)
- To study the absorption spectrum of iodine vapour and to obtain -
 - Energy level diagram for iodine molecule (a)
 - Deducing the electronic excitation energy for iodine molecule (b)
 - Deducing force constant for iodine molecule (c)
- 9. To study the characteristics of a LED and -
 - (a) Determination of Plank's constant
- (b) Determine the material constant
- (c) Determine the temperature coefficient

IV	Spectroscopic Techniques:	
''		10
	Infrared/FTIR Spectroscopy, General description and working of dispersive and	
	FTIR instrument. Interpretation of FTIR spectra. Raman spectroscopy. Nuclear	
	Magnetic Resonance, Chemical Shift, NMR Spectrometer. NMR spectrum	
	analysis.	

- 1. White, H.E., "Introduction to atomic spectra".
- 2. Herzberg, "Spectra of diatomic molecules".
- 3. Weissbluth, M., "Atoms and Molecules".
- 4. Slater, "Quantum theory of Atomic Structure, Vol. 1".
- 5. Slater, "Quantum theory of Molecules and Solids".
- 6. Banwell, C.B., "Fundamentals of Molecular Spectroscopy".
- 7. Barrow, G.M., "Introduction to Molecular Spectroscopy".
- 8. Brown, J.M., "Molecular Spectroscopy".
- 9. Larkin, Peter J., "Infrared and Raman Spectroscopy: Principles and Special Interpretation".
- 10. Ghatak, Ajoy & Thyagarajan, K., "Lasers: Fundamentals and Applications".

Suggestive digital platforms web links-

- 1. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.asnx
- 2. Swayam Prabha DTH Channel,

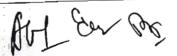
https://www.swayamprabha.gov.in/index.php/program/current_he/8

4. National Programme on Technology Enhanced Learning (NPTEL), https://www.voutube.com/user/nptelhrd

Suggested Continuous Evaluation Methods:

Continuous internal evaluation shall be based on allotted assignment and class tests. The marks shall be as follows:

Quiz/ Assignment	: :	(10 marks)
Class Test	· ·	(15 marks)



10. To study the characteristics of a Photocell and –

(a) Determination of Plank's constant

(b) Determine the material constant

(c) Determine the temperature coefficient

11. To study a single stage R-C coupled amplifier cum feedback amplifier and draw its frequency Response curve and measure –

(a) Voltage/Power gain

(b)

Variation of gain

(c) Input/Output Impedance

(d Phase relationship between input and output waveforms

12. To study a single stage L-C coupled amplifier cum feedback amplifier and draw its frequency response curve and measure –

(a) Voltage/Power gain

(b) Variation of gain

(c) Input/Output Impedance

(d) Phase relationship between input and output waveforms

13. To study the dielectric constant and determine the Curie temperature of the ferroelectric ceramics.

14. To demonstrate the concept of quantization of energy levels in accordance with the Bohr model of atoms by Frank Hertz experiment.

15. To trace a B-H curve for a ferro-magnetic material using CRO and to find magnetic parameters from The B-H curve

16. To calculate the resistivity of a semiconductor by Four-Probe method at different temperatures.

Suggested Continuous Evaluation Methods:

Continuous internal evaluation shall be based on allotted assignment and class tests. The marks shall be as follows:

Record File	(15 Marks)
Viva Voce	(05 Marks)
Class Interaction	(05 Marks)

At San out

Programme/Class: Bachelor (Research)	Year: 4	Semester: 8
Subject: PHYSICS		, _
Course Code: 0820101	Course Title: Statistical Mechanics	

Course Outcomes:

Credits: 4

After completing this course students will be able to understand

- The basic knowledge of statistical mechanics.
- Calculation of statistical quantities of various systems.
- The ensemble theory required for macroscopic properties of the matter in bulk in terms of its constituents.

Core Compulsory / Elective: Core compulsory

- The analysis of properties of ideal Bose gas, Bose-Einstein condensation, liquid helium and electron gas.
- Various theories and models of cluster expansion and fluctuations of thermodynamic variables.
- Explanation of theoretical aspects of order-disorder phase transition in various systems.

		·	
ax. Marl	ks: 75 + 25	Min. Passing Marks: 40	
tal No.	of Lectures-Tutorials-Practical (in ho	urs per week): L-T-P: 4-0-0	
			No. of
Unit		Topics	Lecture
1	Ensembles and Statistics of Ideal Gas System:		15
	- space and □ - space, concept of Macrostates, Number of accessible canonical and grand canonical enfunction of microcanonical, canon	mechanics. Analysis of phase space, phase points, ensemble, density of phase points, Microstates and e microstates. Detailed analysis of micro-canonical, assembles. Partition function formulation. Partition ical and grand canonical ensembles. The entropy of ensemble, Gibbs paradox, Sackur-Tetrode equation	
11	Quantum Statistical Mechanics:		20
	Postulates of quantum statistical quantum statistics, identical particle and particle distribution function of and pressure of B.E. gas. Bose Eir Transition in liquid ⁴ He, Superfluid	cal mechanics to quantum statistical mechanics. mechanics, Density matrix, Indistinguishability and les and symmetry of wave functions. Basic postulate f Bose Einstein statistics. Energy, number of particles astein Condensation, Thermal properties of B.E. gas, dity in ⁴ He. Basic postulate and particle distribution Energy, number of particles, temperature and pressure extron gas. Thermionic Emission	

At En Pos

111	Statistical models for order-disorder phase transition:	15
	Cluster expansion for a classical gas, virial equation of state, first and second order phase transition, Ising model, mean-field and Heigenburg theories of Ising model, Exact solutions in one-dimension, Landau theory of phase transition, Landau theory of liquid He-II, critical exponents.	
IV	Fluctuations:	10
	Introduction to non-equilibrium process, mean square deviation, Energy and density fluctuations, one dimensional random walk, Random walk and Brownian motion, Langevin theory of Brownian motion and relation with diffusion equation, The Fokker-Plank equation	

- 1. Reif, F., "Statistical and Thermal Physics".
- 2. Huang, K., "Statistical Mechanics".
- 3. Pathria, R.K., "Statistical Mechanics".
- 4. Kubo, R., "Statistical Mechanics".
- 5. Landau & Lifshitz, "Statistical Physics".
- 6. Agarwal, B.K. & Eisner, M., "Statistical Mechanics".
- 7. Gopal, E.S.R., "Statistical Mechanics and properties of matter, theory and application"

Suggestive digital platforms web links-

- 1. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
- 2. Swayam Prabha DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8
- 3. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptellind

Suggested Continuous Evaluation Methods:

Continuous internal evaluation shall be based on allotted assignment and class tests. The marks shall be as follows:

Quiz/ Assignment	(10 marks)
Class Test And The A	(15 marks)

At on los

Programme/Class: Bachelor (Research)	Year: 4	Semester: 8
Subject: PHYSICS		
Course Code: 0820102	Course Title: Electrodynamics Physics	

Course Outcomes:

After completing this course students will be able

- Basics of electrostatics, magnetostatics and electromagnetism.
- Concepts of field produced by stationary charged distribution in free space ,metals and dielectrics.
- About the field produced by steady currents in free space and matter and different behavior of materials in magnetic field .
- Basic idea of time varying fields and fundamental equations of electromagnetism.
- The computational skills in solving basic problems of electromagnetism.
- Basic concepts in electromagnetic wave propagation in different media and at interfaces.

Credits: 4		Core Compulsory / Elective: Core compulsory	•
Max. Marks: 75 + 25		Min. Passing Marks: 40	
Total No. of	Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0	
Unit		Topics	No. of Lectures
1	Conductors, Solution of Equations, Methods of in Point charge near a grou Dielectrics and Polarizat	ications, divergence and Curl of E, Electrostatics of f electrostatic problems: Laplace's and Poisson's nages, point charge near an infinite conducting plane, anded conducting sphere, Electrostatic of Dielectrics: ion, Field of polarized object, Electric field inside cement, Linear dielectrics.	15
II	elementary applications, I Magnetostatic fields in M	ady currents; Biot-Savart Law, Ampere's Law and Divergence and curl of B, Magnetic vector potential, Matter, Magnetization, field of a magnetized object, matter, linear and nonlinear magnetic media; sis loop.	15

AT on of

7	1	•	•
t	ſ.	•	ı

111	Time Varying Fields: Faraday's laws of electromagnetic induction (Integral and Differential form), Maxwell's displacement current, Maxwell's equations in free space and dielectrics, Boundary conditions, Poynting theorem, Lienard Wiechert potentials due to a point charge, Field of a point charge in motion, Power radiated by accelerated charges.	15
IV	Plane Electromagnetic Wave: Electromagnetic waves in free space, dielectrics and conductors, Reflection and Refraction of EM Waves at an interface between dielectrics (normal and oblique incidence), transmission, absorption, Fresnel's relation of polarization by reflection and total internal reflection, Reflection from conducting surface.	15

- 1. Jackson, J.D., "Classical Electrodynamics".
- 2. Reitz, J.R., Milford, F.J. & Christy, R.W., "Foundations of Electromagnetic Theory".
- 3. Griffiths, David J., "Introduction to Electrodynamics".
- 4. Verma, H.C., "Classical Electrodynamics".

Suggestive digital platforms web links-

- 1. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
- 2. Swayam Prabha DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8
- 3. National Programme on Technology Enhanced Learning (NPTEL), https://www.vontube.com/user/notelhrd

Suggested Continuous Evaluation Methods:

Continuous internal evaluation shall be based on allotted assignment and class tests. The marks shall be as follows:

Quiz/ Assignment	(10 marks)
Class Test	(15 marks)

AT gar Out

Programme /Class: Bachelor (Research)	Year: 4	Semester: 8
Subject: PHYSICS		
Course Code: 0820103	Course Title: Atomic a	and Molecular Physics

Course Outcomes:

Credits: 4

After completing this course students will be able to understand

- Concepts of atomic spectra of Hydrogen atoms and similar valence electron atoms.
- Interpretation of atomic spectra for many electron atoms.
- Change in behavior of atoms in external applied electric and magnetic field and corresponding changes in observed spectra.
- The rotational, vibrational, electronic and Raman spectra of molecules.
- Different characterization techniques like IR/FTIR, Raman, etc.
- Nuclear Magnetic Resonance (NMR) for structure elucidation of synthesized materials.

The knowledge of various material characterization techniques can impart skills to enhance direct/indirect employability.

Max. Marks:	75 + 25	Min. Passing Marks: 40	
Total No. of L	ectures-Tutorials-Practic	al (in hours per week): L-T-P: 4-0-0	
	Secret for adoles		No. of
Unit	Topics	E.	Lectures
	Relativistic corrections fine structure of hydro	spectra, Quantum states of an electron in Hydrogen atom. for energy levels of hydrogen atom. Concept of spin and ogen atom. Singlet and triplet States of Helium. Broad kali elements. Fine structure in Alkali Spectra.	15
II	Hartree and Hartree- Spectroscopic Terms: L terms for atoms; with t more equivalent optica	Central field approximation, atomic wave function, Fock approximations, Results of Hartree's theory, S coupling, Lande Interval rule, determination of spectral wo or more Non-equivalent optical electrons, and two or lelectrons. Breit's scheme. JJ coupling for many electron of field, Zeeman, Paschen-Bach & Stark effects.	15
111	Molecular Spectra an Vibrational-Rotational of Raman effect. Select fine structure of electranck-Condon princip	oproximation, Classification of Molecules, Types of d Molecular Energy States: Pure Rotational Spectra, Spectra, Raman Scattering, Classical and Quantum theory tion rules, Isotope effect, Formation of electronic spectra, ronic bands. Intensity distribution in electronic bands: ble. Explanation of intensity distribution in absorption and ranck-Condon principle.	20

Core Compulsory / Elective: Core compulsory

Un con out

Programme/Class: Bachelor (Research)			Year: 4	Sen	nester: 8
Subject: PHYS	SICS		:		
Course Code: (0820104	Course T	itle: Nuclear and Part	ticle Physics	
 Basics The dine Radiat Nuclea Gener physic 	ting this course students will be able s of nuclear Physics and Fermi theo ifferent aspects of nuclear physics. Fo tion wit matter ar Models magic numbers and General introduction of nucleus with moderal	ory of allow or example eral idea of e lern technol	ved β decay. i.e Interaction and December 1 elementary partcles. logy may help to per	rsue research ir	n nuclear
Credits: 4			npulsory / Elective: C	.ore compusor	y
Max. Marks:	75 + 25		sing Marks: 40		- المك
Total No. of Le	ctures-Tutorials-Practical (in hours p	er week): L	-T-P: 4-0-0	and the fire	
Unit	·:	Topics		MAN	No. of Lectures
1	General Introduction: Scattering of α particles, Mirror not protonic charged nuclear dime momentum and magnetic mom quantum number, Statistics of nucleapture, Partial wave analysis of nucleon potentials	ensions. N nent, electr lear particle n-p scatterio	luclear mass, Nucl ric quadrupole mor es, Isobaric spin conc	lear angular ment, Parity cept, Electron	
II	General β decay DISINTEGRATION: Fermi theory of allowed β decay. experiment, Internal conversion.		ervation of parity a	and Wu's	05
111	Interaction and Detection of Nuc Biological effects of radiation: Interaction of charged particles wit particles, Range and straggling chamber, Proportional counter Radiation monitoring and Dosime effects of radiation. Effects of ra Penetration and ionizing power of ra	th matter, S of electro ,G.M. co eters, Physicadiation on	Stopping power of he ons. Introduction o ounter ,scintillation cal effects of radiation water and aqueou	eavy charged of lonization counter . on, Chemical us solutions,	20

My En long

IV	Nuclear Models:	10
	Single particle, Individual particle model, predictions of shell model and magic numbers.	
V	Nuclear elementary particles:	
v	General idea of elementary particles, Conservation laws, CP and CPT invariance, introductions of hadrons, Quarks, leptons and mesons Gell-Mann Okubu mass formula, Formation of stars, Chandrashekhar limit, neutron rich matter and supernova explosion	10

- 1. Srivastava, B.B., "Fundamentals of Nuclear Physics".
- 2. Ghoshal, S.N., "Nuclear Physics" S. Chand Publications.
- 3. Tayal, D.C., "Nuclear Physics" Himalaya Publications.

Suggestive digital platforms web links-

- 1. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
- 2. Swayam Prabha DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8
- 3. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user-nytellind

Suggested Continuous Evaluation Methods:

Continuous internal evaluation shall be based on allotted assignment and class tests. The marks shall be as follows:

Quiz/ Assignment	(10 marks)
Class Test	(15 marks)

MI Car of

Programme/Class: Bachelor (Research)	Year: 4	Semester: 8
Subject: PHYSICS		
Course Code: 0820180	Course Title: PHYSICS LAB II	
Course Outcomes: After completing this course students will be able to The basic concepts of electronics through exp The concepts studied by them in the theory The practical knowledge of designing, assem troubleshooting. In-depth knowledge of Physics can be applied	periments. course and correlation with expending and testing electronic circuit	s as well as understanding
Credits: 4	Core Compulsory / Elective: Cor	e Compulsory
Max. Marks: 75 + 25	Min. Passing Marks: 40	300 1000
Total No. of Lectures-Tutorials-Practical (in hours per	week): I -T-P: 0-0-18	ACCURAGE NAME OF THE PARTY OF T

the ar mg

List of Experiments-

Choose another six experiments from the given list.

- 1. To study the frequency response and to calculate the various parameters such as input Impedance, output impedance current gain and voltage gain of the emitter follower.
- 2. To study the Drain characteristics and Mutual characteristics of a N/P channel MOSFET
- 3. To study the characteristics of a junction field effect transistor and to calculate the various parameters as
 - (a) drain dynamic resistance (b) mutual conductance (c) amplification factor
- 4. To study and compare the following transistor biasing techniques and calculate the Bias voltage and transistor currents in-
 - (a) Single battery biasing (a) Two battery biasing (c) Voltage divider bias (d) Collector to base bias
- 5. To study the forward and reverse bias characteristics of the following diodes-
 - (a) Germanium diode (b) Silicon diode (c) Zener diode (d) Light emitting diode
- 6. To study the characteristics of a P-N junction and determine -
 - (a) Reverse saturation current(b) Material constant(c) Determination of temperaturecoefficient of the Junction(d) Junction voltage and energy band gap.
- 7. To study the diffraction pattern of a semiconductor laser and
 - (a) Determine the width of the single slit from the diffraction pattern.
 - (b) Measure the thickness of the wire/obstacle.
 - (c) Determine the wavelength of the laser light using diffraction grating.
- 8. To study the absorption spectrum of iodine vapour and to obtain
 - (b) Energy level diagram for iodine molecule
 - (c) Deducing the electronic excitation energy for iodine molecule
 - (d) Deducing force constant for iodine molecule
- 9. To study the characteristics of a LED and -
 - (e) Determination of Plank's constant
- (b) Determine the material constant
- (c) Determine the temperature coefficient
- 10. To study the characteristics of a Photocell and
 - (a) Determination of Plank's constant
- (b) Determine the material constant
- (c) Determine the temperature coefficient

Kel can on

11.	To study a single stage R-C coupled amplifier cum feedback amplifier and draw its frequency
	Response curve and measure –

- (a) Voltage/Power gain
- (b) Variation of gain
- (c) Input/Output Impedance (d

Phase relationship between input and output waveforms

- 12. To study a single stage L-C coupled amplifier cum feedback amplifier and draw its frequency response curve and measure –
- (a) Voltage/Power gain
- (b) Variation of gain
- (c) Input/Output Impedance
- (d) Phase relationship between input and output waveforms
- 13. To study the dielectric constant and determine the Curie temperature of the ferroelectric ceramics.
- 14. To demonstrate the concept of quantization of energy levels in accordance with the Bohr model of atoms by Frank Hertz experiment.
- 15. To trace a B-H curve for a ferro-magnetic material using CRO and to find magnetic parameters from The B-H curve
- 16. To calculate the resistivity of a semiconductor by Four-Probe method at different temperatures.

Suggested Continuous Evaluation Methods:

Continuous internal evaluation shall be based on allotted assignment and class tests. The marks shall be as follows:

Record File	(15 Marks)
Viva Voce	(05 Marks)
Class Interaction	(05 Marks)

Art an mo

Programme /Class: MASTER OF SCIENCE(M.Sc	Year:5	Semester:9
Subject: PHYSICS		
Course Code: 0920101	Course Title: Op-Amp Applic Electronics	ations & Digital

Course outcomes:

After completing this course, students will be able to understand

- Design of various types of electronic circuits built around OP-Amp and study them experimentally.
- Operational amplifier based circuit analysis.
- Various steps of combinational logic circuit design.
- Working of Clocks and Sequential Logic Circuits:
- The concept of data storage and transfer.
- The basics of microprocessor 8085 and writing simple assembly language programs.

Credits:4	ts:4 Core Compulsory/Elective: Core compulsory		/
Max. Mar	ks: 75+25	Min.PassingMarks:40	
TotalNo.o	fLectures-Tutorials-Practical(inhours	sperweek):L-T-P:4-0-0	
Unit		Topics	No.of
			Lectures
	follower, Summing and Difference Sources: Voltage Controlled Volta Current Controlled Voltage Source, Non-Linear OP-Amp Circuits: Rectifit Triggers, Integrator and Differential Active Filter and Oscillators: Low Police Sources	p Inverting and Non-Inverting amplifier, voltage amplifier, Adder and Subtractor, Controlled ge Source, Voltage Controlled Current Source, Current Controlled Current Source. ers, Clippers, Clampers, Comparators and Schmitt	15
II	Boolean Algebra: Describing logic of for Boolean equations, Boolean The NAND and NOR gates. SOP and P maxterm notations, converting a trubolean equations: Algebraic simply variables, K-Map simplification met languagementing Don't Care conditions.	ombinational Logic Circuits: and timing diagrams ameters, TT Land MOS Logic Families circuits algebraically, Implementing logic circuits eorems, De Morgan's theorems, Universality of OS forms of Boolean equations, minterm and oth table to aPOS and SOP equation. Simplifying colification, Karnaugh Map (K-Map) up to four thod for Boolean equations: Pair, Quad, Octet. Arithmetic Circuits: HalfAdder, FullAdder, Half processing Circuits: Multiplexer, Demultiplexer,	15

Up Con cos

111	Clocks and Sequential Logic Circuits:	
	Clock Waveform, 555 Timer IC and its application as astable and mono stable multivibrator	15
	Flip Flops: NOR gate latch and NAND gate latch, Level Clocked and Edge-triggered, Flip-Flops,R-SFlip-Flop,D-FlipFlop,J-KFlip-Flop,T-FlipFlop,ExcitationTableofFlip-Flops, Flip-Flop timing considerations, Master/Slave Flip-Flops.	
	Counters: Asynchronous (Ripple) counters, Up and Down Counter, Asynchronous counter with Mod Number<2N, Synchronous counter, Synchronous counter design.	
	Register: Serial-in-serial out, Serial-in-parallel out, Parallel-in-serial out, Parallel-in parallel out, Shift Register, Shift Register counter (Ring Counter and Johnson Counter).	
IV	Analog/Digital Interfacing Memories and Microprocessor: Digital to Analog conversion: DAC specifications, Binary Weighted Register DAC, R/2R Ladder DAC. Analog to Digital Conversion: ADC specifications, Counter Type ADC, Successive Approximation ADC, Dual Slope ADC and Flash ADC. Basic Terms and Idea of Memory Devices. Microprocessor-8085: Architecture and its operations, Memory and I/O interfacing devices, Writing Assembly language Programs (Simple Cases of data transfer and arithmetic operations).	15

- 1. Gayakwad, R.A., "Op-Ampand Linear Integrated Circuit".
- 2. Tocci, RonaldJ., "Digital Systems, Principles and Applications".
- 3. Malvino ,A.P. & Leach,D.P., "Digital Principles and Applications".
- 4. Maini, AnilK., "Digital Electronics , Principles and Integrated Circuits".
- $5.\ Gaonkar, Ramesh, "Microprocessor Architecture, Programming and Applications with the 8085".$

Suggestive digital platforms web links-

- 1. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/Search Content.aspx and the property of th
- 2. Swayam Prabha- DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8
- 3. National ProgrammeonTechnologyEnhancedLearning(NPTEL),https://www.youtube.com/user/nptelhrd

Suggested Continuous Evaluation Methods:

Continuous internal evaluation shall be based on allotted assignment and class tests. The marks shall be as follows

Quiz/Assignment	(10marks)
ClassTest	(15marks)

Programm	e /Class: MASTER OF SCIENCE(M.Sc.)	Year:5	emester:9		
.Subject: PF					
Course Cod	Course Code: 0920102				
		Course Title: Condensed Matter Physics			
After compThe corX-ray diVariousElectror magnet	 Course outcomes: After completing this course, students will be able to understand The correlation and virtual lattice which is the key of structure property relation ship of any solid. X-ray diffraction techniques and its applications. Various crystal imperfections and their impacton properties of the material. Electronic and magnetic properties which may help to design new materials with desired electronic and magnetic properties. Basic concept of super conductivity and its application in various fields. 				
		· · · · · · · · · · · · · · · · · · ·			
Credits:4 Core Compulsory/Elective: Core compulsory					
Max .Mark	Max Marks: 75+25 Min.PassingMarks:40				
Total No. of Lectures - Tutorials - Practical (inhours perweek): L-T-P: 4-0-0					
Unit	. 1	Topics	No.of Lectures		
1	Crystal structure: Lattice, primitive and non primitive cell, Classification of Bravais lattice, Common crystal structures: NaCl and CsCl Structure, close-packed structure, X-ray diffraction,Reciprocallattice,andBrillouinzone;Pointdefects(Schottky&Frank el Defects) Imperfections, Line defects (Edge & Screw dislocations),				
II	Band Theory of solids: Different types of bonding in so hydrogen bonding & ionic bonding cohesive energy. Elastic propertie	lids, covalent, metallic, Vander Waal, g, Madelung constant of ionic crystals, s, phonons, lattice specific heat. Free cific heat. Drude model of electrical and			
III	Electronics Properties of Solids: Electrons in a periodic lattice: Bloch theorem, The Kronig-Penny Model, Effective mass of an electron, Tight-binding approximation, Cellular and pseudo potential methods, Fermi surface and Brillouin zones				
IV	Superconductivity:		10		
	Review of basic properties, N superconductors, thermodynami phenomenological theory, Flux qua	Neissner effect, Type-I and Type-I cs of superconductors, London's ntization. Elements of BCS theory.			

fre au long

1		10
	Weiss theory of ferromagnetism, Heisenberg model and molecular field	
	theory, Ferromagnetic domains, The Bloch-wall, Spin waves and Magnons,	
	Curie- Weiss law for susceptibility, Ferri and anti ferro-magnetic order	

- 1. Verma&Srivastava, "Crystallography for Solid State Physics".
- 2. Azaroff, "Introduction to Solids".
- 3. Pillai, S.O., "Solid State Physics".
- 4. Omar, "Elementary Solid-StatePhysics".
- 5. Aschr off & Mermin, "SolidStatePhysics".
- 6. Kittel, "Solid State Physics".
- 7. Chaikin&Lubensky, "Principles of Condensed Matter Physics".

Suggestive digital platforms weblinks-

- 1. UttarPradeshHigherEducationDigitalLibrary, http://heecontent.upsdc.gov.in/SearchContent.aspx
- 2. SwayamPrabha-DTHChannel,https://www.swayamprabha.gov.in/index.php/program/current_he/8
- 3. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd

Suggested Continuous Evaluation Methods:

Continuous internal evaluations hall be based on all otte dassignment and class tests. The marks shall be as follows

Quiz/Assignment	(10marks)	
ClassTest	(15marks)	

Att on low

Programme /Class: MASTEROFSCIENCE(M.Sc	:.) Year:5		Semester:9
Subject: PHYSICS			
Course Code: 0920103 Course Title: Introduction to Nano Science & Technology			nce & Technology
Course outcomes:			

After completing this course, students will be able to understand

- The basics of nanoscience and fundamental concepts behind size reduction in various properties of materials.
- The phenomena of size dependence of physical properties.
- Quantum Confinement in different dimensions.
- The electronic band structure and density of states of different types of nanostructures.

Credits	:4	Core Compulsory	
Max.M	x.Marks: 75+25 Min.PassingMarks:40		
Total No. of Lectures - Tutorials - Practical (inhours perweek): L-T-P: 4-0-0			
			No.of
Unit		Topics	Lectures
I	Fundamentals of Nano materials:		15
	History of Nano science & Nanotechnology, Feynman's vision on Nano Science & technology, bulk Vs Nano materials. Central importance of Nano scale morphology-small things making big differences, nanotechnology as nature's technology, clusters and magic numbers. Recent developments in Application of Nano materials and Carbon Nano tubes, challenges and future prospects of Nano materials.		
II	Size and shape dependent properties of Nano materials: Size and shape dependent properties, Melting points and lattice constants, Surface Tension, Surface energy .Mechanical properties, Optical properties Surface Plasmon resonance in metal nanoparticles and quantum size effect in Semiconductors ,Electrical conductivity :Surface scattering, change of electronic structure, Magnetic. properties: Ferroelectrics, dielectrics and super para magnetism.		15
111	Classification of nano materials:		15
	Classification based on the dimensionality,Zero dimensional nano structures: metal ,		
	semiconductor and oxide nano particles. One-dimensional, nano structures. nano wires		
	and nano rods,Two-dimensional nano structures: Thin films, Three dimensional nano		
	materials, Special Nanomaterials: Car	rbon fullerenes and carbon Nano tubes, From a	
	Graphene Sheet to a Nano tube, Single wall and Multi walled Nano tubes, Zigzag and		
	Armchair Nano tubes, Micro and meso porous materials,		'

Physics of Nano materials:	15
Idea of band structure of insulators semi conductors & conductors Group velocity, Concept of Effective mass & and Fermi surfaces, Localized particles Do Acceptors and Deep and shallow traps, Mobility, Density of states, variation of density states with energy and dimensions of the crystal Conductivity in relation to band structure confinement and its effects in Nanostructures i.e. Quantum well, Quantum and Quantum dot,	of

References/compulsory reading

- ${\bf 1.\ Charles P. Poole, Jr. Frank J. Owens, "Introduction to Nanotechnology" John Wiley \& Sons Inc. \\$
- 2. PradeepT."AtextbookofNanoscience&Technology"TataMcGraw-HillEducation2012.
- 3. Wilson , M., "Nanotechnology: Basic Science and Emerging Technologies"
- ${\bf 4.~G. Cao and Y. Wang, Nanostructures and Nanomaterials, 2nd Ed., Imperial College Press, 2004.}$
- 5. R.Kelsall,I.Hamleyand M.Geoghegan,NanoscaleScienceandTechnology,Wiley,2005.
- 6. K.J Klabunde, R.M. Richards, Nanoscale Materialsin Chemistry, 2 ndEd., Wiley, 2009.
- 7. G.Schmidt, Nanoparticles: from Theoryto applications, Wiley-VCH, 2004

Supplementary/Suggested reading

- Murty, B.S., P. Shankar, Baldev Raj, B.B. Rath, and James Murday. Textbook of Nano Science and nanotechnology. Springer Science & Business Media, 2013
- ${\bf 2. Robert K, lan H, Mark G, Nanoscale Science and Technology, John Wiley \& sons Ltd., 2005.}$

Suggestive digital platforms web links-

- 1. Uttar Pradesh Highe rEducation Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
- 2. SwayamPrabha-DTHChannel, https://www.swayamprabha.gov.in/index.php/program/current he/8
- 3. NationalProgrammeonTechnologyEnhancedLearning(NPTEL), https://www.youtube.com/user/nptelhrd

Suggested Continuous Evaluation Methods:

Continuous internal evaluation shall be based on allotted assignment and class tests. The marks shall be as follows

Quiz/Assignment	 (10marks)
ClassTest	 (15marks)

At Con Mg

Programme /Class: Bachelor (Research)	Year:5	Semester:9
Subject: PHYSICS		
Course Code: 0920180	Course Title: ELECTRONICS L	AB
Designing, assembling, and testing ele		ing of troubleshooting
Credits:4	Core Compulsory/ Elective: Co	ore Compulsory
Max. Marks: 75+25	Min. Passing Marks: 40	
Total No. of Lectures-Tutorials-Practical (in h	ours per week):L-T-P:0-0-18	1 349

í**c**

Af an long

List of Experiments:

Choose any six experiments from the given list.

- 1. To study the various logic gates, Half Adder, Full Adder, Half Subtractor and Full Subtractor by using digital IC's.
- 2. To study the performance characteristics of various optical transducers, such as (a) photovoltaic cell (b) photoconductive cells (c) Characteristics of photo diode (d) phototransistors.
- 3. To study the features of an IC 555 timer and to set up and operate is as a (a) free running multivibrator (b) monostable
- 4. To study the operational amplifier as-(a) inverting amplifier (b) non-inverting amplifier (c) Voltage follower
- 5. To study the operational amplifier as-(a) adder or summing amplifier (b) subtractor (C)integrator (d) differentiator
- 6. To study the active filters of first and second stage using operational amplifier as- (a) As low pass filter (b) High pass filter (c) Band pass filter
- 7. To study the R-S flip flop circuits by using (a) NOR gates only. (b) a combination of AND and NOR gates.(c) Clocked R-S flip flop (d) T flip flop.
- 8. To study the digital to analog conversion by using a R-2R ladder circuit.
- 9. To study the analog to digital conversion by using the IC ADCO808
- 10. To construct any desired circuit on a digital breadboard using the digital /analog trainer kit
- 11. To stimulate the given circuit by the computer simulation software LT Spice.

Suggested Continuous Evaluation Methods:

Continuous internal evaluation shall be based on allotted assignment and class tests. The marks shall be as follows:

Record File	(15 marks)
Viva Voce	(05 marks)
Class Interaction	(05 marks)

At En Ore

Programme	/Class: MASTER OF SCIENCE(M.Sc.)	Year: 5	Semester:10
Subject: PHY	/SICS		
Course Code: 1020101 Course Title: QUANTUM MECHANICS II			
	eting this course ,students will be able to		
The probThe	pabilities. quantum theory of radiations.	mic, and molecular systems. proach and its applications in real life, trans	sition
Credits:4	relativistic quantum theory.	Core Compulsory/Elective :Core compuls	ory
Max.Marks:	75+25	Min.PassingMarks:40	
TotalNo.ofLe	ectures - Tutorials - Practical (inhours perwe	eek):L-T-P:4-0-0	
Unit	5.725.727627	Topics	No.of Lectures
l	scattering amplitude, differential	systems, scattering by potential field, and total cross sections, partial wave -Schwinger equation, and First Born	1
II	an electromagnetic field, Transition approximation. Einstein's coefficients by	Perturbation, Interaction of an atom with probabilities, Fermi Golden rule, Dipole pasedonquantummechanics, Induced and adiabatic and sudden approximation.	15
111	Quantum Theory of Radiation: Classicalradiationfield, Fourierdecom field, dipoleapproximation, Creation, a states, Basic matrix elements for em	positionandelectromagneticradiation annihilationandnumberoperators,Photon hission and absorption, explanation of on on the bases of quantum mechanics,	15
lv	theory, Difficulties in KG equation, D matrices and spinors, Plane wave so	e wave solution, Probability density in KG Dirac equation for a free electron, Dirac plutions, Charge and current densities, nent from Dirac equation of electroninan on for central field with spin orbit	15

interaction, Energy levels of Hydrogen atom from the solution of Dirac

equation, covariant form of Dirac equation.

Att En mg

- 1. Khare, S.P., "Quantum Mechanics and Atomic Physics".
- 2. Schiff, L.I., "Quantum Mechanics".
- 3. . Sakurai J.J., "Advanced Quantum Mechanics
- 4. . Zettili, N., "Quantum Mechanics: Concepts and Applications".
- 5. Chaddha, G.S., "Quantum Mechanics".

Suggestive digital platforms web links

- 1 Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
- 2 Swayam Prabha DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8
- 3 .National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd

Continuous internal evaluation shall be based on allotted assignment and class tests. The marks shall be as follows:

Quiz/Assignment	(10marks)
Class Test	(15marks)

BOL Gar One

Programme/Class: MASTER OF SCIENCE (M.Sc.)	Year : 5	Semester: 10
Subject : PHYSICS		
Course Code: 1020102	Course Title: Sy	nthesis of Nanomaterials

Course Outcome

After completing this courses students will be able to understand

- The differentiation among nanomaterials according to their confinements in 1-D, 2-D and 3-D.
- Different approaches i.e. Top down and Bottom-up approaches of nanomaterials synthesis.
- The synthesis of nanomaterials by sol-gel method, spray pyrolysis ball milling, physical Vapour deposition, sputtering, microwave plasma and a few other processes.
- The role of surfactants in the formation of self-assembled nanostructures.
- The various parameters required for good quality thin film deposition with quantum dots and nanowires morphology.
- Synthesis of single walled and multi walled carbon nano tubes.

Credits:4	Core Compulsory
Max. Marks: 75+25	Min. Passing Marks:40

TotalNo.ofLectures-Tutorials-Practical(inhoursperweek):L-T-P:4-0-0

Unit	Topics	No.of Lectures
Ī	Surface science for nano materials: Key issues in synthesis of Nano materials, surface energy & Surface stress capping agents, Stabilization mechanisms Steric stabilization and Electro steric stabilization, Critical radius, homogenous and heterogenous nucleation. Subsequent growth of nuclei	10
II	Synthesis of nano materials: Bottom-up and top-down approaches - Synthesis of zero-dimensional nanostructures - colloidal nano synthesis - synthesis of metallic (Au, Ag) nano particles - synthesis of semiconducting nano particles (CdSe, CdS) - synthesis of oxide nano particles - Self Assembly, sol-gel method, Ball milling Synthesis of 1D nanostructures - spontaneous growth - vapor-liquid-sold growth - template based synthesis. Electro spinning, Synthesis of carbon nanotubes, Arc discharge, RF plasma, laser ablation	15
	Synthesis of 2D nano structures – Fundamentals of film growth – Physical Vapour deposition – Sputtering – Chemical vapour deposition – Atomic layer deposition – Self assembly – LangmuirBlodgett films. Inert gas condensation, Ion, Sputtering, , Spray pyrolysis, Ion Implantation, Molecular Beam Epitaxy	15

My Eur Dog

Lithography techniques —Overview of Lithography, Rayleigh criteria for resolution,
Photolithography source, Optical Lithography- contact, proximity and projection,
resolution limit and limitations. Electron lithography- concept of mask generation,
electron optics and resolution.X-raylithography—Proximity and mask, wet chemical
,dry etching, plasma etching and ion milling for material removal.

Suggested Readings:

- 1. Frank J. Owens, Charles P. Poole Jr, The Physics and Chemistry of Nanosolids, John Wiley & Sons, 2008.
- 2. Dieter Vollath, Nanomaterials: An introduction to Synthesis, Properties, and Applications (second edition), Wiley-VCH, 2013.
- 4. Edward L. Wolf, Nanophysics and Nanotechnology An Introduction to Modern Concepts in Nanoscience, Wiley-VCH, 2006.
- 6.V. I. Klimov (Ed.), Semiconductor and Metal Nanocrystals Synthesis and Electronic and Optical properties, Marcel Dekker Inc., 2004
- 8. Guozhong Cao, Nanostructures and Nanomaterials- Synthesis, properties and Applications, Imperial college press, 2004.
- 10. Challa Kumar (Ed.). Semiconductor Nanomaterials, Wiley-VCH, 2010.
- 11. Ampere A Tseng (Ed.), Nanofabrication-Fundamentals and Application, World Scientific, 2008.

Suggestive digital platforms web links-

- 1. UttarPradeshHigherEducationDigitalLibrary, http://heecontent.upsdc.gov.in/SearchContent.aspx
- 2. SwayamPrabha-DTHChannel, https://www.swayamprabha.gov.in/index.php/program/current he/8
- 3. NationalProgrammeonTechnologyEnhancedLearning(NPTEL), https://www.youtube.com/user/nptelhrd

Suggested Continuous Evaluation Methods:

Continuous internal evaluation shall be based on allotted assignment and class tests. The marks shall be as follows:

Quiz/Assignment	(10marks)
Class Test	(15marks)

the au of

Programme/Class: MASTER OF SCIENCE(M.Sc.)	Year:5	Samuel and 10
Subject: PHYSICS		Semester: 10
CourseCode: 1020103	CourseTital	<u> </u>
	CourseTitle: Characterization of Nano	o materials

Course Outcomes:

After completing this course students will be able to understand

- The working and principles of various analytical tools such as XRD, XPS,
- UV-VIS spectroscopy, Raman spectroscopy.
- The principle and working of Electron Microscopic techniques e.g. SEM&TEM, required for the characterization of nanomaterials.
- Scanning Probe Microscopic techniques like AFM & STM .
- The investigation of the thermal and electrical properties by Thermogravimetric (TGA) and two /four probe method can be understood .
- To interpret and analyze the data.

•

Total No. of Lectures-Tutorials-Practical(inhoursperweek):L-T-P:4-0-0

Unit	Topics	No.of Lectures
Ī	X-ray diffraction: Interaction of x- rays with matter, Fundamentals of x-ray diffraction. X-ray diffraction methods, Powder diffraction method, Single crystal, laue and Rotating crystal method, diffraction under non ideal conditions Derivation of Scherer formula for grain size determination of nano particles. Increase in with of XRD peaks of nanoparticles, X-Ray Photo electron Spectroscopy (XPS)	15
11	Spectroscopy: UV-VIS-NIR spectroscopy, Emission Absorption Spectroscopy, Shift in absorption spectra of nanoparticles and their correlation with energy band gap, shift in photoluminescence peaks, Fluroscence spectroscopy, Basic Principal of Fourier Transform infra red FTIR& Raman spectroscopy	15
III	Electron microscopy: Electron & Matter interaction, Scanning Electron Microscope(SEM) with EDX Analysis Transmission Electron Microscope(TEM) with SAED Studies Scanning, Probe microscopy (SPM), Scanning Tunnelling Electron Microscopy(STM) and Atomic Force Microscopy (AFM).	
lv	Thermal and electrical characterization techniques Differential Scanning Calorimetry (DSC), Thermo Gravimetric Analysis (TGA), Differential Thermal Analysis (DTA), Two and Four probe method, Van der Pauw method, Hall probe method, Electrochemical (IV, CV, Impedance, Capacitance) Measurements, BET, Surface area measurement	15

for an long

- 1. Charles P. Poole, Jr. Frank J. Owens, "Introduction to Nanotechnology" John Wiley & Sons Inc.
- 2. PradeepT."A,text,bookofNanoscience&Technology"TataMcGraw-HillEducation2012.
- 3. Wilson, M., "Nanotechnology: Basic Science and Emerging Technologies"
- 4. G.CaoandY.Wang, Nanostructures and Nanomaterials, 2nd Ed., Imperial College Press, 2004.
- 5. R.Kelsall,I.HamleyandM.Geoghegan,NanoscaleScienceandTechnology,Wiley,2005.
- 6. K.JKlabunde, R.M.Richards, Nanoscale Materials in Chemistry, 2nd Ed., Wiley, 2009.
- 7. G.Schmidt, Nanoparticles: from Theoryto applications, Wiley-VCH, 2004

Supplementary/Suggestedreading

- Murty, B.S., P. Shankar, Baldev Raj, B.B. Rath, and James Murday. Textbook of NanoScience and nan otechnology. Springer Science & Business Media, 2013
- $2. \ Robert K, Ian H, Mark G, Nanoscale Science and Technology, John Wiley \& sons Ltd., 2005.$

Suggestive digital platforms we blinks-

- 1. UttarPradeshHigherEducationDigitalLibrary, http://heecontent.upsdc.gov.in/SearchContent.asox
- 2. SwayamPrabha-DTHChannel, https://www.swayamprabha.gov.in/index.php/program/current_he/8
- 3. NationalProgrammeonTechnologyEnhancedLearning(NPTEL), https://www.youtube.com/user/inptelling

Suggested Continuous Evaluation Methods:

Continuous internal evaluation shall be based on allotted assignment and class tests. The marks shall be as follows:

Quiz/Assignment	(10 Marks)
Class Test	(15 Marks)

My En Por



BROWN THE WARREN

Programme /Class: Bachelor(Research)	Year:5	Semester:10
Subject: PHYSICS		
Course Code: 1020180	Course Title: Lab Nano Science	
Course Outcomes		

Course Outcomes:

At the end of the laboratory course, every student is expected to understand

- Basic concepts of Nano science and Electronics through experiments.
- The concepts studied in the theory course and their correlation with experimental observations.
- Practical knowledge of characterization techniques as well as understanding of Lithography & nano materials synthesis.

In-depth knowledge of experimental aspect can be applied in higher studies in every field of physics.

Credits:4	Core Compulsory/ Elective: Core Compulsory	
Max. Marks: 75+25	Min. Passing Marks: 40	
TotalNo.ofLectures-Tutorials-Practical(inhours)	perweek):L-T-P:0-0-18	

List of Experiments-

Choose any six experiments from the given list.

- 1. X-ray diffraction-structure evaluation and identification of material with JCPDS data '
- 2. Analysis of given X-ray diffraction pattern of nanocrystalline samples of different crystallite sizes -Strain analysis and particle size determination by XRD and Phase determination by JCPDS.
- 3. Measurement of resistivity of low and high resistivity semiconductors-four probe method
- 4. Study of Hall effect and calculation of Hall coefficient of the given semiconductor
- 5. Measurement of magnetioresistance of semiconductors
- 6. Determination of thickness of a film by envelope method and calculation of band gap using the given transmittance spectrum of the film.
- 7. Determination of band gap of a semiconductor nanomaterial using UV-visible absorption spectra
- 8. Study of optical properties of material by using UV-Vis spectroscopy
- 9. Preparation of a thin film nanostructured sample by Spin Coating
- 10. Study of transmission line characteristics and calculate the various parameters like (i) Attenuation coefficient (ii) Phase shift coefficient (ii) Characteristic impedance
- 11. Study of amplitude modulation and demodulation and calculate the modulation index
- 12. Study of frequency modulation and demodulation and calculate modulation index

for Eur OR