



CBCS CURRICULUM OF

M.Sc PHYSICS PROGRAMME

SUBJECT CODE = PHYS

FOR POST GRADUATE COURSES UNDER NILAMBER-PITAMBER UNIVERSITY

Members of the Board of Studies of C.B.C.S. Post Graduate syllabus as per guidelines of Nilamber- Pitamber University, Medininagar, Palamau

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Credit distribution and weightage of hours to different courses spread over different semesters. One Lecture / Tutorial is of 1 hr. duration.

Table - 1

Semester –I				Course Credits	Hours / Week		
S. No.	Course Code	Paper	Course Name		L	T	P
1	FCPHYS101	FC	Mathematical Methods in Physics	5	5	1	0
2	CCPHYS101	CC1	Quantum Mechanics –I	5	5	1	0
3	CCPHYS102	CC2	Solid State Physics and General Electronics	5	5	1	0
4	CCPHYS103P	CC3-P	Gen. Electronics and Atomic & Nuclear Physics Lab.	5	0	0	10

Table - 2

Semester –II				Course Credits	Hours / Week		
S. No.	Course Code	Paper	Course Name		L	T	P
1	ECPHYS201	EC1	Any one from the List in Annexure –I	5	5	1	0
2	CCPHYS204	CC4	Quantum Mechanics –II	5	5	1	0
3	CCPHYS205	CC5	Statistical Physics	5	5	1	0
4	CCPHYS206P	CC6-P	Optics and Spectroscopy Lab.	5	0	0	10

Table - 3

Semester –III				Course Credits	Hours / Week		
S. No.	Course Code	Paper	Course Name		L	T	P
1	CCPHYS307	CC7	Spectroscopy	5	5	1	0
2	CCPHYS308	CC8	Nuclear Physics –I	5	5	1	0
3	ECPHYS302	EC2	Any one from the Module A, B and C: Part -I (Annexure –II)	5	5	1	0
4	ECPHYS303P	EC3-P	Lab. of the Elective Paper ECPHYS301	5	0	0	10

Table - 4

Semester –IV				Course Credits	Hours / Week		
S.N.	Course Code	Paper	Course Name		L	T	P
1	CCPHYS409	CC9	Nuclear Physics – II	5	5	1	0
2	ECPHYS404	EC4	Any one from the Module A, B and C: Part –II (Having correspondence with Part –I) Annexure –II	5	5	1	0
3	ECPHYS405P	EC5-P	Lab. Of the Elective Paper ECPHYS403	5	5	1	0
4	CCPHYS410	CC10	Project / Dissertation	5	0	0	10

Annexure –I: List of Elective under AECC (Ability Enhancement Core Course)/Skill Enhancement Core Course (SECC)

- A. Numerical Methods
- B. Experimental Techniques

Annexure – II: List of Discipline Specific Elective Coerces for Semester – III and Semester - IV

Table - 5

Elective Modules: Part –I, Sem-III			Elective Modules: Part –II, Sem-IV		
A	1	Electronics and Communication	A	1	Electronics and Communication
	2	Lab. on Electronics		2	Lab. on Electronics
B	1	Condensed Matter Physics	B	1	Condensed Matter Physics
	2	Lab. of CMP		2	Lab. of CMP
C	1	Nanophysics and Nanomaterials	C	1	Nanophysics and Nanomaterials
	2	Lab. on Nanophysics		2	Lab. on Nanophysics

Table: Semester Wise Examination Structure for Mid Sem & End Sem Examinations

Core, AE/ GE/ DC/ EC and Compulsory FC Courses					Examination Structure		
Sem	Paper	Paper Code	Credit	Name of Paper	Mid Semester Evaluation (F.M.)	End Semester Evaluation (F.M.)	End Semester Practical/ Viva (F.M.)
I	FC	FCPHYS101	5	Mathematical Methods in Physics	30	70	
	CC1	CCPHYS101	5	Quantum Mechanics –I	30	70	
	CC2	CCPHYS102	5	Solid State Physics and General Electronics	30	70	
	CC3-P	CCPHYS103P	5	Gen. Electronics and Atomic & Nuclear Physics Lab.			100
II	EC1	ECPHYS201	5	Any one from the List in Annexure –I	30	70	
	CC4	CCPHYS204	5	Quantum Mechanics –II	30	70	
	CC5	CCPHYS205	5	Statistical Physics	30	70	
	CC6-P	CCPHYS206P	5	Optics and Spectroscopy Lab.			100
III	CC7	CCPHYS307	5	Spectroscopy	30	70	
	CC8	CCPHYS308	5	Nuclear Physics –I	30	70	
	EC2	ECPHYS302	5	Any one from the Module A, B and C: Part -I (Annexure – II)	30	70	
	EC3-P	ECPHYS303P	5	Lab. of the Elective Paper ECPHYS301			100
IV	CC9	CCPHYS409	5	Nuclear Physics – II	30	70	
	EC4	ECPHYS404	5	Any one from the Module A, B and C: Part –II (Having correspondence with Part –I) Annexure – II	30	70	
	EC5-P	ECPHYS405P	5	Lab. Of the Elective Paper ECPHYS403			100
	CC10	CCPHYS410	5	Project / Dissertation			100

SEMESTER – I

Marks 30 (MSE 20 1 Hr + 5 Attd. + 5 Assign) + 70 (ESE : 3 Hrs) = 100

Pass Marks (MSE : 17 + ESE : 28) = 45

MID SEMESTER EXAMINATION (MSE)

The Mid Semester Examination shall have three components: (a) Two Semester Internal Assessment Test (SIA) of 20 marks each. “Better of Two” shall be applicable for computation of marks for SIA. (b) Attendance / Regular Interactions of 05 marks and (c) Assignment of 05 marks.

END SEMESTER EXAMINATION (ESE)

A total of **EIGHT** questions will be set in which Question 1 will be **Short Answer Type** and **COMPULSORY**. Any **four** questions shall have to be answered by the examinees out of the remaining seven questions. The questions will be of equal marks and will be so framed that the students are able to answer them within the stipulated time.

**FCPHYS101: MATHEMATICAL METHODS IN
PHYSICS**

Credits: 5, Lectures: 75

Matrices and Tensors: Introduction of matrices through rotation of co-ordinate systems, Orthogonal, Hermitian, Unitary, Null and Unit matrices, Singular and Non-singular matrices, Inverse of a matrix, Trace of a matrix, Eigenvalues and Eigenvectors, Diagonalization. Tensorial character of physical entities, Covariant, Contravariant and Mixed tensors, Contraction, Quotient rule, Differentiation, Kronecker tensor, Pseudotensor, Symmetric and Anti symmetric tensors.

15 Lectures

Green's Function: Introduction Construction of the Green's function for 1d, 2d and 3d problems. Solution of some standard problems using Green's function technique.

5 Lectures

Group Theory: Definition and examples of physically important finite groups, Basic symmetry operations and their matrix representations, Multiplication table, Cyclic groups and subgroups, Classes. Reducible and Irreducible representation,

Schur's lemma, Orthogonality theorem, Character of a representation, Construction character tables.

15 Lectures

Electrodynamics and Relativity: Lorentz transformation as orthogonal transformation in 4-dimensions, 4-vectors and light cone, energy-momentum 4-vectors, Relativistic force equation, Covariance of Maxwell's equation, Transformation of electromagnetic fields, Solution of wave equation in covariant form, Field due to a charge moving with constant velocity, Radiation from oscillating dipole, Total power radiated from an accelerated charge, Larmor formula, Principle of equivalence, Principle of covariance, Covariant differentiation, Curvature tensor, field equation, Reduction to Newton's laws of gravitation.

25 Lectures

Signal Processing and Data Analysis: Fast transforms, Random noise and signal, White and coloured noise, Power spectrum, Convolution, Auto-correlation and cross-correlation, Matched filtering techniques, Maximum entropy method.

15 Lectures

Books Suggested:

1. Mathematical Methods for Physicists, G.B.Arken, H.J.Waber, E.E. Harris, 2013, 7th Edn., Elsevier.
2. Boas, M.L., "Mathematical Methods in Physical Sciences", 3rd Edn., Wiley International Editions.
3. Group Theory and Quantum Mechanics, M.Timkham, Dover Publications Inc.; Illustrated edition (17 December 2003).
4. Matrices and Tensors: A. W. Joshi, 4th Edn., New Age International.
5. Mathematical Physics: H.K Dass & Dr. Rama Verma, 8th Edn., S.Chand.
6. Mathematical Physics: A.K.Ghatak, I.C.Goyal & S.J. Chua, Laxmi Publications Pvt Ltd.
7. Mathematical Methods for Physicist & Engineers: Pipes & Harvel, Dover Publications Inc.; 3rd edition.
8. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
9. Mathematical Methods for Scientists and Engineers: D.A.McQuarrie, 2008, Viva Book.
10. Advanced Engineering Mathematics: D.G.Zill and W.S.Wright, 7th Edn., 2022, Jones and Bartlett Learning.
11. Advanced Engineering Mathematics, Erwin Kreyszig, 10th Edn., 2018, Wiley India.
12. Essential Mathematical Methods, K.F.Riley & M.P.Hobson, 2011, Cambridge Univ. Press.

SEMESTER – I**Marks 30 (MSE 20 1 Hr + 5 Attd. + 5 Assign) + 70 (ESE : 3 Hrs) = 100****Pass Marks (MSE : 17 + ESE : 28) = 45****MID SEMESTER EXAMINATION (MSE)**

The Mid Semester Examination shall have three components: (a) Two Semester Internal Assessment Test (SIA) of 20 marks each. “Better of Two” shall be applicable for computation of marks for SIA. (b) Attendance / Regular Interactions of 05 marks and (c) Assignment of 05 marks.

END SEMESTER EXAMINATION (ESE)

A total of **EIGHT** questions will be set in which Question 1 will be **Short Answer Type** and **COMPULSORY**. Any **four** questions shall have to be answered by the examinees out of the remaining seven questions. The questions will be of equal marks and will be so framed that the students are able to answer them within the stipulated time.

CCPHYS101: QUANTUM MECHANICS– I**Credits: 5, Lectures: 75**

Mathematical Foundation of Quantum Mechanics: Vectors and Linear vector space, Closure property, Linear independence of vectors, Bases and dimensions. Some examples of linear vector spaces, Dirac's notations, Bra and Ket vectors, Combining bras with kets, Inner product and inner product space, Orthonormality of vectors, Gram Schmidt orthogonalization of vectors in a linear vector space, Schwartz inequality, Arbitrary Vectors in an orthonormal basis, Completeness condition, Outer product, Hilbert spaces, Operator on a linear vector space, Algebra of linear operators, Hermitian operators and their properties, Unitary, Projection, Commuting operators and related theorems, Complete set of commuting operators, Eigenvalues and eigenfunctions (continuous and bounded operators), Co-ordinate and momentum representation, Time differentiation of operators.

30 Lectures

Hilbert Space Formalism of Quantum Mechanics: Postulates, Expectation values and probabilities, Explicit representation of operators, The general uncertainty relationship, The minimum uncertainty product.

9 Lectures

Quantum Dynamics: The equation of motion- The Schrodinger; the Heisenberg and the Interaction pictures; Applications to linear harmonic oscillator and the hydrogen atom. Linear harmonic oscillator using Creation and annihilation operator.

12 Lectures

Heisenberg Matrix Mechanics: Matrix representation of states and operators, Matrix transformation, Diagonalizability of matrix, Application to linear harmonic oscillator problem.

8 Lectures

Angular Momentum: Commutation relations for angular momentum operators, Eigenvalues and eigenvectors, Pauli spin matrices and spin eigenvectors, Addition theorem, Clebsch-Gordon co-efficient, Angular momentum and rotation, Motion in a centrally symmetric field.

8 Lectures

Invariance Principle and Conservation Laws: Space-time symmetries and conservation Laws for linear momentum, Angular momentum, Energy and Parity.

8 Lectures

Books Suggested:

1. Nouridine Zettili, "Quantum Mechanics", 3rd Edn., Wiley.
2. Merzbacker, E., "Quantum Mechanics", 3rd Edn., John Wiley
3. Messiah, A., "Quantum Mechanics", North-Holland Publishing Co.
4. Schiff, L.I., "Quantum Mechanics", Tata McGraw-Hill, 4th Edition 2017
5. Ghatak, A., "Quantum Mechanics", 6th Edn., Laxmi Publications Pvt Ltd.
6. D.J Griffiths, "Introduction to Quantum Mechanics", 3/e, Cambridge University Press.
7. Landau, L.D. & Lifshitz, E.M., "Quantum Mechanics", 3rd Edn., Pergmon Press
8. Quantum Mechanics for Scientists and Engineers, D.A.B. Miller, 2008, Cambridge University Press
9. Introductory Quantum Mechanics, Richard L. Liboff, 4th Edn., Pearson, New Delhi.
10. Quantum Physics by H.C Verma, 3rd Edn., TBS.

SEMESTER – I

Marks 30 (MSE 20 1 Hr + 5 Attd. + 5 Assign) + 70 (ESE : 3 Hrs) = 100

Pass Marks (MSE : 17 + ESE : 28) = 45

MID SEMESTER EXAMINATION (MSE)

The Mid Semester Examination shall have three components: **(a)** Two Semester Internal Assessment Test (**SIA**) of 20 marks each. “Better of Two” shall be applicable for computation of marks for SIA. **(b)** Attendance / Regular Interactions of 05 marks and **(c)** Assignment of 05 marks.

END SEMESTER EXAMINATION (ESE)

A total of **EIGHT** questions will be set in which Question 1 will be **Short Answer Type** and **COMPULSORY**. Any **four** questions shall have to be answered by the examinees out of the remaining seven questions. The questions will be of equal marks and will be so framed that the students are able to answer them within the stipulated time.

**CCPHYS102: SOLID STATE PHYSICS AND GENERAL
ELECTRONICS**

Credits: 3+2, Lectures: 75

Crystal Physics: Laue theory of X-ray diffraction, Geometrical structure factor and intensity of diffraction maxima. Calculation of structure factor for bcc, fcc and diamond structure, Intensity of diffraction maxima, Extinction due to Lattice centering.

12 Lectures

Electronic Properties: Electron in a Periodic lattice, Block Theorem, Band Theory, Tight Binding, Cellular and Pseudopotential method, Fermi surface, de Haas van Alphen Effect, Cyclotron resonance, Magnetoresistance, Quantum Hall Effect.

15 Lectures

Magnetism: Exchange interaction, Heisenberg model and molecular field theory, spin waves and magnons, Ferri and Antiferromagnetic order, Domains and Bloch Wall energy.

10 Lectures

Superconductivity: Basic properties of superconductors, Josephson Effect, BCS

theory, High temperature superconductivity.

8 Lectures

GROUP – B

General Electronics

Microwave Components / Devices: Attenuators, phase shifters, directional couplers, T junction, Magic Tee, Standing wave detectors and cavity resonators (circular). Reflex klystron, TWT, Velocity modulation, Magnetron, Cavity Magnetron, Principle of operation of magnetrons in pi-mode and anode strapping.

15 Lectures

Photonic Devices: Radiative and non-radiative transitions, optical absorption, bulk and thin film photoconductive devices (LDR), diode photo detectors, solar cell (open circuit voltage and short circuit current, fill factor), LED (high frequency limit, effect of surface and indirect recombination current, operation of LED), Blue LED, LEDs as commercial sources of lighting, diode lasers conditions for population inversion in active region, optical gain and threshold current for lasing.

15 Lectures

1. Books Suggested:

1. Kittel, C., "Solid-State Physics", 2019, Wiley.
2. Arun Kumar, "Introduction to Solid State Physics", 2015, PHI Learning
3. Ashcroft, N.W. and Mermin, N. D., "Solid-State Physics", 2016, Cengage Learning Asia.
4. Verma and Srivastava, Crystallography for Solid State Physics, 2nd Edn., New Age International (P) Ltd.
5. A.A.Khan & K.K.Dey, A first course in Electronics, 2006, PHI
6. Arun Kumar, Basic Electronics, Bharati Bhawan
7. S. O. Pillai, "Solid State Physics", 9th Edn., New Age International.
8. Allen, Optoelectronics, Theory & Practical, McGraw Hill
9. Pallabh Bhattacharya, Semiconductor Optoelectronics Devices, 2nd Edn., Pearson.

10. Jordon & Balmain, Electromagnetic Waves & Radiating System,
PHI

11. Kulkarni, Microwave & Radar Engineering, 5th Edn., Umesh
Publication

12. Optical Electronics, Ajoy Ghatak and K. Thyagarajan, 2017,
Cambridge
University Press.

13. Dinesh C Dube, “Microwave Devices & Applications”, Narosa
Publishing House.

14. Chattopadhyay & Rakshit. “Electronic Fundamentals and Applications”,
16th Edn., New Age International.



SEMESTER – I**Marks 80 (ESE Pr : 6Hrs) +20 Viva = 100****Pass Marks : 45**

Practical Course would be of 100 marks, but there will be no internal written examination.
The total 100 marks will have two components :- 80 marks for practical and 20 marks will be awarded on the performance in viva-voce.

CCPHYS103P: GENERAL ELECTRONICS AND ATOMIC & NUCLEAR PHYSICS LAB.**Credits: 05, Hrs. per week: 10**

1. 'e/m' measurement by Braun's tube and by Magnetron valve method.
2. 'e' measurement by Millikan oil drop apparatus.
3. Design and characteristics of passive attenuators (T- and π -types)
4. BJT based voltage amplifier: design and performance study with and without negative feedback.
5. JFET based voltage amplifier: design and performance study.
6. Half- and Full wave rectifier with and without filters
7. Series and shunt voltage regulators using Zener diode.
8. Verification of Truth table of Logic circuit using NAND gates and its DC characteristics.
9. Characterization of Photo-resistor.
10. Determine the plateau characteristics of the given GM counter.
11. Verification of Inverse Square Law for Gamma-rays.
12. To measure the absorption coefficient of gamma rays in Aluminum or Copper.
13. To plot the Gaussian or normal distribution curve for background radiation.
14. Determination of dead time of the GM Counter.
15. Experiment with Frank Hertz experiment.

SEMESTER – II**Marks 30 (MSE 20 1 Hr + 5 Attd. + 5 Assign) + 70 (ESE : 3 Hrs) = 100****Pass Marks (MSE : 17 + ESE : 28) = 45****MID SEMESTER EXAMINATION (MSE)**

The Mid Semester Examination shall have three components: **(a)** Two Semester Internal Assessment Test (**SIA**) of 20 marks each. “Better of Two” shall be applicable for computation of marks for SIA. **(b)** Attendance / Regular Interactions of 05 marks and **(c)** Assignment of 05 marks.

END SEMESTER EXAMINATION (ESE)

A total of **EIGHT** questions will be set in which Question 1 will be **Short Answer Type** and **COMPULSORY**. Any **four** questions shall have to be answered by the examinees out of the remaining seven questions. The questions will be of equal marks and will be so framed that the students are able to answer them within the stipulated time.

**ECPHYS201: NUMERICAL METHODS AND
SIMULATION****Credits: 5, Lectures: 75**

Solution of Linear System: Numerical solution of algebraic equation, Iteration, Newton Raphson method, Solution of Linear system, Direct method, Gauss, Gauss-Jordon elimination method, Matrix inversion and LU decomposition, Eigenvalues and Eigenvectors, Applications.

10 Lectures

Interpolation, Lagrange approximation, Newton and Chebyshev Polynomials, Least square fitting, Application in some physical problems.

10 Lectures

Numerical Differentiation and Integration: Numerical solution of ordinary differential equation, Iteration method, Picards method, Euler’s method and improved Euler’s method. Introduction to quadrature, trapezoidal and Simpson’s rule Applications.

10 Lectures

Numerical Solution of Partial Differential Equations: First and second order, Linear and non-linear differential equations, Solution by method of iteration,

Euler and RungeKutta methods. Finite difference method, Relaxation, Fourier and cyclic reduction and the Rayleigh-Ritz method, Application to diffusion of dopant in a semiconductor, Wave equation in a coaxial cable, Vibrating strings and membranes, Poisson equation, Schrodinger equations.

15 Lectures

Monte Carlo Technique: Evaluation of single and multi-dimensional integrals, Optimization problems, Applications to statistical mechanics, Metropolis algorithm.

05 Lectures

Simulation/ Modeling: Concept of modeling, Introduction to techniques of modeling, State variable model of system, Model parameters and simulation using SCILAB / MATLAB / SIMULINK, Time domain and frequency domain analysis of systems using SCILAB / MATLAB, Spice modeling of semiconductor devices (pn diode and BJT) and programming methodology, Circuit simulation using PSpice / LabView / ORCAD

10 Lectures

Basic programming concepts using Scilab / Matlab to solve the problems based on the following:

15 Lectures

1. Interpolation and extrapolation: Least Square Fitting.
2. Solution of simultaneous equation: Polynomial equation, Polynomial equation fitting.
3. Matrix manipulations, Matrix inversion, Eigenvalues computations.
4. Numerical integration and differentiation.
5. Ordinary boundary-value problems, Two dimensional problems.
6. Monte Carlo method and its applications, Evaluation of two and three dimensional integrals.

Books Suggested:

1. Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., PHI Learning Pvt. Ltd.
2. Schaum's Outline of Programming with C++, J. Hubbard, 2nd Edn., McGraw-Hill Pub.
3. Numerical Recipes in C: The Art of Scientific Computing, W.H Press et al, 3rd

Edn., Cambridge University Press.

4. A First Course in Numerical Methods, U.M Ascher& C. Greif, 5th Edn., PHI Learning.

5. Elementry Numerical Analysis, K.E.Atkinson, 3rd Edn., Wiley India Edition

6. Numerical Methods for Scientists & Engineers, R.W. Hamming, 2nd Edn., Courier Dover Pub.

7. An Introduction to Computational Physics, T. Pang, 2nd Edn., Cambridge Univ.

8. Simulation of ODE/PDE Models with Matlab® , Octave and Scilab, Scientific and Engineering Applications: A.V. Wouwer, P.Saucez, C.V.Fernandez. 2014 Springer.

9. Scilab by Example: M. Affouf 2012, ISBN: 978-1479203444.

10.Scilab(A free Software to Matlab): H.Ramchandran, A.S. Nair. 2011, S.Chand& Company.

11.Scilab Image Processing, Lamberr M.Surhone, 2010 Betascript Publishing.



SEMESTER – II

Marks 30 (MSE 20 1 Hr + 5 Attd. + 5 Assign) + 70 (ESE : 3 Hrs) = 100

Pass Marks (MSE : 17 + ESE : 28) = 45

MID SEMESTER EXAMINATION (MSE)

The Mid Semester Examination shall have three components: **(a)** Two Semester Internal Assessment Test (**SIA**) of 20 marks each. “Better of Two” shall be applicable for computation of marks for SIA. **(b)** Attendance / Regular Interactions of 05 marks and **(c)** Assignment of 05 marks.

END SEMESTER EXAMINATION (ESE)

A total of **EIGHT** questions will be set in which Question 1 will be **Short Answer Type** and **COMPULSORY**. Any **four** questions shall have to be answered by the examinees out of the remaining seven questions. The questions will be of equal marks and will be so framed that the students are able to answer them within the stipulated time.

ECPHYS201B: EXPERIMENTAL TECHNIQUES

Credits: 5, Lectures: 75

Sensors: Characteristics, Sensitivity, reproducibility, Sensors for displacement, Velocity, acceleration, Strain, Temperature, Pressure, Magnetic field.

05 Lectures

Thin Film Coating: Evaporative coating, DC and plasma sputtering, Laser ablation techniques for measuring thickness of thin film.

10 Lectures

Low Temperatures Techniques: Properties of cryogenic fluids, bath cryostat and continuous flow cryostat, Cryogenic refrigerators, Temperature measurements, a Cryostat for resistivity measurement.

10 Lectures

High Pressure Techniques: High pressure cell for resistivity measurement, Measurement of high pressure, Diamond anvil cell for very high pressure.

10 Lectures

Spectroscopic Techniques: IR absorption to study molecular vibrations and rotations, band gap of semiconductors, superconducting energy gap, Visible and UV absorption for the study of electric energy levels, defects in solids etc.

Raman effect for the study of molecular vibrations and vibrations in solids,

Main components of spectrometers, Sources, Dispersing element and detector, IR, UV, Visible absorption spectra, Description of Raman spectrometer and Raman spectra.

10 Lectures

NMR and EPR Spectrometers: Principle of operation, Basic components of the spectrometer, Typical NMR and EPR spectra and applications.

10 Lectures

X-ray Diffraction Techniques and Electron Microscope: Principle of x-ray diffraction, Bragg's law and Laue pattern, Powder diffraction method, Transmission and Scanning electron microscopes and applications.

10 Lectures

Surface Probe Techniques: Principle of AFM, STM, MFM and applications.

10 Lectures

1. Books Suggested:

1. Molecular Spectroscopy, An Introduction, Jagmohan, Narosa Publication.
2. An Introduction to Experimental Physics, Colin Cooke London, UCL Press.
3. Cryogenics and Measurement of Properties of Solids at Room Temperatures, R. Srivasan, A.K. Raychaudhury, and S.Kasturanjan, Allied Publishers.
4. Manual on the Experiments with IAS Kit by R.Srivasan
5. Introduction to Raman Spectroscopy, John R. Ferraro and Kazuo Nakamoto, 2004, 2nd Edn., Elsevier.
6. Electron Microscopy and Analysis, Peter J. Goodhew, 3rd Edn., CRC Press.
7. Scanning Probe Microscopy and Spectroscopy: Theory and Applications Edited by Dan Bonnell, 2nd Edn., Wiley

SEMESTER – II

Marks 30 (MSE 20 1 Hr + 5 Attd. + 5 Assign) + 70 (ESE : 3 Hrs) = 100

Pass Marks (MSE : 17 + ESE : 28) = 45

MID SEMESTER EXAMINATION (MSE)

The Mid Semester Examination shall have three components: **(a)** Two Semester Internal Assessment Test (**SIA**) of 20 marks each. “Better of Two” shall be applicable for computation of marks for SIA. **(b)** Attendance / Regular Interactions of 05 marks and **(c)** Assignment of 05 marks.

END SEMESTER EXAMINATION (ESE)

A total of **EIGHT** questions will be set in which Question 1 will be **Short Answer Type** and **COMPULSORY**. Any **four** questions shall have to be answered by the examinees out of the remaining seven questions. The questions will be of equal marks and will be so framed that the students are able to answer them within the stipulated time.

CCPHYS204: QUANTUM MECHANICS – II

Credits: 5, Lectures: 75

Approximation Methods: The WKB approximation and its applications to one dimensional bound system and barrier penetration problem, The vibrational method (Ritz method) and its application to linear harmonic oscillator and helium atom, Stationary perturbation theory, non-degenerate and degenerate cases and applications to an-harmonic oscillator; linear Stark effect; Zeeman effect and spin-orbit coupling in the hydrogen atom. Time-dependent perturbation theory, constant perturbation and Fermi Golden rule, harmonic perturbation (Einstein's A and B co-efficient).

30 Lectures

Theory of Scattering: Scattering amplitude and cross-section, Partial wave analysis, Born approximation and its validity with application to Rutherford's α -particle scattering.

10 Lectures

Identical Particles: Many particle Schrodinger equation, The Indistinguishability principle, Symmetric and anti-symmetric wave functions, Pauli exclusion principle, Importance of symmetry character of wave function in the dynamics of bound system (helium atom), Hydrogen molecule (Heitler-

London theory).

15 Lectures

Relativistic Quantum Mechanics: Klein-Gordon equation for free particle, Dirac equation, Properties of Dirac matrices, Probability and current densities, Covariance of Dirac equation, Free particle solution and negative energy states, magnetic moment and spin of electron, Dirac equation for central field, Energy states of the hydrogen atom.

15 Lectures

Second Quantization: Number representation of fermions and bosons, Creation and annihilation operators, Electromagnetic field in vacuum.

05 Lectures

Books Suggested:

1. Thankappan, V.K., "Quantum Mechanics", Wiley Eastern
2. Ramamurti Shankar, "Principles of Quantum Mechanics", Springer.
3. The Feynman Lectures on Physics – Volume III, Pearson.
4. Mathews, P.M. & Venkatesan, K., "A Text Book of Quantum Mechanics", TMH.
5. J.J Sakurai, "Modern Quantum Mechanics" 3rd Edn., Cambridge University Press.
6. Also the books recommended earlier in Quantum Mechanics Course – I

SEMESTER – II**Marks 30 (MSE 20 1 Hr + 5 Attd. + 5 Assign) + 70 (ESE : 3 Hrs) = 100****Pass Marks (MSE : 17 + ESE : 28) = 45****MID SEMESTER EXAMINATION (MSE)**

The Mid Semester Examination shall have three components: (a) Two Semester Internal Assessment Test (SIA) of 20 marks each. “Better of Two” shall be applicable for computation of marks for SIA. (b) Attendance / Regular Interactions of 05 marks and (c) Assignment of 05 marks.

END SEMESTER EXAMINATION (ESE)

A total of **EIGHT** questions will be set in which Question 1 will be **Short Answer Type** and **COMPULSORY**. Any **four** questions shall have to be answered by the examinees out of the remaining seven questions. The questions will be of equal marks and will be so framed that the students are able to answer them within the stipulated time.

CCPHYS205: STATISTICAL PHYSICS**Credits: 5, Lectures: 75**

Quantum Ensemble Theory: Micro-canonical Canonical and Grand Canonical ensembles, Phase space, Distribution functions, Partition function and relationship to thermodynamic quantities, Fluctuations in energy, particle density, Pressure and volume, Equivalence of ensembles.

15 Lectures

Quantum Statistics: Equation of state of ideal Fermi and Bose gases, Degenerate electron gas and specific heat, Degenerate Bose gas, Bose-Einstein condensation, Evaluation of constant α and β and its thermodynamics interpretation, Thermal properties of Bose-Einstein gas and liquid He^4 , The Lambda transition, The two fluid model, Black body distribution law. Density matrix and classical limit for N-particles partition function.

15 Lectures

Imperfect Gases: Classical and Quantum cluster expansion, Virial equation of state, Virial coefficients in classical limit, Second Virial coefficients for hard-sphere and square-well potentials.

10 Lectures

Phase Transitions: Ising model, Bragg-Williams Approximation, Mean field theories of the Ising model In three, two and one dimensions, Exact solutions in

one dimension, Landau theory of phase transition, Critical indices, Scale transformation and dimensional analysis.

10 Lectures

High-Density Gases: Thermo-ionic and photoelectric emission, Spin Paramagnetism, Landau Diamagnetism, Equation of state at very high density, Equilibrium of bodies of large mass, Chandrasekhar mass limit, White dwarf and neutron stars.

10 Lectures

Non-Equilibrium Statistical Mechanics: Boltzman Transport equation, Boltzman H-theorem, Equations of motion in classical mechanics, Time correlation function, Linear response theory, Electrical conduction, Langevin's equation and Brownian motion, Debye theory of dielectric relaxation. Motion due to fluctuating force. The Fokker-Planck Equation, Solution on Fokker-Planck Equation.

15 Lectures

Books Suggested:

1. Sinha, S.K., "Statistical Mechanics", Narosa.
2. Kerson & Huang, "Statistical Mechanics", 2nd Edn., Wiley.
3. Friedman, H.L., "A Course in Statistical Mechanics", PHI.
4. McQuarrie, D.A., "Statistical Mechanics"
5. Landau, L, & Lifshitz, "Statistical Mechanics", 3rd Edn., Elsevier.
6. "Statistical Mechanics", R.K. Patharia, Paul D Beale, 4th Edn., Elsevier.
7. Fundamental of Statistical and Thermal Physics, F. Rief, McGraw Hill International Edition.
8. Fundamental of Statistical Mechanics, B.B. Laud, 2nd Edn., New Age International Pub.
9. R.K. Srivastava & J. Ashok, "Statistical Mechanics", PHI.
10. Hill, T.L., "Statistical Mechanics", Dover Pub.
11. Gupta & Kumar, "Statistical Mechanics", Pragati Prakashan – Meerut
12. Agrawal, B.K., Statistical Mechanics, 3rd Edn., New Age International.
13. Prakash Satya & Agrawal J.P., "Thermodynamics, Statistical Physics & Kinetics", Pragati Prakashan – Meerut.

SEMESTER – II**Marks 80 (ESE Pr : 6Hrs) +20 Viva = 100****Pass Marks : 45**

Practical Course would be of 100 marks, but there will be no internal written examination.
The total 100 marks will have two components :- 80 marks for practical and 20 marks will be awarded on the performance in viva-voce.

CCPHYS206P: OPTICS, LASER AND SPECTROSCOPY**LAB.****Credits: 05, Hrs. per week: 10**

1. Studies with Michelson's Interferrometer.
 - (a) Determination of wavelength separation of sodium D-lines.
 - (b) Determination of thickness of mica sheet.
2. Studies with Fabre-Perot Etalon.
3. Studies with Edser-Butler Plate.
4. Studies of phenomena with polarized light:
 - (a) Verification of Brewster's law.
 - (b) Verification of Fresnel's law of reflection of plane polarized light.
 - (c) Analysis of elliptically polarized light using $\lambda/4$ plate and Babinet's compensator.
5. Verification of Rayleigh's criterion for the limit of resolution of spectral lines using
 - (a) prism spectrum and (b) grating spectrum.
6. Determination of optical constants of metal in thin film form.
7. Studies on Zeeman effect.
8. Young's modulus determination by optical method.
9. Experiments using He-Ne laser source:
 - (a) Determination of laser parameters.
 - (b) Measurement of the angle of a wedge plate using Heidinger fringes.
 - (c) Determination of grating pitch using phenomena of self-imaging.
 - (d) Determination of wavelength with a vernier caliper.

SEMESTER – III

Marks 30 (MSE 20 1 Hr + 5 Attd. + 5 Assign) + 70 (ESE : 3 Hrs) = 100

Pass Marks (MSE : 17 + ESE : 28) = 45

MID SEMESTER EXAMINATION (MSE)

The Mid Semester Examination shall have three components: (a) Two Semester Internal Assessment Test (SIA) of 20 marks each. “Better of Two” shall be applicable for computation of marks for SIA. (b) Attendance / Regular Interactions of 05 marks and (c) Assignment of 05 marks.

END SEMESTER EXAMINATION (ESE)

A total of **EIGHT** questions will be set in which Question 1 will be **Short Answer Type** and **COMPULSORY**. Any **four** questions shall have to be answered by the examinees out of the remaining seven questions. The questions will be of equal marks and will be so framed that the students are able to answer them within the stipulated time.

CCPHYS307: SPECTROSCOPY

Credits: 5, Lectures: 75

Atomic Spectra: Space quantization, Relation between angular momentum and magnetic moment, Bohr magneton. Fine structure of spectral lines, Term symbols of alkali and alkaline earth atoms. LS and JJ coupling. Quantum theory of Zeeman effect (normal and anomalous), Paschen-Back effect, Stark effect (linear and non-linear). Hyperfine structure of spectral lines, X-ray spectra characteristics and absorption.

15 Lectures

The Rotation of the Molecule: Rotational spectra-Rigid diatomic molecule, The intensities of spectral lines, Effect of isotopic substitution, the non-rigid rotator, Simple harmonic oscillator, The an-harmonic oscillator, Diatomic vibrating rotator, Born-Oppenheimer approximation, Techniques and instrumentation applications.

15 Lectures

Molecular Spectra: Infrared and Raman spectra of diatomic molecules using an-harmonic oscillator, non-rigid rotator and vibrating rotator as models. Electronic states and electronic transitions in diatomic molecules, Frank-Condon principle.

15 Lectures

Resonance Spectroscopy: Nature of spinning particle, Interaction between spin and a magnetic field, Larmor Precession, Theory of NMR, Chemical shift-relaxation Mechanism, experimental study of NMR, Theory and experimental study of NQR, Theory of ESR, Hyperfine structure and fine structure of ESR, Experimental studies and applications, Mossbauer spectroscopy, Principle-Isomer shift, Quadrupole effect, effect of magnetic field, Instrumentation applications.

15 Lectures

Laser and Holography: Spontaneous and stimulated emission, Einstein A and B coefficients, Basic Principles of Laser, Population Inversion-Two level and Three level Laser system, optical pumping-rate equation, modes of resonator and coherence length, The Nd^{3+} , YAG laser, The Neodymium Glass laser, The CO_2 Laser, Organic Dye lasers, Semi-conductor Laser, Liquid Laser, Principle of Holography, Theory Practical applications including data storage.

15 Lectures**Books Suggested:**

1. Kuhn, "Atomic Spectra", 2nd Edn., PHI.
2. Ghatak&Loknathan, "Quantum Mechanics", 6th Edn., Laxmi Publications Pvt Ltd.
3. Banwell & McCash, "Fundamentals of Molecular Spectroscopy", 4/e, McGraw Hill
4. Elements of Spectroscopy: Gupta, Kumar and Sharma, PragatiPrakashan.
5. Fundamentals of Molecular Spectroscopy: Colin and Elaine, 4th Edn., TMH.
6. Laser and Non-linear Optics: B.B.Laud, 3rd Edn., New Age Publications.
1. 7. Atomic and Molecular Spectra:Laser by Raj Kumar, KNRN.

SEMESTER – III

Marks 30 (MSE 20 1 Hr + 5 Attd. + 5 Assign) + 70 (ESE : 3 Hrs) = 100

Pass Marks (MSE : 17 + ESE : 28) = 45

MID SEMESTER EXAMINATION (MSE)

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END SEMESTER EXAMINATION (ESE)

A total of **EIGHT** questions will be set in which Question 1 will be **Short Answer Type** and **COMPULSORY**. Any **four** questions shall have to be answered by the examinees out of the remaining seven questions. The questions will be of equal marks and will be so framed that the students are able to answer them within the stipulated time.

CCPHYS308: NUCLEAR PHYSICS – I

Credits: 5, Lectures: 75

Fundamental Properties of Nuclei: Electric moments and magnetic moments of nucleous, Measurement of magnetic moment of neutron, proton and nuclear magnetic moments, Parity and statics of nucleus, i-spin formalism.

15 Lectures

Two-Nucleon Forces: Theory of ground state of the deuteron, Partial wave analysis of low energy n-p and p-p scattering, Effective range theory of low energy n-p and p-p scattering, Coherent n-p scattering and spin dependence of nuclear force, Exchange forces and tensor forces, Meson theory of nuclear force, Yukawa interaction, Charge independence and charge symmetry of nuclear forces.

15 Lectures

Nuclear Structure (models): Single particle shell model and its successes, Semi-empirical formula of Weizsaker energy, β -activity of isobars, Liquid-drop model and Bohr-Wheeler theory of fission, Collective model of Bohr and Mottelson.

15 Lectures

Nuclear Interactions and Nuclear Reactions: Compound nucleus theory, Resonance reaction, Breit Wigner dispersion formula for $l=0$ neutrons, Weak

interaction-phenomenon of β -decay; Fermi's theory; selection rules for β transition; parity non-conservation in β decay. Experimental demonstration.

15 Lectures

Particle Physics: Fundamental interactions, Conservation laws, Discrete symmetries - parity; charge conjugation and time reversal; G parity and CPT theorem, Internal symmetries -Isospin formalism; SU2 and SU3 groups and their applications to multiplet mesons and baryons; Quark model -Gell Mann - Okubo mass formula for octet and decuplet hadrons - charm, bottom and top quarks, Gluons as mediators of strong interaction.

15 Lectures

Books Suggested:

1. Introductory nuclear Physics by Kenneth S. Krane, Wiley India Pvt. Ltd., 2008.
2. Concepts of nuclear physics by Bernard L. Cohen, 2017 Indian Edn., Tata Mcgraw Hill.
3. Introduction to Elementary Particles by D. Griffith, 2nd Edn., John Wiley & Sons
4. Introductory Nuclear Physics by Samuel S.M. Wong, 2nd Edn., Wiley.
5. Theoretical Nuclear Physics by J.M. Blatt, & V.F. Weisskoff, Springer.
6. Nuclear Physics by R.R. Roy & B.P.Nigam, 2nd Edn., New Age International.
7. Nuclear Physics by S.B Patel, 3rd Edn., New Age International.
8. Quarks and Leptons by F. Halzen and A.D. Martin, Wiley India, New Delhi
9. Introduction to the physics of nuclei & particles by R.A. Dunlap, Brooks/Cole.

SEMESTER – III

Marks 30 (MSE 20 1 Hr + 5 Attd. + 5 Assign) + 70 (ESE : 3 Hrs) = 100

Pass Marks (MSE : 17 + ESE : 28) = 45

MID SEMESTER EXAMINATION (MSE)

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END SEMESTER EXAMINATION (ESE)

A total of **EIGHT** questions will be set in which Question 1 will be **Short Answer Type** and **COMPULSORY**. Any **four** questions shall have to be answered by the examinees out of the remaining seven questions. The questions will be of equal marks and will be so framed that the students are able to answer them within the stipulated time.

ECPHYS302: ELECTRONICS AND COMMUNICATION – I

Credits: 5, Lectures: 75

Operational Amplifier: Operational amplifier (op amp) types, salient features, parameters and modeling, Voltage op amp based circuits such as:

- Instrumentation amplifier (IA)
- Negative impedance converter (NIC)
- Inductance simulation
- Precision rectification
- Active Butterworth low pass, high pass and band pass 2nd order filters
- Simulation of differential equations
- Analog multiplier and its use in integer power generation, frequency multiplication, divider and generation of fractional powers
- D/A and A/D converters

20 Lectures

Current Conveyor: Current conveyor types, their salient features, modeling and simple applications in realizing bandwidth independent gain amplifier, Current conveyor based differentiator, integrator, adder and instrumentation amplifier, Advantages of current conveyor based circuits over the conventional voltage op amp based circuits.

08 Lectures

BJT Logic Families: TTL logic NAND gate circuit, ECL logic OR/NOR gate circuit, analysis and evaluation of logic parameters.

08 Lectures

MOS Logic Families: NMOS inverter circuit and its analysis with linear and non-linear loads, CMOS inverter.

06 Lectures

Radar: Basic arrangement of radar system, Azimuth and range measurement, Operating characteristics of a radar system, Derivation of radar range equation.

08 Lectures

Antenna: Antenna action, Short electric doublet, Linear array of n isotropic sources of equal amplitude and spacing, Broad-side array, Ordinary end-fire array, End fire array with increased directivity, Beam width of the main lobe, Yagi antenna, Resonant and non-resonant array arrangement

15 Lectures

Satellite Communication: Orbital and geostationary satellites, Orbital patterns, Look angles, Satellite system, Link modules.

10 Lectures**Books Suggested:**

1. A first course in Electronics, A.A.Khan & K.K.Dey, Prentice Hall India.
2. Basic Electronics, Arun Kumar, Bharati Bhawan
3. Millman & Grabel, "Microelectronics", 2nd Edn., McGraw-Hill (International Students' Edition).
4. Millman's Integrated Electronics-Analog and Digital Circuit Systems, 2/e, McGraw Hill
5. Electronic Devices and Circuit Theory by Boylestad and Nashelsky, 11/e, Pearson.
6. Gayakwad, "Op-Amps and Linear Integrated Circuits", 4/e, Prentice-Hall of India
7. Sedra & Smith, "Microelectronic Circuits", 7th Edn., Oxford University Press.
8. Microwave and Radar Engineering, Kulkarni, 5th Edn., Umesh Publication.
9. Electromagnetic Waves and Radiating Systems: Jordan, 2nd Edn., Pearson
10. Hand Book of Electronics, Gupta & Kumar, Pragati Prakashan-Meerut.
11. Electronics Communications: Roddy Coolen, 4th Edn., Pearson.
12. Electronic Communication: Kennedy & Davis, 5th Edn., TMH

SEMESTER – III**Marks 30 (MSE 20 1 Hr + 5 Attd. + 5 Assign) + 70 (ESE : 3 Hrs) = 100****Pass Marks (MSE : 17 + ESE : 28) = 45****MID SEMESTER EXAMINATION (MSE)**

The Mid Semester Examination shall have three components: (a) Two Semester Internal Assessment Test (SIA) of 20 marks each. “Better of Two” shall be applicable for computation of marks for SIA. (b) Attendance / Regular Interactions of 05 marks and (c) Assignment of 05 marks.

END SEMESTER EXAMINATION (ESE)

A total of **EIGHT** questions will be set in which Question 1 will be **Short Answer Type** and **COMPULSORY**. Any **four** questions shall have to be answered by the examinees out of the remaining seven questions. The questions will be of equal marks and will be so framed that the students are able to answer them within the stipulated time.

ECPHYS302: CONDENSED MATTER PHYSICS – I**Credits: 5, Lectures: 75**

X-ray Diffraction Theory: Coherent and incoherent scattering, Derivation of Laue equations and expression for structure factor, Data reduction.

08 Lectures

Crystal Structure Determination: The phase problem in crystallography, Electron density as Fourier transform of structure factor and vice versa, Techniques to solve the phase problem – Fourier and Patterson methods, Heavy atom technique, The Single Isomorphous Replacement (SIR) and Multiple Isomorphous Replacement(MIR) techniques, Anomalous scattering technique, Direct methods.

20 Lectures

Experimental Techniques: The Weissenberg and Precession methods, The Diffractometer, Area Detector and Image Plate.

10 Lectures

Fermi Surface: Construction of Fermi surface, Zone schemes, Electron, hole and open orbits, Cyclotron resonance. *Determination of Fermi surface* – Quantization of orbits in magnetic field; de-Hass – van-Alfen effect; External orbits; Outline of other methods.

12 Lectures

Phonons: *Harmonic crystals*, Crystal potential; Harmonic and adiabatic approximations; Normal modes and phonons; Phonon spectrum by neutron scattering; Crystal momentum. *Anharmonic crystals*, Anharmonicity, Lattice thermal conductivity, Umklapp process; Second sound.

10 Lectures

Magnetism: Interaction of solids with magnetic fields, Magnetization density and susceptibility, Calculation of atomic susceptibility, Susceptibility of insulators (Larmor diamagnetism), Ground state of ions with partially filled shells (Hund's rule), van Vleck paramagnetism, Curie laws for free ions and solids, Pauli paramagnetism, Conduction electron diamagnetism, Exchange interaction, Ferromagnetic domains, Anisotropy energy, Thickness and energy of Bloch walls, Ising model, Bragg-Williams approximation, Solution of Ising problem for a linear chain.

15 Lectures**Books Suggested:**

1. Philips, "An Introduction to Crystallography",
2. Woolfson, M.M., "An Introduction to X-ray Crystallography",
3. International Tables for X-ray Crystallography, Vol. I
4. Verma, A. R. & Krishna, P., "Polymorphism and Polytypism",
5. Kittel, C., "Solid-State Physics",
6. Raghavan, V., "Material Science and Engineering".
7. Ashcroft, N.W. and Mermin, N. D., "Solid-State Physics".
8. Bunge, M.J., "Crystal Structure Analysis".
9. Bunge, M.J., "X-ray Crystallography".
10. Staut & Jenson, "A Practical Guide to X-ray Crystal Structure Determination"

SEMESTER – III

Marks 30 (MSE 20 1 Hr + 5 Attd. + 5 Assign) + 70 (ESE : 3 Hrs) = 100

Pass Marks (MSE : 17 + ESE : 28) = 45

MID SEMESTER EXAMINATION (MSE)

The Mid Semester Examination shall have three components: **(a)** Two Semester Internal Assessment Test (**SIA**) of 20 marks each. “Better of Two” shall be applicable for computation of marks for SIA. **(b)** Attendance / Regular Interactions of 05 marks and **(c)** Assignment of 05 marks.

END SEMESTER EXAMINATION (ESE)

A total of **EIGHT** questions will be set in which Question 1 will be **Short Answer Type** and **COMPULSORY**. Any **four** questions shall have to be answered by the examinees out of the remaining seven questions. The questions will be of equal marks and will be so framed that the students are able to answer them within the stipulated time.

ECPHYS302: NANOPHYSICS AND NANOMATERIALS– I

Credits: 5, Lectures: 75

Nanophysics: Introduction to nanophysics and quantum size effect, Dimensionalities and density of states, Optical and transport properties of two-dimensional electron gas formed at heterostructures and within novel grapheme monolayers with external fields, Quantum Hall effects, Physics of one-dimensional electron systems including carbon nanotubes and semiconductor nanowires, Fundamental Physics of zero-dimensional electron system, Single electron effects, Quantum dots and nanocrystals, Fundamental principles and applications of scanning tunneling microscopy in the study of nanophysics.

25 Lectures

Synthesis of Nanomaterials: Top down and Bottom up approach, Synthetic procedures and their significance, Types of nanomaterials synthesis processes, ROHS and WEEE guideness, Physics method, Photolithography, Advanced Ceramics (Solid State reaction method), Ball milling method, Chemical method, Co-precipitation technique, So-gel method, Soft chemical technique (citrate tartrate, etc.), Hydrothermal method, Bio-chemical method, Thin film technology, Thermal Evaporation method, Sputtering (RF and DC), Spray pyrolysis method, Spin coating method, Pulsed laser deposition method, Vacuum

arc discharge, Chemical vapor deposition method (CVD), MOCVD, MBE, Ion beam deposition, Electron-beam lithography. MBE growth of quantum dots.

30 Lectures

Characterization Technique:Introductory remarks, Structural, X-ray and neutron diffraction, XPS, Electron beam techniques, Scanning Electron Microscope, Transmission Electron Microscope, Scanning Tunneling Microscope, Atomic Force Microscope, Photo luminescence Cathodo-luminescence, Electro-luminescence, UV-visible and Fourier transformed infrared spectrophotometry, Thermal analysis, Thermogravimetry analysis, Differential Scanning Calorimeter, Dielectric and Impedance analysis, Magnetic measurements.

20 Lectures

Books Suggested:

1. C.P.Poole, Jr. Frank J.Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.)
2. S.K.Kulkarni, Nanotechnology, Principle & Practices (Capital Publishing Company).
3. K.K.Chatopadhyay and A.N.Banerjee, Introduction to Nanoscience & Technology (PHI Learning Private Limited)
4. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).
5. M. Hosokawa, K. Nogi, M. Natia, T.Yokoyama, Nanoparticle Technology Hanbook (Elsevier, 2007)
6. Bharat Bhushan, Springer Handbook of Nanotechnology (Springer-Verlag, Berlin, 2004).

SEMESTER – III**Marks 80 (ESE Pr : 6Hrs) +20 Viva = 100****Pass Marks : 45**

Practical Course would be of 100 marks, but there will be no internal written examination.
The total 100 marks will have two components :- 80 marks for practical and 20 marks will be awarded on the performance in viva-voce.

ECPHYS303P: ELECTRONICS AND COMMUNICATION**LAB. – I****Credits: 5 Hrs. per week: 10**

1. Operational amplifier parameters measurements and their dependence on frequency.
2. Basic operational amplifier configurations: inverting amplifier, non-inverting amplifier, voltage follower, differentiator, integrator and instrumentation amplifier.
3. Butterworth second order active low pass and high pass filters.
4. Studies on second order band-pass and band-elimination active filters.
5. Precision rectification: half- and full- wave.
6. Design and study of Wein bridge oscillator circuit.
7. Design and study of op amp based square wave oscillator.
8. To draw the characteristic curve of SCR and to determine its holding voltage, holding current and break-over voltage
9. Use of IC 555 timer.
10. To simulate electronic circuits using PSpice.
11. BCD adder and subtractor.
12. DIAC and TRIAC characteristics and applications.

SEMESTER – III**Marks 80 (ESE Pr : 6Hrs) +20 Viva = 100****Pass Marks : 45**

Practical Course would be of 100 marks, but there will be no internal written examination.
The total 100 marks will have two components :- 80 marks for practical and 20 marks will be awarded on the performance in viva-voce.

ECPHYS303P: CONDENSED MATTER PHYSICS LAB. – I**Credits: 5 Hrs. per week: 10**

1. Studies on semiconductors: 4-Probe method for the determination of band gap and the dependence of resistivity on temperature.
2. Hall Effect study: Hall co-efficient, carrier concentration and carrier mobility.
3. Electrical properties of thin film samples.
4. ESR study.
5. Determination of magnetic parameters of some minerals using hysteresis loop tracer.
6. Crystal structure analysis using 3D – X-ray diffraction data (Data supplied).
 - (a) Use of heavy atom technique.
 - (b) Use of Direct Methods.
 - (c) Computation of 3 –D Fourier and its interpretation.
 - (d) Computation of Bond length, bond angle and H-bond & other geometrical parameters of known structures.
 - (e) ORTEP plot of molecule.
7. Ionic conductivity of sodium chloride.
8. Determination of polarizability of sugar solution.

SEMESTER – III**Marks 80 (ESE Pr : 6Hrs) +20 Viva = 100****Pass Marks : 45**

Practical Course would be of 100 marks, but there will be no internal written examination.
The total 100 marks will have two components :- 80 marks for practical and 20 marks will be awarded on the performance in viva-voce.

ECPHYS303P: NANOPHYSICS AND ANOMATERIALS**LAB. – I****Credits: 5 Hrs. per week: 10**

1. Synthesis of metal nanoparticles by chemical route.
2. Synthesis of semiconductor nanoparticle.
3. Surface Plasmon study of metal nanoparticles by UV-Visible spectrophotometer.
4. XRD pattern of nanomaterials and estimation of particle size.
5. To study the effect of size on color of nanomaterials.
6. To prepare composite of CNTs with other materials.

SEMESTER – IV**Marks 30 (MSE 20 1 Hr + 5 Attd. + 5 Assign) + 70 (ESE : 3 Hrs) = 100****Pass Marks (MSE : 17 + ESE : 28) = 45****MID SEMESTER EXAMINATION (MSE)**

The Mid Semester Examination shall have three components: (a) Two Semester Internal Assessment Test (SIA) of 20 marks each. “Better of Two” shall be applicable for computation of marks for SIA. (b) Attendance / Regular Interactions of 05 marks and (c) Assignment of 05 marks.

END SEMESTER EXAMINATION (ESE)

A total of **EIGHT** questions will be set in which Question 1 will be **Short Answer Type** and **COMPULSORY**. Any **four** questions shall have to be answered by the examinees out of the remaining seven questions. The questions will be of equal marks and will be so framed that the students are able to answer them within the stipulated time.

CCPHYS409: NUCLEAR PHYSICS – II**Credits: 5, Lectures: 75****Nuclear Radiation Detectors**

Detection: Simple model of of detector, energy measurement, position and time measurement.

Solid State Detectors: Semiconductor detectors, Surface barrier detectors, Scintillation counters: Organic and inorganic scintillators, Photomultiplier tubes, Gamma Ray Scintillation Spectrometer.

High Energy Particle Detectors: General principles, Nuclear emulsions, Cloud chambers, Bubble chamber.

Nuclear Electronics: Pulse shaping, Linear amplifiers, Pulse height discriminators, Single channel and Multichannel analyzer.

25 Lectures**Nuclear Reactor Theory**

Fundamentals of Nuclear Fission: Fission fuels, Prompt and delayed neutrons, Chain reaction, Multiplication factor, Condition for criticality, Breeding phenomena.

Diffusion of neutrons: Neutron current density, The equation of continuity,

Fick's law, The diffusion equation, Measurement of diffusion parameters.

15 Lectures

Neutron Moderation: Moderation without absorption, Energy loss in elastic collisions, Average logarithmic energy decrement, slowing down power and moderating ratio of a medium. Slowing down densities, Moderation- Space dependent slowing down, Fermi's age theory, Moderation with absorption

15 Lectures

Criticality of an Infinite Homogenous Reactor: The critical equation, Optimum reactor shapes, Material and geometrical bucklings, Neutron balance in a thermal reactor, Four factor formula, Calculation of critical size and composition in simple cases.

15 Lectures

Power Reactor: Fast breeder reactors, Thermo-nuclear reaction, nuclear fusion in stars, Concept of fusion reactor.

05 Lectures

Books Suggested:

1. Segre, E., "Experimental Nuclear Physics", John Wiley
2. Singru, R.M., "Introduction to Experimental Nuclear Physics", John Wiley & Sons, 1974.
3. W.R. Leo, "Techniques for Nuclear and Particle Physics Experiments", 2nd Rev. Edn., Springer.
4. Kapoor S.S and Ramamurthy V.S., "Nuclear Radiation Detectors", New Age International Publishers 1986.
5. Syed Naeem Ahmed, "Physics and Engineering of Radiation Detection", 2nd Edn., Elsevier.
6. Glasstone, S. and Edlund, M. C., "The Elements of Nuclear Reactor Theory", Van Nostrand Co., 1953.
7. Stacey, W. M., "Nuclear Reactor Physics", 3rd Rev. Edn., Wiley.
8. Lamarsh, J. R., "Introduction to Nuclear Reactor Theory", Addison Wesley, 1966
9. Radiation Detection and Measurement by Glenn F. Knoll, Wiley.

SEMESTER – IV**Marks 30 (MSE 20 1 Hr + 5 Attd. + 5 Assign) + 70 (ESE : 3 Hrs) = 100****Pass Marks (MSE : 17 + ESE : 28) = 45****MID SEMESTER EXAMINATION (MSE)**

The Mid Semester Examination shall have three components: (a) Two Semester Internal Assessment Test (SIA) of 20 marks each. “Better of Two” shall be applicable for computation of marks for SIA. (b) Attendance / Regular Interactions of 05 marks and (c) Assignment of 05 marks.

END SEMESTER EXAMINATION (ESE)

A total of **EIGHT** questions will be set in which Question 1 will be **Short Answer Type** and **COMPULSORY**. Any **four** questions shall have to be answered by the examinees out of the remaining seven questions. The questions will be of equal marks and will be so framed that the students are able to answer them within the stipulated time.

ECPHYS404: ELECTRONICS AND COMMUNICATION – II**Credits: 5, Lectures: 75**

Transmission line: Types of transmission line, distributed parameters, voltage and current relations on a radio frequency transmission line with respect to sending and receiving ends, propagation constant (γ), attenuation constant (α) and phase constant (β), expressions for α and β , transmission line distortion and attenuation, conditions for no distortion, low distortion and low loss, line termination across a short circuit, open circuit pure resistance and complex impedance, quarter wave and half wave lines and their impedance matching properties.

20 Lectures

Wave Guide: Field expression for propagating TE and TM waves in hollow circular cylindrical wave guides, Impossibility of TEM waves in hollow wave guide, Attenuation in wave guides and Q-factor.

10 Lectures

Fiber Optic Communication: Principle of light transmission in a fiber. Light sources for fiber optic communication, Effect of index profile on propagation, Modes of propagation, Number of modes a fiber may support, Single mode fiber

(SMF), Losses in fibers.

15 Lectures

Microprocessor Architecture: 8085 Microprocessor Architecture, Real Mode and protected modes of memory addressing, memory paging.

Addressing Modes: Data addressing modes, Program memory addressing modes, stack memory addressing modes.

Instruction Set: Data movement instructions, arithmetic and logic instructions, Program control instruction, Assembler details.

Interrupts: Basic interrupt processing, Hardware interrupt. Expanding the interrupt structure 8259A PIC.

Direct Memory Access: Basic DMA operation, 8237 DMA controller, Shared Bus operation Disk Memory systems.

30 Lectures

Books Suggested:

1. Miah, "Fundamentals of Electromagnetic", TMH
2. Mano, "Computer System Architecture", 3rd Rev. Edn., Pearson..
3. Goankar, Microprocessors Architecture, Programming & Applications with 8085, 6th Edn., Penram International Publishing.
4. Senior, "Optical Fiber Communications: Principles and Practice", 3/e, Pearson.
5. Jordon & Balmain, "Electromagnetic waves and Radiating Systems", 2nd Edn., Pearson.

SEMESTER – IV

Marks 30 (MSE 20 1 Hr + 5 Attd. + 5 Assign) + 70 (ESE : 3 Hrs) = 100

Pass Marks (MSE : 17 + ESE : 28) = 45

MID SEMESTER EXAMINATION (MSE)

The Mid Semester Examination shall have three components: **(a)** Two Semester Internal Assessment Test **(SIA)** of 20 marks each. “Better of Two” shall be applicable for computation of marks for SIA. **(b)** Attendance / Regular Interactions of 05 marks and **(c)** Assignment of 05 marks.

END SEMESTER EXAMINATION (ESE)

A total of **EIGHT** questions will be set in which Question 1 will be **Short Answer Type** and **COMPULSORY**. Any **four** questions shall have to be answered by the examinees out of the remaining seven questions. The questions will be of equal marks and will be so framed that the students are able to answer them within the stipulated time.

ECPHYS404: CONDENSED MATTER PHYSICS – II

Credits: 5, Lectures: 75

Phase Transformations and Diagram: Phase rule, Single component system, Binary phase diagrams, Lever rule, Nucleation and growth, Nucleation kinetics, Growth and overall transformation kinetics and applications to steel and glass.

10 Lectures

ESR: Basic theory, Relaxation mechanism, Effect of spin orbit coupling and crystal fields on g values, Fine and hyperfine structures. Ferromagnetic resonance (FMR): General features of FMR, Shape effect in FMR, Antiferromagnetic resonance.

10 Lectures

NMR: Basic theory, Spin lattice relaxation, Bloch equation and their steady state solutions, General features of NMR spectra, Chemical shifts, Fine structure due to spin-spin coupling, Application to molecular structure and bondings.

10 Lectures

Superconductivity: BCS theory of susceptibility, Cooper pairs, superconducting ground state, Flux quantization in superconducting ring, Quasi-particles and energy gaps, Temperature dependence of energy gap, London equation, Coherence length, Persistent current, Single particle tunneling Josephson

tunneling, Josephson effects (AC and DC), Microscopic quantum interference, Qualitative idea of high temperature superconductors, Critical fields and moments.

15 Lectures

Thin Films: Deposition techniques, Thermal, electron and sputtering methods, Metallic, semiconductor and insulator thin films and their electrical, electronic and optical properties. Magnetic and superconducting thin films and applications.

15 Lectures

Dielectrics: Structure of dielectrics, Polarization mechanism, Effect of temperature and frequency, Conduction (ionic and electronic) in dielectrics, Dielectric losses and breakdown, Electrets and MIM.

15 Lectures

Books Suggested:

1. Kittel, C., "Introduction to Solid-State Physics",
2. Arun Kumar, "Introduction to Solid State Physics", PHI Learning
3. Ashcroft, N.W. and Mermin, N. D., "Solid-State Physics"
4. Raghavan, V., "Material Science and Engineering".
5. Goswami, A., "Thin Films Fundamentals"
6. Bunget, I, & Popescu, M., "Physics of Solid Dielectrics".

SEMESTER – IV**Marks 30 (MSE 20 1 Hr + 5 Attd. + 5 Assign) + 70 (ESE : 3 Hrs) = 100****Pass Marks (MSE : 17 + ESE : 28) = 45****MID SEMESTER EXAMINATION (MSE)**

The Mid Semester Examination shall have three components: (a) Two Semester Internal Assessment Test (SIA) of 20 marks each. “Better of Two” shall be applicable for computation of marks for SIA. (b) Attendance / Regular Interactions of 05 marks and (c) Assignment of 05 marks.

END SEMESTER EXAMINATION (ESE)

A total of **EIGHT** questions will be set in which Question 1 will be **Short Answer Type** and **COMPULSORY**. Any **four** questions shall have to be answered by the examinees out of the remaining seven questions. The questions will be of equal marks and will be so framed that the students are able to answer them within the stipulated time.

ECPHYS404: NANOPHYSICS AND NANOMATERIALS–II**Credits: 5, Lectures: 75**

Optical Properties: Coulomb interaction in nanostructures, Concept of dielectric constant for nanostructures and charging of nanostructure, Quasi-particles and excitons, Excitons in direct and indirect band gap semiconductor Nano crystals, Quantitative treatment of quasi-particles and excitons, charging effects, Radiative processes, General formalization, absorption, emission and luminescence, Optical properties of hetero-structure and nanostructures.

15 Lectures

Electron Transport: Electrical properties of Polymers, Ceramics, Dielectrics and Amorphous Materials, Electrical conduction in Metals, Alloys and Semiconductors, Band structure, Carrier transport in nanostructures, Coulomb blockade effect, thermionic emission, tunneling and hopping conductivity, Defects and impurities, Deep level and surface defects.

20 Lectures

Magnetic Properties of Materials: Classification of magnetic materials, Magnetic materials of technical importance, Magnetization processes, Superparamagnetism, Magnetic domain structure, Superconductivity, Phenomenology of superconductivity.

10 Lectures

Applications: Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, Solar Cells). Single electron devices (no derivation). CNT based transistors. Nanomaterial Devices, Quantum dots hetero-structure lasers, optical switching and optical data storage. Magnetic quantum well, magnetic dots – magnetic data storage, Micro Electromechanical systems (NEMS), Nano, Electromechanical Systems (NEMS). Integrated optical devices, SQUIDS, Spintronic devices, Ferroelectric, Pyro-electric, Piezoelectric and electro-optic devices.

25 Lectures**Books Suggested:**

SAME AS IN ECPHYS403B



SEMESTER – IV**Marks 80 (ESE Pr : 6Hrs) +20 Viva = 100****Pass Marks : 45**

Practical Course would be of 100 marks, but there will be no internal written examination.
The total 100 marks will have two components :- 80 marks for practical and 20 marks will be awarded on the performance in viva-voce.

ECPHYS405P: ELECTRONICS AND COMMUNICATION**LAB. – II****Credits: 5 Hrs. per week: 10**

1. Studies on the polar pattern of microwave transmitting horn antenna.
2. Familiarity with microwave components, microwave propagation in hollow rectangular wave-guide and measurement of dielectric constant in X-band.
3. Amplitude modulation and demodulation.
4. Studies on Phase Locked Loop (PLL) IC 565 and its use in frequency multiplication.
5. Design, construct and test electronically regulated power supplies using Zener diode, 3-pin regulators (78xx/79xx) and IC 723.
6. Design and study of the characteristics of TTL logic NAND gate and the evaluation of its parameters.
7. Familiarity with circuit simulation and fundamentals of PSpice commands and circuit programming.
8. Simulation of amplifier, oscillator and TTL logic NAND gate circuits. Analog computation using PSpice: solution of differential equations.

SEMESTER – IV**Marks 80 (ESE Pr : 6Hrs) +20 Viva = 100**

Practical Course would be of 100 marks, but there will be no internal written examination.
The total 100 marks will have two components :- 80 marks for practical and 20 marks will be awarded on the performance in viva-voce.

ECPHYS405P: CONDENSED MATTER PHYSICS**LAB. –II****Credits: 5 Hrs. per week: 10**

1. Determination of magnetic susceptibility using Guoy's method.
2. Determination of Curie temperature by dielectric constant apparatus.
3. Determination of modulus of rigidity and internal friction by modulus of rigidity apparatus.
4. Study of impedance spectrometry of a given sample using LCR meter.
5. Study of temperature dependence of Hall coefficient.
6. Synthesis of materials under different stoichiometric ratio.
7. Study of dielectric constant of polar and non-polar molecules.
8. Study of absorption pattern of a given sample using FTIR spectrometer.

SEMESTER – IV**Marks 80 (ESE Pr : 6Hrs) +20 Viva = 100****Pass Marks : 45**

Practical Course would be of 100 marks, but there will be no internal written examination.
The total 100 marks will have two components :- 80 marks for practical and 20 marks will be awarded on the performance in viva-voce.

ECPHYS405P: NANOPHYSICS AND NANOMATERIALS**LAB. – II****Credits: 5 Hrs. per week: 10**

1. Growth of quantum dots by thermal evaporation.
2. Prepare a disc of ceramic of a compound using ball milling, pressing and sintering and study its XRD.
3. Fabricate a thin film of nanoparticles by spin coating (or chemical route) and study transmittance spectra in UV-Visible region.
4. Prepare a thin film capacitor and measure capacitance as a function of temperature or frequency.
5. Fabricate a PN diode by diffusing Al over the surface of N-type Si and study its V-I characteristic.

SEMESTER – IV**ECPHYS410: PROJECT / DISSERTATION****Marks 100 (ESE) = 100****Pass Marks : 45**

The written component of project will be of 80 marks and 20 marks will be for Viva examination, jointly conducted by external and internal examiners appointed by the university.

Guidelines to Examiners for**End Semester Examination (ESE):**

Overall project dissertation may be evaluated under the following heads:

- Motivation for the choice of topic
- Project dissertation design
- Methodology and content depth
- Results and Discussion
- Future Scope & References
- Participation in Internship programme with reputed organization
- Application of Research technique in Data collection
- Report Presentation
- Presentation style
- Viva-voce

Topics of Project

Each student shall have to complete a project work on any topic of his choice, not relevant to the frontier area of Science and Technology, or on a topic allotted by his/her project Guide/Supervisor/Department in Semester – IV. This is compulsory and the candidate shall ensure that his project is on a relevant topic completed by him independently with the help and inputs from his/her guide/supervisor. Other guidelines pertaining to this paper shall be provided by the Department.

NB: Students will select topics for the project work in consultation with a teacher of the department. The seminar will be held in the Department of Physics, Nilamber-Pitamber University, Medininagar, Palamu.