PREAMBLE

Nanoscience and Nanotechnology is a rapidly developing research area having enormous potential for technological applications. Universities and Research Institutes in India and world over have taken strong initiatives to start academic and research programmes in this field. A Centre for Nanoscience and Nanotechnology was started in the University in December 2006 with the aims of establishment of state-of-the-art laboratories for research and for offering academic programmes for the purpose of generating man power in this frontier area. The Centre is thriving for achieving these goals. The Centre has already set-up high level research facilities and offers two M. Phil courses - M. Phil Nanoscience and Nanotechnology, and M. Phil Nanobiology - and a Ph. D programme. University of Kerala is the first University in Kerala State to start an academic programmes in the area of Nanoscience and Nanotechnology. For further development of the Centre for Nanoscience and Nanotechnology and to generate man power in this area, it would be highly appropriate to start a Post Graduate programme in this area and this programme may be called M. Sc programme in Nanoscience.

Students having B. Sc Degree in Physics, Chemistry or Biology would have the required basic knowledge for undergoing a properly structured M. Sc programme in Nanoscience. The students completing the M. Sc course in Nanoscience should be competent enough to qualify GATE/NET/UGC examination to equip themselves for higher studies and for employment. Hence, the M. Sc course in Nanoscience has to be structured in such a way that students with a B. Sc Degree in Physics would learn enough core physics courses and courses in Nanoscience for the M. Sc course, students with a B. Sc Degree in Chemistry would learn enough core chemistry courses and courses in Nanoscience for the M. Sc course, and students with a B. Sc Degree in Biology would learn enough core biology courses and courses in Nanoscience for the M. Sc course. Initially, an M. Sc course in Nanoscience with eligibility for admission as a B. Sc degree in Physics of University of Kerala or equivalent degree from a recognized University/Institute may be started. The other two M. Sc courses with B. Sc in Chemistry or Biology (the exact subject/subjects to be decided) as the basic qualification for admission can be started during the coming years.

UNIVERSITY OF KERALA
CENTRE FOR NANOSCIENCE AND NANOTECHNOLOGY

M. Sc PROGRAMME IN NANOSCIENCE

The programme shall extend over a period of two academic years comprising of four semesters each of 5 months duration

<table>
<thead>
<tr>
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<td>Electronic Devices and Circuits</td>
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Semester II

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<td>Introduction to Nanoscience and Nanotechnology</td>
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<td>NSP 525</td>
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**NSP 511 MATHEMATICAL PHYSICS**

**Unit I**

**Vector analysis and matrices**


**Complex analysis**

Cauchy–Riemann conditions-Cauchy’s integral theorem and formula-singularities and mapping-calculus of residues-dispersion relations.

**Fourier series and applications**

General principles of Fourier series-advantages and applications-Gibbs phenomenon-Discrete Fourier Transform-Fast Fourier transform.

**Probability**

Definitions and simple properties of probability-random variables-Chebychevs in equality and moment generating function-discrete and continuous probability distributions-binomial distributions-Poisson distributions-Gauss Normal distribution error analysis duf and least square fitting- chi-square and student ‘t’ distributions.

**Unit II**

**Differential equations**

Special functions


Unit III

Tensor analysis

Notations and conventions in tensor analysis-Einstein’s summation convention covariant and contravariant and mixed tensors-algebraic operations in tensors symmetric and skew symmetric tensors-tensor calculus-Christoffel symbols-kinematics in Riemann space-Riemann—Christoffel tensor.

References


NSP 512 CLASSICAL MECHANICS

Unit I

Lagrangian mechanics


Two body central force problem

Reduction to one body problem-equations of motion-equivalent one dimensional problem-differential equation for the orbit in the case of integrable power law potentials-Kepler’s problem-inverse square law of force-scattering in central -Virial theorem-transformation of the scattering problem to laboratory coordinates.

Theory of small oscillations

Equilibrium and potential energy-theory of small oscillations-normal modes with examples-longitudinal vibrations- longitudinal vibrations of carbon dioxide molecule.

Unit II

Hamiltonian mechanics

Generalized momentum and cyclic coordinates-conservation theorems-Hamilton’s equations-examples in Hamiltonian dynamics-canonical transformations-generating functions-Poisson brackets-Liouville’s theorem.

Hamilton-Jacobi equations

Hamilton-Jacobi equation-harmonic oscillator as an example-separation of variables in Hamilton-Jacobi equation-action angle variables-Kepler’s problem.

Rigid body dynamics

Generalized coordinates of rigid body-Euler’s angles-infinitesimal rotations as vectors angular momentum and inertia tensor-Euler’s equations of motion of a rigid body force freemotion of symmetrical top-motion of heavy symmetrical top.
Unit III

Introduction to non-linear dynamics and chaos

Linear and nonlinear systems - integration of second order non-linear differential equation - pendulum equation - phase plane analysis of dynamical systems - linear stability analysis - limit cycles.

References

**NSP 513 ELECTRODYNAMICS**

Unit I

**Electrodynamics**


**Plane Electromagnetic Waves**

Plane waves in lossless media - TEM waves - polarization of plane waves - plane waves in lossy media - flow of electromagnetic power - Poynting’s vector - normal incidence at plane conducting boundary - oblique incidence at a plane conducting boundary - normal incidence at a plane dielectric boundary - oblique incidence at a plane dielectric boundary.

**Unit II**

**Waveguides and Cavity Resonators**

Waves between parallel plates – TE, TM and TEM waves – rectangular wave guides - TE and TM modes in rectangular wave guides – circular wave guide – dielectric wave guides – cavity resonators.

**Radiation Theory**

Dipole radiation – electric dipole radiation – magnetic dipole radiation – radiation from an arbitrary source.

**Unit III**

**Special Theory of relativity**

Proper time and four-vectors - Minkowski’s geometry of space-time - Lorentz transformation in four dimensional space - covariant four dimensional formulation - force and energy - equations in relativistic mechanics - relativistic energy. Elements of general theory of relativity (qualitative study).

**Relativistic Electrodynamics**

Magnetism as a relativistic problem – transformation of the fields – electric field of a point charge moving uniformly – electromagnetic field tensor – electrodynamics in tensor notation – potential formulation of relativistic electrodynamics.

**Motion of a charged particle in an electromagnetic field**

Uniform E and B fields – non uniform fields – time varying E and B fields.

**Reference**
NSP 514 ELECTRONIC DEVICES AND CIRCUITS

Unit I

Frequency response of amplifiers


Field Effect Transistor

Biasing of FET - small signal model - analysis of common souse and common drain amplifiers - high frequency response – FET and VVR and its applications - CMOS logic and logic packages

Power Amplifiers

Types of power amplifiers - series fed class A amplifier - series fed transformer coupled class B– push-pull circuits - harmonic distortion in amplifiers - class C and D amplifiers - design considerations.

Unit II

Operational Amplifier Circuits


Monolithic timers and their applications

RS flip flop, basic timing concept, 555 functional diagram and pin configuration, astable multivibrator - monostable multivibrator - free running ramp.

Unit III


References

**List of Experiments - Minimum 10 experiments to be done**

(More number of experiments may be included in the list)

1. Half wave and full wave rectifier with filter
2. Stabilized power supply
3. Phase shift oscillator
4. RC coupled amplifier with out and with feed back
5. Emitter follower
6. Astable multivibrator
7. RC differentiator and Integrator
8. Study of OP Amp circuits
9. Characteristics of JFET and MOSFET
10. Study of clipping and clamping circuits
11. SR and JK Flip Flops - construction using Logic Gates and study of truth tables
12. Study of active filters using OP amps (a) low pass ( b) high pass ( c) band pass for both first order and second order-gain/ roll off determination
13. Wave form generation using OP amp circuits: (a) astable and monostable multivibrators (b) square, triangular and saw-tooth wave generation
14. IC 555 timer experiments (a) monostable and astable multivibrators (b) VCO
15. BCD to decimal decoder and seven segment display using IC

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**Inadequacy of Classical Physics** (Experimental results and qualitative discussion only, Derivations not required) - particle aspect of radiation - black body radiation- Max Planck’s quantum hypothesis, Photoelectric effect- Einstein’s explanation, Bohr model of Hydrogen atom, Old Quantum theory- Wilson-Sommerfeld quantum conditions- Inadequacy of old quantum theory.


Time dependent Schrödinger equation – Development of time dependent Schroedinger equation, Physical significance of the wave function, $\psi$- Probability interpretation, orthogonal, normalized and orthonormal functions, Probability current density, Limitations on $\psi$, Expectation value of dynamical quantities, Ehrenfest’s theorem. The general solution of time dependent Schrödinger equation for a free particle (one dimensional), Free particle propagator, Wave packet, Time dependent evolution of a wave packet, Group velocity and Phase velocity, Time independent Schrödinger equation, Stationary states- the Gaussian wave packet – spread of the Gaussian packet with time – principle of causality.

**Eigenvalue Problems in one-dimension** - infinite square well – finite square well – The potential step – the

**Unit II**

**Eigenvalue problems in three-dimension** - separation of Schrödinger equation in Cartesian co-ordinates – the free particle – three dimensional box – square well in three dimensions.

Spherically symmetric systems – potential barrier – barrier tunnelling - application to $\alpha$-decay linear harmonic oscillator – oscillator wave functions and parity.spherical harmonics and their properties – the hydrogen atom.


Unit III


Time-independent perturbation theory - stationary perturbation theory for non degenerate and degenerate levels - anharmonic oscillator with cubic and quadratic perturbations - Stark effect in hydrogen.

WKB approximation - WKB method - the connection formulas – energy levels in a potential well - barrier tunneling - application to alpha decay - application to bound state - validity of WKB approximation.

References

NSP 522 CONDENSED MATTER PHYSICS

Unit I

Crystal physics
Lattice points and space lattice - basis and crystal structure - unit cells and lattice parameters - symmetry elements in crystals – space groups - Bravais lattice - density and lattice constant relation - crystal directions - planes and Miller indices - reciprocal lattice - allotropy and polymorphism in crystals - imperfections in crystals.

Lattice vibrations and thermal properties

Free electron and band theory

Unit II

Semiconductors
Free carrier concentration in semiconductors - mobility of charge carriers of semiconductors - Hall effect in semiconductors - semiconductor junction properties.
Dielectric and magnetic properties of materials


UNIT III

Superconductivity


References


NSP 523 SPECTROSCOPY

Unit I

Group theory

Definitions of a group - elementary properties - sub groups - homomorphism and isomorphism of groups - representation of groups - similarity transformation and classification of symmetry operations - matrix representation of point group - reducible and irreducible representations - character of a matrix - orthogonality theorem - rules derived from orthogonality theorem (proof not required) - setting up of character tables of simple groups such as C_{2v} and C_{3v} on the basis of rules - the four areas of the character table - reduction of reducible representations to irreducible representations - applications of character tables to spectroscopy - transition moment operators - application of character table to orbitals - construction of hybrid orbitals - symmetry adapted LCAO.

Unit II

Rotation of Molecules

The rotation of molecules – rotational spectra of diatomic molecules – rigid rotator - intensities of spectral lines – effect of isotopic substitution – non-rigid rotator - spectra of non-rigid rotator – rotational spectra of linear and symmetric top molecules.

Vibration of Molecules


Raman Spectroscopy

Classical theory of Raman effect - experimental techniques - pure rotational Raman spectra - vibrational Raman spectra – rule of mutual exclusion - Raman spectrometer - structure determination from Raman and infrared spectroscopy.
Unit III

Electronic Spectra of Atoms


Electronic Spectra of Diatomic Molecules


NMR spectroscopy

Nuclear magnetic resonance spectra - basic principle - experimental techniques – idea of chemical shift and spin orbit coupling – applications.

ESR spectroscopy


Mossbauer spectroscopy


References


NSP 524 INTRODUCTION TO NANOSCIENCE AND NANOTECHNOLOGY

UNIT I


Synthesis of nanomaterials - bottom-up and top-down approaches - metal nanoparticles – properties of individual nanoparticles – consequences of small particle size - increase of mechanical frequencies in small systems - dominance of viscous forces - disappearance of frictional forces.  

(Ref. 1– 4)
UNIT II


(Ref. 1,2,5,6)

UNIT III


(Ref. 1,7)

References:

6. V.I. Klimov (Ed.), Semiconductor and Metal Nanocrystals – Synthesis and Electronic and Optical properties, Marcel Dekker Inc., 2004

NSP 525 NANOSCIENCE - LAB I

List of Experiments - Minimum 10 experiments to be done

(More number of experiments may be included in the list)

1. Analysis of given X-ray diffraction pattern.
2. X-ray diffraction – structure evaluation and identification of a material.
3. Interpretation of electron diffraction pattern (SAED pattern).
4. Determination of $e/k$
5. Determination of particle size of given material using He-Ne laser
6. Determination of Fermi energy of copper
7. Study of variation of resistance of a semiconductor with temperature
8. Hall effect in a semiconductor
9. Study of arc spectra
10. Study of hydrogen spectrum
11. Absorption spectrum of KMnO$_4$ solution
12. Interpretation of vibration spectra of simple molecules using Raman and IR spectra.
13. Study of dielectric constant
14. Measurement of resistivity of low and high resistivity semiconductors – four probe method
15. Photocurrent measurement in a semiconductor
16. Measurement of magnetoresistance of semiconductors
17. Magnetic susceptibility – Quinke’s method
18. Determination of thickness of a film by envelope method and calculation of band gap using the given transmittance spectrum of the film.

**NSP 531 SYNTHESIS AND FABRICATION OF NANOMATERIALS**

**UNIT I**

Synthesis of zero-dimensional nanostructures - fundamentals of homogeneous nucleation - subsequent growth of nuclei - colloidal nanosynthesis - inorganic surface modification - shape control - phase transition and phase control - nanocrystal doping - synthesis of metallic (Au, Ag) nanoparticles - synthesis of semiconducting nanoparticles (CdSe, CdS) - synthesis of oxide nanoparticles - sol-gel method - synthesis of multicomponent nanostructures - fundamentals of heterogeneous nucleation - synthesis of nanoparticles.

Epitaxial core–shell nanoparticles – core-shell quantum dots - type I and type II core- shell quantum dots - quantum dot quantum wells. - sonochemical synthesis of nanoparticles – spray pyrolysis - electrospinning. (Ref. 1 – 3)

**UNIT II**


Lithography techniques - optical lithography - electron beam lithography - focused ion beam lithography - X-ray lithography. (Ref. 1, 4)

**UNIT III**

Nanomanipulation and nanolithography - manipulation by scanning tunnelling microscope - manipulation of atoms, molecules, and nanoclusters by scanning tunnelling microscope - manipulation of single atoms, single molecules and nanoclusters by atomic force microscope – nanolithography - soft lithography - micro contact printing, molding, nanoinprint - dip-pen nanolithography. (Ref. 1, 5)

**References**

NSP 532 PHYSICS AND CHEMISTRY OF NANOSOLIDS

UNIT I


Quantum wire devices - transport in one dimensional electron systems (1 DES) - ideal 1DES - semiconductor 1DESs - silicon 1DESs - semiconductor quantum dots as zero dimensional electron systems (0 DES).

(Ref. 1-4)

UNIT II


(Ref. 5 – 7)

UNIT III


(Ref. 8)

References


NSP 533 NANOELECTRONICS

UNIT I

– MOSFET scaling theory - dopant number fluctuation - scaling limits of charge based devices - examples of quantum electronic devices - short-channel MOS transistor - electronic devices based on nanostructures-MODFETs- heterojunction bipolar transistors - resonant tunnel effect - tunneling diode- resonant tunneling diode - hot electron transistors - resonant tunneling transistor. (Ref. 1 – 4)

UNIT II

Single electron tunnelling - Coulomb blockade- single electron transistor (SET) - performance of SET - fabrication of SET - operation of single electron transistors - mesoscopic arrays with nanoelectrodes - from single particle properties to collective charge transport - one, two and three dimensional arrangement of particles - logic circuits with single electron transistors- bias conditions for SETs - design scheme for SET logic circuits.


UNIT III

Spintronics – spin-diffusion length - spin dependent resistivity in transition metal alloys - giant magnetoresistance (GMR) – Mott’s two-current model – experiments on GMR - GMR spin valve - spin injection - spin injection into a non-magnetic conductor - spin injection in semiconductors - magnetic random access memory (MRAM) - silicon-based spin transistor - design and fabrication - electrical characterization – spin-FETs – spin-MOSFETs. (Ref. 8 – 11)

References

NSP 534 CHARACTERIZATION TECHNIQUES FOR NANOMATERIALS

Unit I


Spectroscopic methods - UV-Visible, infrared and Raman spectroscopy, photoluminescence spectroscopy – principle - instrumentation – recording and interpretation of the spectra.

Unit II

Electron spectroscopy - X-ray photoelectron spectroscopy (XPS), ultra-violet photoelectron spectroscopy (UPS) - Auger electron spectroscopy (AES) - X-ray fluorescence spectroscopy

Microscopy - optical microscopy - electron microscopy – transmission electron microscopy (TEM) – high resolution transmission electron microscopy (HRTEM) - scanning electron microscopy (SEM) – micro analysis - EDS and WDS - scanning probe microscopy - scanning tunneling microscopy (STM) – atomic force microscopy AFM)

Unit III

Thermal analysis- TGA, DTA, DSC. VSM and SQUID magnetic measurements - electrical conductivity - two probe and four probe methods - dynamic light scattering techniques – BET technique.

References


NSP 53E1 COMPUTATIONAL METHODS

UNIT I


Eigen values and eigenvectors - determinant of a matrix - eigen value problem - largest and smallest eigen values - House Holder’s method - eigen values of a symmetric tri-diagonal matrix - QR method - singular values of decomposition.

UNIT II

Interpolation - finite differences – forward, backward and central differences - differences of a polynomial - Newton’s formula for interpolation - central difference interpolation formulae - Gauss’s central difference formulae - Stirling’s formula- Bessel’s formula - Everette’s formula - interpolation of unevenly spaced points – Lagrange’s interpolation formula - divided differences and Newton’s general interpolation formula - Interpolation with Cubic splines.

Curve fitting - least square curve fitting procedure - fitting a straight line – non-linear curve fitting - curve fitting by sum of exponentials - weighted least square approximation - linear and non-linear - methods of least squares for continuous functions.
UNIT III

Numerical differentiation - derivation of numerical differentiation formula from Newton’s difference formulae - cubic spline method.


References


NSP 53E2 THERMODYNAMICS AND STATISTICAL MECHANICS

Unit I

Thermodynamics

Unit II

Phase transitions

Triple point-Van der Waals equation equation and phase transitions-first and second order phase transitions-Ehrenfest’s equations-Ising model-Yang and Lee theory of phase transitions-London theory of phase transitions (Chapter 12 of Satyaprakash)

Unit III

Foundations of classical and statistical physics Phase space-ensembles-Liouville’s theorem-statistical equilibrium-microcanonical ensemble-partition functions and thermodynamic quantities-Gibb’s paradox-Maxwell-Boltzmann distribution laws-grand canonical ensemble (Chapter 6 and 7 of Satyaprakash)

Quantum statistics

References


NSP 53E3 ADVANCED QUANTUM MECHANICS

Unit I


Unit II


Unit III


References

NSP 54E1 NANO TECHNOLOGY AND ENERGY APPLICATIONS

UNIT I

Introduction to solar energy conversion - sun as an energy source - generation of photovoltaic solar cells - solar cells based on single pn junctions - silicon crystalline cells - basic mechanisms in solar cells - current-voltage characteristics of pn junction - limitations of energy conversion in solar cells - maximum efficiency of solar cells - concepts for improving the efficiency of solar cells - tandem cells

Thin film solar cells - first generation thin film solar cells - amorphous silicon alloy solar cells - CdTe based thin film solar cells - CIS based thin film solar cells - next generation thin film solar cells - thin film silicon, microcrystalline-silicon, GaAs - organic solar cells - high efficiency thin film solar cells. (ref. 1-3)

UNIT II


UNIT III


References

5. Rafael Luque, Rajender S Varma (Eds.), Sustainable Preparation of Metal Nanoparticles: Methods and Applications, RSC publishing, 2013
NSP 54E2 ADVANCED NANOTECHNOLOGY

UNIT I

Carbon-based nanomaterials for electrochemical energy storage – principle of a supercapacitor – carbons for electric double layer capacitors – carbon-based materials for pseudo-capacitors – lithium-ion batteries – anodes based on nanostructured carbons – anodes based on Si/C composites – origins of irreversible capacity of carbon anodes.

Nanotechnology for carbon dioxide capture – CO₂ capture processes – nanotechnology for CO₂ capture – porous coordination polymers (PCPs) for CO₂ capture – molecular modeling of CO₂ adsorption on PCPs.  (Ref. 1)

UNIT II

Nanostructured organic light emitting devices – organic-light emitting diodes (OLEDs) and polymer-based light emitting diodes (PLEDs) – quantum confinement and charge balance for OLEDs and PLEDs – multilayer structured OLEDs and PLEDs – charge balance in a polymer blended system – phosphorescent materials for OLEDs and PLEDs – enhancement of light out-coupling –

Hydrogen generation and storage - efficient photocatalytic dissociation of water into hydrogen and oxygen – hydrogen production by semiconductor nanomaterials – need for nanomaterials – nanomaterials based photoelectrochemical cells for H₂ production – application of nanotubes and nanodisks - nanostructured materials for hydrogen storage – hydrogen storage by physisorption - hydrogen storage by chemisorptions.  (Ref. 1)

UNIT III

Nanoscale technology in biological systems – learning from nature – DNA nanotechnology – nanoparticles for biological assays - core-shell nanoparticles for drug delivery and molecular imaging – therapeutic applications of nanoparticles – application of nanoparticles for noncancer applications – physiological and uptake of particles – nanoparticles and hyperthermic cancer therapeutics – nanoparticles and thermal ablation - targeting nanoparticles to specific sites for tumor ablation – in vivo anticancer platform delivery - superparamagnetic nanoparticles of iron oxides for MRI applications.  (Ref. 2 – 4)

References

3. Chella Kumar (Ed.), Nanomaterials for Medical Diagnosis and Therapy, Wiley-VCH, 2007

NSP 54E3 ADVANCED MATERIALS AND DEVICES

Unit I

Unit II

Optoelectronic devices - optical sources – LEDs, Device configuration and efficiency – LED structures – Heterojunction -LED, surface emitting LED, edge emitting LED. Junction Laser, - Operating principle – Heterojunction Laser-Photodetectors, photoconductors, Pin photo diode, heterojunction diodes, avalanche - photodiodes, basic idea of photo transistors

Nano-microelectromechanical systems (NEMS/MEMS) – MEMS fabrication techniques – NEMS fabrication techniques – NEMS/MEMS motion dynamics – MEMS devices and applications – NEMS devices and applications. (Ref. 2, 3)

Unit III


References


NSP 54E4 NANO-OPTOELECTRONIC DEVICES AND SENSORS

Unit I

Fabrication of quantum dots (QDs) for nanophotonic devices – fabrication of self-assembled QDs – shortening emission wavelengths of self-assembled QDs – controlling the density of self-assembled QDs – fabrication of ultrahigh density QDs –nanopositioning technique for quantum structures with dioxide mask – artificially prepared nanoholes for arrayed QD structure fabrication –fabrication technique of Si nanoparticles as Si-QD structures.

Nanomaterials processing for device manufacturing – classification of CNTs using microfluidics – dielectrophoretic phenomenon on CNTs – separation of semiconducting CNTs – deposition of CNTs by microrobotic workstation - carbon nanotube schottky photodiodes – review of CNT photodiodes – design of CNT Schottky photodiodes – symmetric and asymmetric Schottky photodiodes . (Ref. 1, 2)

Unit II

Nanophotonics recording device for high-density storage – thermally assisted magnetic recording simulation – the ‘Nanobeak’, a near-field optical probe – bit patterned medium with magnetic nanodots – near-field optical efficiency in hybrid recording.


Optical sensors using grapheme – fabrication of graphene-based devices – electrical and optical behaviors of various graphene-based devices. Nanoantennas on nanowire - based optical sensors – nanoantenna design consideration for IR sensors – nanoantenna near-field effect – fabrication of nanosensor combined with nanoantenna – photocurrent measurement of nanosensor combined with nanoantenna. (Ref. 1, 2)

Design of photonic crystal waveguides – photonic bandgap of photonic crystals – photonic crystal cavity – basic design of photonic crystal defect – defect from dielectric constants and dielectric size – effect from lattice number – photoresponses of CNT-based IR sensors with photonic crystal cavities – photocurrent mapping of the CNT-based IR sensors with photonic crystal cavities. (Ref. 1, 2)

References

NSP 543  NANOSCIENCE - LAB II
List of Experiments - Minimum 8 experiments to be done
(More number of experiments may be included in the list)
1. X-ray diffraction of nanoparticles – identification, particle size and strain determination.
3. Synthesis of ZnS quantum dots and determination of size using Scherrer’s equation.
5. Synthesis of ZnO nanoparticles of two different sizes and determination of band gap.
7. Synthesis of silver nanoparticles by polyol method and study of surface plasmon resonance.
8. Synthesis of rod-like silver nanoparticles and recording of UV-Vis spectra – study of plasmon resonance.
9. Doping of silica glass with silver nanoparticles by ion exchange method and study of surface plasmon resonance.
10. Synthesis of metal oxide nanoparticles by high energy ball milling and determination of their structure and particle size.
11. Synthesis of nanostructured CuO films by oxidation of given nanostructured Cu films and determination of band gap and its resistivity at different temperatures.
12. Deposition of nanostructured semiconductor film by spray pyrolysis and determination of its structure and band gap.
14. Photoluminescence spectra of semiconductor nanoparticles – study of energy levels.
15. Preparation of nanostructured films using the given nanoparticles and determination of structure.
16. I – V characteristic of a DSSC
17. Study of photocatalytic activity of semiconducting oxide nanoparticles.
UNIVERSITY OF KERALA
CENTRE FOR NANOSCIENCE AND NANO TECHNOLOGY
M. Sc NANOSCIENCE

Time : 3 Hours       Max. Marks : 60

Part A
Answer any FOUR questions. Each question carries 3 marks.
1. 
2. 
4. 
5. 
6. (3 x 4 = 12 marks)

Part B
Answer ALL questions. Each question carries 10 marks.
7 A (i) 
(ii) ~ OR 
7B (i) 
(ii) 
8A (i) 
(ii) ~ OR 
8B (i) 
(ii) 
9A (i) 
(ii) ~ OR 
9B (i) 
(ii) (10 x 3 = 30 marks)

Part C
Answer any THREE questions. Each question carries 6 marks.
10. 
11. 
12. 
13. 
14. 
15. (6 x 3 = 18 marks)
Model Question Paper (For courses NSP 524 to NSP 534 and NSP 54E1 to NSP 54E4)

UNIVERSITY OF KERALA
CENTRE FOR NANOSCIENCE AND NANOTECHNOLOGY
M. Sc NANOSCIENCE

Time : 3 Hours       Max. Marks : 60

Part A
Answer any EIGHT questions. Each question carries 3 marks.

1. 
2. 
4. 
5. 
6. 
7. 
8. 
9. 
10. 
11. 
12. (3 x 8 = 24 marks)

Part B
Answer ALL questions. Each question carries 12 marks.

13 A (i) 
(ii) 
OR

13 B (i) 
(ii) 

14 A (i) 
(ii) 
OR

14 B (i) 
(ii) 

15 A (i) 
(ii) 
OR

15 B (i) 
(ii) 
(12 x 3 = 36 marks)

* * *
CENTRE FOR NANOSCIENCE AND NANOTECHNOLOGY

M. Sc PROGRAMME IN NANOSCIENCE

Regulation, Scheme and Syllabus

(The Regulation for the M. Sc course in Nanoscience will be the same as that for the existing M. Sc courses in the Departments of the University of Kerala)

Eligibility for admission: B. Sc degree in Physics of University of Kerala or equivalent degree from a recognized University/Institute.

With effect from 2016 Admission