Ph.D. Course work

Pre-Ph.D. Examination Syllabus

(DEEMED TO BE UNIVERSITY)

DEPARTMENT OF PHYSICS,
K L UNIVERSITY,
VADDESWARAM - 522502,
ANDHRA PRADESH, INDIA.

Koneru Lakshmaiah Education Foundation (KLEF)

(Deemed to be University)

Green Fields, Vaddeswaram 522502, Guntur.

List of Pre-Ph.D Courses approved by DEPARTMENT OF PHYSICS, KLEF.

S.NO	PAPER – 2	Course Code	PAPER – 3	Course Code
1.	Spectroscopic Studies On Transition Metal Ions	21PHY201	Spectroscopic Studies On Rare Earth Ions	21PHY301
2.	Nano Science And Technology	21PHY 202	Solid State Ionics	21PHY302
3.	Remote Sensing Techniques	21PHY203	Upper Atmospheric Science	21PHY303
4.	Nuclear Physics-1	21PHY204	Nuclear Physics - II	21PHY304
5.	Liquid Crystals-I	21PHY205	Liquid Crystals-II	21PHY305
6.	Physics of Solar Cells	21PHY206	Thin Film Technology And Applications	21PHY306
7.			Molecular Modeling	21PHY307
8.			Aeronomy	21PHY308
9.			Advanced Solar Energy Storage Technologies	21PHY309

Dr. G. SUNITA SUNDARI
Associate Professor & HOD
Department of Physics
KLEF, VADDESWARAM,
Guntur District. 522 502.

डा. डी. हरनाथ / Dr. D. Haranath
सह–आचार्य / Associate Professor
भौतिक विज्ञान विभाग / Department of Physics
राष्ट्रीय प्रौद्योगिकी संस्थान
NATIONAL INSTITUTE OF TECHNOLOGY
वरंगल - 506004, तेलंगाना / Warangal - 506004, Telangana

[J. SURYANARAYANA]
Dr. J. Suryanarayana
Department of Physics

Code: 21PHY201

PHY-PhD-1 Spectroscopic Studies on Transition metal ions

Unit – I: INTRODUCTION:

The concept of ligand field - The scope of ligand field theory – The‘d’ and other orbital’s.The physical properties affected by ligand fields.

Unit – II: QUANTITAVIVE BASIS OF CRYSTALFIELDS:

Crystal field theory – The octahedral crystal field potential on the‘d’ wave function – Theevaluation of 10 Dq – The tetrahedral potential.

Unit – III: FREE ION IN WEAK, MEDIUM, AND STRONG CRYSTALFIELDS:

The effect of a cubic crystal field on S and P terms – on D terms – on F terms – on G, H and I terms – Strong field configurations – Transition from weak to strong crystal fields – term energy level diagrams – Tanabe-Sugano diagrams.

Unit – IV: BASIC THEORYg-FACTOR:

The g-factor – the general Hamiltonian – The crystal field and orbital symmetry – Symmetry of p and d orbitals – Effect of crystal field – Jahn-Teller distortion and Kramer’s theorem – Magnitude of the crystal field – Calculation of g-factors – Ti^{3+} in octahedral field. The spin-Hamiltonian – effect of field orientation – Fine structure – Zero-fieldsplittingThe Spin-Hmiltonian for V^{3+} and FeO_4^{2-}S-stateions-Mn^{2+} ion.

Unit – V: NUCLEAR HYPERFINESTRUCTURE:

Introduction – General treatment – Isotropic hyperfine interaction – The spin-Hamiltonianenergy levels – Interpretation of isotropic hyperfine coupling constant – Unpaired spin density – Anisotropic hyperfine interaction – The Spin-Hamiltonian energy levels – Interpretation of anisotropic hyperfine coupling constants – the term <(1 – 3 Cos2 / r3)>av

TEXT BOOKS:

1. Introduction to LigandFields.
B.N.Figgis, Wiley – Eastern Ltd., New Delhi (1976).
2. Electron Spin Resonance inChemistry.
Peter B.Ayscough. Methuen and Co.Ltd., London (1964). 3. Instrumental Methods and Analysis.
H.Willard, L.Merritt, J.Dean,F.Settle, CBS publishers and distributors (1986).
4. Fundamentals of Molecular Spectroscopy.
C.N.Banwell, Tata-McGraw-Hill publishing company Ltd, New Delhi (1990).

MODEL QUESTION PAPER

Spectroscopic Studies on Transition metal ions

Time:3hrsMax. Marks: 100

Answer any five of the following questions. All questions carry equal marks

1. Explain the effect of octahedral crystal field on the d wave functions and compare the corresponding effect by a tetrahedral field.
2. Describe the effect of cubic crystal field on S, P, D terms in detail.
3. Distinguish between static and dynamic Jahn-Teller effects and their role in the electronic spectra of complex molecules.
4. Explain the energy levels and g-factor for Ti^{3+} in an octahedral field.
5. Explain how spin-orbit coupling is evaluated from the experimental studies on atomic spectroscopy and ESR spectra of crystals.
6. Distinguish between isotropic and anisotropic hyperfine interaction and explain the corresponding spin-Hamiltonian energy levels.
7. Write the spin-Hamiltonian for S-state ions explain each term in it. Give the energy level diagram of Mn^{2+}ion.
8. Write notes on any two of the following.

(a) Zero-field splitting

(b) Tanabe-Sugano diagrams.

Dr. G. SUNITA SUNDARI
Associate Professor & HOD
Department of Physics
KLEF, VADDESWARAM,
Guntur District. 522 502.

डा. डी. हरनाथ / Dr. D. Haranath
सह–आचार्य / Associate Professor
भौतिक विज्ञान विभाग / Department of Physics
राष्ट्रीय प्रौद्योगिकी संस्थान
NATIONAL INSTITUTE OF TECHNOLOGY
वरंगल - 506004, तेलंगाना / Warangal - 506004, Telangana

[J. SURYANARAYANA]
Dr. J. Suryanarayana
Department of Physics
Indian Institute of Technology

Code: 21**PHY301**

PHY-PhD-2 Spectroscopic Studies on Rare Earth ions

Unit – I: ATOMICSPECTROSCOPY:

The free ion: Free ion terms for d_2 and f_2 configurations; Spin-orbit coupling; Ground states for fn configurations; Coulomb and spin-orbit energies; Intermediate coupling.

Unit – II: ABSORPTION CHARACTERISTICS OF RARE EARTHIONS:

Intra-configurational f-f transitions; magnetic dipole, electric dipole and induced electric dipole transitions; Intensity of absorption bands; Judd-Ofelt theory for induced electric dipole transitions and evaluation of Judd-Ofelt parameters.

Unit – III: LUMINESCENCE CHARACTERISTICS OF RARE EARTHIONS:

Radiative transition rates, Emission cross-sections and Branching ratios, relaxiation process: Non-radiative relaxiation: Multi-phonon, Radiative quantum efficiencies of rare earth ion energy levels.

Unit – IV: ENERGY TRANSFER IN RAREEARTHS:

Possible mechanisms of energy transfer: Resonance energy transfer; Process of IR to Visible upconversion; Energy transfer from lanthanides to other species.

Unit – V: RARE EARTH DOPEDLASERS:

Principle of laser action: typical rare earth lasers- Nd: YAG: Energy level diagram of Nd(III) ion in YAG laser.

TEXT BOOKS:

1. Introduction to Ligand Fields.
B N Figcgis, Wiely Eastern Ltd, New Delhi.
2. Optical Spectra of Transparent Rare Earth Compounds. S Hufner, Academic Press, London.
3. Lasers and excited states of Rare Earths.
R Reisfield and C K Jorgensen, Springer-Verlag, New York.

Dr. G. SUNITA SUNDARI
Associate Professor & HOD
Department of Physics
KLEF, VADDESWARAM,
Guntur District. 522 502.

डा. डी. हरनाथ / Dr. D. Haranath
सह–आचार्य / Associate Professor
भौतिक विज्ञान विभाग / Department of Physics
राष्ट्रीय प्रौद्योगिकी संस्थान
NATIONAL INSTITUTE OF TECHNOLOGY
वरंगल - 506004, तेलंगाना / Warangal - 506004, Telangana

Indian Institute of Technology
Dr. J. Suryanarayana
Department of Physics

[J. SURYANARAYANA]

MODEL QUESTION PAPER

Spectroscopic Studies on Rare Earth ions

Time:3hrsMax. **Marks: 100**

Answer any five of the following questions. All questions carry equal marks

1. Obtain the free-ion terms of d2 configuration. Explain diagrammatically the splitting of these terms in spin-orbit coupling.
2. Derive the free-ion terms of f2 configuration. Explain how to obtain ground states and what are the ground states for the trivalent lanthanides?
3. Explain magnetic dipole and electric dipole transitions in lanthanide absorption spectra. How do you measure the intensity of the spectral lines from absorption bands?
4. Give the Judd-Ofelt theory for the analysis of intensities of induced electric dipole transitions. Derive the expression for the intensity parameters($\Omega\lambda$).
5. Write down the various expressions for the luminescence characteristics like radiative transition rates, radiative lifetimes, branching ratios, emission cross sections and quantum efficiencies.
6. Explain the relaxation process. Discuss the non radiative multiphonon relaxiation phenomena in rare earth ions.
7. What are the different possible mechanisms of energy transfer? Explain the phenomenon visible of upconversion in detail.
8. What are the various principles involved in laser action. Illustrate the Nd:YAG laser with its energy level diagram.

Dr. G. SUNITA SUNDARI
Associate Professor & HOD
Department of Physics
KLEF, VADDESWARAM,
Guntur District. 522 502.

डा. डी. हरनाथ / Dr. D. Haranath
सह–आचार्य / Associate Professor
भौतिक विज्ञान विभाग / Department of Physics
राष्ट्रीय प्रौद्योगिकी संस्थान
NATIONAL INSTITUTE OF TECHNOLOGY
वरंगल - 506004, तेलंगाना / Warangal - 506004, Telangana

Dr. J. Suryanarayana
Department of Physics

[J. SURYANARAYANA]

Code: 21PHY202

PHY-PhD-3 NANO SCIENCE AND TECHNOLOGY

Unit - I: Introduction: Importance of Nano science &technology, Emergence of Nano-technology, Types of Nano materials, Bottom-up and Top-down approaches,, Applications of Nano Technology in Science and technology.

Unit - II:

Zero Dimensional Nano-structures: Nano particles through homogenous nucleation; Growth of nuclei, synthesis of metallic nano particles, Nano particles through heterogeneous nucleation; Fundamentals of heterogeneous nucleation and synthesis of nano particles using micro emulsions and Aerosol.

Unit – III:

One Dimensional Nano-structure, Nano wires and nano rods: Spontaneous growth: Evaporation and condensation growth, Casting method, vapor-liquid-solid growth, Electrochemical deposition and Electro spinning.

Unit – IV:

Two dimensional nano-structures: Fundamentals of film growth. Physical vapour Depostion(PVD): Chemical Vapour Depostion (CVD) Characterization of nano materials by using spectroscopic and microscopic techniques-XRD,FTIR,DSC,SEM and TEM. Electrical measurements of nano composite materials by using fourprobe method.

Unit – V:

Introduction to Carbon Nano Tubes(CNTs), Properties, Preparation of CNTs-Laser ablation method, Arc method, chemical vapor deposition (CVD), Sol-Gel method, Carbon nanotube Polymer Nano composites ,Applications of Nano in drug delivery system.

Text books:

1. Introduction to Nano technologyby Charles P.Poole.Jr.& Frank J.ownesJohn wielly&sons Inc. Publishers-2006
2. Nano structures and Nano materials: Synthesis, properties and applicationsGuozhong Cao- Imperial Collegepress.

Reference Book:" Nano structured Materials" by Jackie Ying academic press, 2001

MODEL QUESTION PAPER

NANO SCIENCE AND TECHNOLOGY

Time:3hrs **MaxMarks:100**

Answer any FIVE of the following Questions. Each Question carries Equal Marks.

1. a) What are nano materials? Explain different types of nano materials? b)Discuss the size effects on nanomaterials.
2. (a) List out few methods of Synthesis of nano particles.
(b) Explain how can you prepare the silver metal nano particles by using PhysicalVapour Synthesis method with neatsketch?
3. (a) Mention different methods used to produce carbon nanotubes.
(b) Mention the properties and applications of carbon nano tubes
4. What is meant by SEM? Explain the construction and working of SEM? Give itsapplications?
5. Explain how you can Fabricate Nickel metal nano particles by using Chemical Vapour Deposition (CVD) method with neatsketch?
6. Briefly explain about Bottom-up and Top-down approaches. Explain the synthesis of nano particles using aerosolmethod.
7. How can characterize a nano composite material by using XRD ,DSC andSEM
8. Briefly explain thefollowing

i) Nano wires and nanorods

ii) Physical vapour Deposition(PVD)

iii) Distinguish between SEM andTEM

iv) Applications of carbon Nanotubes in engineering

Dr. G. SUNITA SUNDARI
Associate Professor & HOD
Department of Physics
KLEF, VADDESWARAM,
Guntur District. 522 502.

डा. डी. हरनाथ / Dr. D. Haranath
सह–आचार्य / Associate Professor
भौतिक विज्ञान विभाग / Department of Physics
राष्ट्रीय प्रौद्योगिकी संस्थान
NATIONAL INSTITUTE OF TECHNOLOGY
वरंगल - 506004, तेलंगाना / Warangal - 506004, Telangana

Dr. J. Suryanarayana
Department of Physics
[J. SURYANARAYANA]

Code: 21PHY302

PHY-PhD-4 SOLID STATE IONICS

UNIT – I: Introduction

Classification of solids – crystalline, amorphous materials and its processing techniques, structural characterization by IR, XRD, DSC/TGA and SEM methods

UNIT – II: Ionic Materials

Introduction to polymeric materials – Blends, Composites and polymer electrolytes, Solid conducting polymer electrolytes – Fast ion conductors, Characterization. Solid conducting polymer electrolytes composites – Synthesis, processing and characterization and their device applications – Electrochemical cells, Rechargeable polymer battery, electro chromic devices, electro chemical solar cells, sensors.

UNIT – III: Nano materials

Introduction to nano particles and nano composites, synthesis and processing technologies for nanostructure materials – Chemical co-precipitation method, soldzer method, hydrothermal method, copolymerization method – Chemical oxidative polymerization method, structural, mechanical, optical and electrical studies of nano composites conductivity and electrical transport properties of processable nano
materials – Applications.

UNIT – IV: Electrochemical cell Devices

Introduction to Electro chemical cells, sensors and fuel cells – Types– Synthesis and development of solid electrolyte membranes – Characterization by XRD, Differential scanning calorimetry (DSC), SEM(Scanning ElectronMicroscopy)

UNIT-V: Measurements:

Measurement of electrical conductivity of solid electrolyte membranes – Determination of transference number by Wagner's polarization method, water balance in membranes – Fabrication and working principles of Electro chemical cell, fuel cell, sensors– Calculation of open circuit voltage (OCV), short circuit current, resistivity, current density, power density and estimation of efficiency, V-I characteristics of fuel cells, Application of fuel cells in transportation and low temperature electronic devices .

Prescribed Books: 1.Solid state Ionics for Batteries By M. Tatsumisago,M. Wakihara etc., Springer Publishers

2. Solid state Ionics by B.V.R. Chowdary,Wenji.B .World Scientifics Ltd.

MODEL QUESTION PAPER

SOLID STATE IONICS

Time:3hrsMax **Marks:100**

Answer any FIVE of the following Questions. Each Question carries Equal Marks

1. (a) Explain briefly the different types of Solid PolymerElectrolytes.
(b) Describe the working mechanism of a Polymer battery?.How can you estimate the efficiency of an Electrochemical cell?
2. (a) What is meant by Carbon Nano Tube? Give different SynthesizingMethods.
(b) How can you synthesize a Carbon Nano Tubes by using RF Plasma method.
3. (a) Define Transition Temperature and Melting Temperature of PolymericMaterial.
(b) Explain the Mechanical Properties of Polymers by stiffness, strength and toughness with neat diagrams.
4. (a Discuss the Transport properties of Solid ElectrolyteMembranes.
(b) How can you determine the Transferce Number of a given Solid Electrolyte Membrane by using Wagner's Polarization method.
5. (a). What is meant by a Solid Polymer Nano composite? Mention itsCharacteristics.
(b) Discuss the Complexzation in Polymer Composites .How can you Study or Analyse the Complexation Mechanism by using different IR,XRD, Spectroscopic Techniques.
6. (a).Define a Fuel Cell. Discuss different types of FuelCells.
(b) What is PEM Fuel Cell? Explain the working of PEM Fuel Cell with neat Diagram.What is the role of Electrolyte in PEM Fuel Cell?
7. a) Explain transport phenomenon in polymer electrolytes?
b)Determine transference number by using Wagnerpolarization method c)Explain V-I characterstics of fuelcells
8. Write a brief note on theFollowing.
(i) Structural Characterisation of a material byXRD
(ii) Electrochemical SolarCells.
(iii) Synthesis Methods for NanostructuredMaterials.
(iv) Fabrication of a PEM Fuelcell

Dr. G. SUNITA SUNDARI
Associate Professor & HOD
Department of Physics
KLEF, VADDESWARAM,
Guntur District. 522 502.

डा. डी. हरनाथ / Dr. D. Haranath
सह-आचार्य / Associate Professor
भौतिक विज्ञान विभाग / Department of Physics
राष्ट्रीय प्रौद्योगिकी संस्थान
NATIONAL INSTITUTE OF TECHNOLOGY
वरंगल - 506004, तेलंगाना / Warangal - 506004, Telangana

Dr. J. Suryanarayana
Department of Physics
[J. SURYANARAYANA]

Code: 21PHY203

PHY-PhD-5 Remote Sensing Techniques

Unit - I: Introduction

Definition - SONAR, Satellite Images Vs Maps, Remote Sensing Vs GIS, Remote Sensing Vs Aerial Photography / Photogrammetry, Remote Sensing Vs SONAR, Spatial data acquisition-ground based and remote sensing methods, application of remote sensing-Agriculture, Forestry, Geology, Hydrology, Sea Ice, Land Cover & Land Use, Mapping, Oceans & Coastal Monitoring.

Unit - II: Electromagnetic Radiation

Electromagnetic energy, Interaction mechanisms, Laws regarding the amount of energy radiated from an object, Planck Radiation Law, Wien's displacement law, Black body concept,
Emissivity and Radiant Temperature, Electromagnetic Spectrum, Wavelength bands, Atmosphere effects, Scattering, Absorption, Reflectance spectra, Mixtures, Grain Size Effects, The Continuum and Band Depth,Continuum-Removed
Spectral Feature Comparison, Viewing Geometry

Unit - III: SENSORS and PLATFORMS

Introduction, Sensors – passive sensors, active sensors – radar, principles of imaging radar, geometric properties of radar, data formats, distortions in radar images, interpretation of radar images, applications of radar, Airborne remote sensing, Space borne remote sensing, Image data characteristics, Data selection criteria.

Unit - IV: RADIO METRIC CORRECTIONS

Introduction, From satellite to ground radiances: atmospheric correction, Atmospheric correction in the visible part of the spectrum – cosmetic corrections, relative AC methods based on ground reflectance, Absolute AC methods based on atmospheric processes.

Unit - V: THERMAL REMOTE SENSING

Introduction, principles of thermal remote sensing- physical laws, blackbodies and emissivity, Radiant and kinetic temperatures, Processing of thermal data – band ratios and transformations, determining kinetic surface temperatures, Thermal applications – rock emissivity mapping, thermal hot spot detection.

Ref: Principles of remote sensing by Wim H.Bakker, Karl A.Grabmaier, GerritC.huumeman, FreekD.Vander Meer, AnupmaPrakash, Klaus tempfli, Ambro S.M. Gieske, chrisA.Hecker,LucasL.F.Janseen,GabrielN.parodi, colinV.Reeves, MichaelJ.C.weir, Ben G.H.Gorte,JohnA.Hom,Normankerle, Christine pohl, Frank J.VanRuitenbeek,TsehaieWoldai.

Dr. G. SUNITA SUNDARI
Associate Professor & HOD
Department of Physics
KLEF, VADDESWARAM,
Guntur District. 522 502.

MODEL QUESTION PAPER

Remote sensing techniques

Time:3hrs **MaxMarks:100**

Answer any 5 of the following:

1. Explain or give an example how ground based and remote sensing methods may complement eachother?
2. List three possible limitations of remote sensing data and also discuss theirimplications?
3. List and describe the two models used to describe electromagneticenergy?
4. What is the electromagnetic spectrum and explain why the microwave band has been utilized most by thecommunity?
5. List and define the three types of atmospheric scattering with pictorialrepresentations?.
6. What specific interaction takes place at different levels of atmospheric regions of the Earth when EM energy from the sun hits the Earth'ssurface.
7. Explain the sensor-platformconcept
8. Mention two types of passive and active sensors and Explain the sensor-platformconcept.

Dr. G. SUNITA SUNDARI
Associate Professor & HOD
Department of Physics
KLEF, VADDESWARAM,
Guntur District. 522 502.

डा. डी. हरनाथ / Dr. D. Haranath
सह–आचार्य / Associate Professor
भौतिक विज्ञान विभाग / Department of Physics
राष्ट्रीय प्रौद्योगिकी संस्थान
NATIONAL INSTITUTE OF TECHNOLOGY
वरंगल - 506004, तेलंगाना / Warangal - 506004, Telangana

[J. SURYANARAYANA]
Dr. J. Suryanarayana
Department of Physics

Code: 21PHY303

PHY-PhD-6 Upper atmospheric science

Unit – I:

Introduction, survey of atmosphere, physical properties of the upper atmosphere – atmospheric
composition, atmospheric dynamics, atmospheric energetics, atmospheric layers and relationto temperature.

Unit – II:

Earth System & Interaction of energetic solar photons with the upper atmosphere
History of Climate and the Earth System, Components of the Earth System, Hydrologic & carbon cycles, Solar irradiance, optical depth, photoionization, photo dissociation, photoelectrons.

Unit – III:

Atmospheric Thermodynamics Gas Laws, Hydrostatic Equation, First Law of Thermodynamics, Adiabatic Processes, Water Vapor in Air, Static Stability, Second Law of Thermodynamics and Entropy

Unit – IV:

Radiative Transfer Spectrum of Radiation, Quantitative Description of Radiation, Blackbody Radiation, Physics of Scattering and Absorption and Emission, Radiative Transfer in Planetary Atmospheres, Radiation Balance at the Top of the Atmosphere

Unit – V:

Atmospheric Chemistry Composition of Tropospheric Air, Sources,Transport, and Sinks of Trace Gases, Some Important Tropospheric Trace Gases, Tropospheric Aerosols, Air Pollution, Tropospheric Chemical Cycles, Stratospheric Chemistry

Reference Books

Physics and chemistry of the Upper atmosphere By M.H.Rees

Atmospheric Science By John M.Wallace, Peter V. Hobbs & CHAPTER2 from Physics and chemistry of the Upper atmosphere By M.H.Rees

Dr. G. SUNITA SUNDARI
Associate Professor & HOD
Department of Physics
KLEF, VADDESWARAM,
Guntur District. 522 502.

डा. डी. हरनाथ / Dr. D. Haranath
सह–आचार्य / Associate Professor
भौतिक विज्ञान विभाग / Department of Physics
राष्ट्रीय प्रौद्योगिकी संस्थान
NATIONAL INSTITUTE OF TECHNOLOGY
वरंगल - 506004, तेलंगाना / Warangal - 506004, Telangana

Dr. J. Suryanarayana
Department of Physics

[J. SURYANARAYANA]

Code: 21PHY204

PHY-PhD-8 NUCLEAR PHYSICS-1

UNIT – I:

Basic nuclear properties: size, shape, charge distribution, spin and parity; Binding energy, semi-empirical mass formula; Liquid drop model; Fission and fusion.

UNIT – II:

Two nucleon problem, Elementary ideas of alpha, beta and gamma decays and their selection rules; Nuclear Forces: Characteristics of nuclear forces – Ground state of Deuteron – Proton – Proton scattering – Neutron – Proton scattering – Meson theory of nuclear forces.

UNIT – III:

Nuclear Models: Introduction – The liquid drop model – Bethe-Weizacker semi-empirical binding energy equation and its applications – Nuclear shell model – Shell Model: Single particle model with square well, harmonic oscillator and spin-orbit potentials, Collective model, Nilsson model. Energy levels and calculation of angular momentum – Collective model.

UNIT –IV:

Nuclear Reactions: Types of nuclear reactions – Compound nuclear reactions – Nuclear cross section – Resonance theory – Briet Wigner formula.

UNIT – V:

Nuclear interactions: Direct and compound nuclear reaction mechanisms- cross sections in terms of partial wave amplitudes–compound nucleus–Scattering Matrix–Reciprocity theorem–Breit-Wigner one – level formula- Resonance scattering.

Reference Books

1) Concepts of Nuclear Physics, B. L. Cohen (Tata McGrawHill)
2) Nuclear Physics - An Introduction, S. B. Patel
3) Subatomic Physics, Frauenfelder and Hanley(Prentice-Hall)
4) Nuclear Physics, I.Kaplan
5) Nuclei and Particles, EmilioSegre
6) Nuclear Radiation Detectors, S. S. Kapoor, V. S.Ramamurthy
7) Techniques for Nuclear and Particle Physics Experiments, W RLeo
8) Radiation Detection and Measurement, G FKnoll

Dr. G. SUNITA SUNDARI
Associate Professor & HOD
Department of Physics
KLEF, VADDESWARAM,
Guntur District. 522 502.

डा. डी. हरनाथ / Dr. D. Haranath
सह–आचार्य / Associate Professor
भौतिक विज्ञान विभाग / Department of Physics
राष्ट्रीय प्रौद्योगिकी संस्थान
NATIONAL INSTITUTE OF TECHNOLOGY
वरंगल - 506004, तेलंगाना / Warangal - 506004, Telangana

Dr. J. Suryanarayana
Department of Physics
[J. SURYANARAYANA]

MODEL QUESTIONPAPER

Nuclear Physics-I

Time:Three Hours   Maximum: 100marks

Answer any 5 of the following

1. ExplainthepredictionsofShellmodel.Howthediscrepanciescausedinshellmodelisovercomein collectivemodel.
2. ExplainthetypesofnuclearfissionDiscussBhorandWheeler’stjeoryofnuclearfusion.

3. Whatarenuclearforces?Listthepropertiesofnuclearforces.DescribeindetailMesotheoryofnuclear forces.
4. WhatismeantbyQvalueofanuclearreaction?Obtainanexpressionforit.Writethelawsofnuclear reactions.
5. (a).Provethatnuclearabsorptioncross-sectionvariesinverselyproportionaltothevelocityofthe incidentneutronforlowenergyneutrons.

(b) Discuss briefly various types of the direct reactions for low energy neutrons.

6. (a)ExplainhowtheL.S.interactionhelpsustoreproducethemagicnumberin Shellmodel?

(b) Discuss the salient features of the Collective model.

7. (a)Describetheclassificationoftheelementaryparticles,fundamental Interactions, andconservation laws.

(b) Describe neutron-proton scattering at low energies.

8. (a)Withasquarewellpotential,deriveanexpressionforthebindingenergyofa deuteron,asafunctionofthedepthandwidthofthepotential.

(b)Withasquarewellpotential,deriveanexpressionforthebindingenergyofa deuteron,asafunctionofthedepthandwidthofthepotential.

Dr. G. SUNITA SUNDARI
Associate Professor & HOD
Department of Physics
KLEF, VADDESWARAM,
Guntur District. 522 502.

डा. डी. हरनाथ / Dr. D. Haranath
सह–आचार्य / Associate Professor
भौतिक विज्ञान विभाग / Department of Physics
राष्ट्रीय प्रौद्योगिकी संस्थान
NATIONAL INSTITUTE OF TECHNOLOGY
वरंगल - 506004, तेलंगाना / Warangal - 506004, Telangana

Dr. J. Suryanarayana
Department of Physics

[J. SURYANARAYANA]

Code: 21PHY304

PHY-PhD-9 NUCLEAR PHYSICS - II

Unit – I:

Nuclear Decays: Nuclear transformations – Radioactive decay – Alpha decay – Gamow‟s theory – Beta decay – Fermi theory –Selection rules – Interaction of gamma radiation with matter – Photo electric effect; – Compton scattering – Pair production.

UNIT – II:

Nuclear Accelerators: Introduction – Linear accelerators – Drift tube and Wave guide accelerators – Low energy circular accelerators – Cyclotron and Betatron – High energy circular accelerators – Synchrotron and Microtron

UNIT – III:

Nuclear Reactors: Nuclear fission and fusion reactions – Nuclear chain reactions – Four factor formula – The critical size of a reactor – General aspects of reactor design – Classification of reactors – Power reactors (elementary aspects only)

UNIT – IV:

Nuclear Structure: Problem of Nucleon Nucleon Interactions and Nuclear Forces, Nuclear Models and Nuclear Matter, Electromagnetic and Weak Interactions.

UNIT – V:

Experimental methods: Gamma-ray spectroscopy, conversion-electron and charged-particle spectroscopy associated with nuclear reactions and Coulomb excitation, Compton-suppressed Ge detectors, multiplicity filter, Neutron detectors, Sector field electron spectrometer, mini-range spectrometer, Recoll mass- separator, Advanced detector arrays-INGA, GAMMASPHERE and EUROBALL etc.

References:

1) Concepts of Nuclear Physics, B. L. Cohen (Tata McGrawHill)
2) Nuclear Physics - An Introduction, S. B.Patel
3) Nuclear Physics, I.Kaplan
4) Nuclei and Particles, EmilioSegre
5) Nuclear Radiation Detectors, S. S. Kapoor, V. S.Ramamurthy
6) Techniques for Nuclear and Particle Physics Experiments, W R Leo 7) Radiation Detection and Measurement, G FKnoll

Dr. G. SUNITA SUNDARI
Associate Professor & HOD
Department of Physics
KLEF, VADDESWARAM,
Guntur District. 522 502.

डा. डी. हरनाथ / Dr. D. Haranath
सह–आचार्य / Associate Professor
भौतिक विज्ञान विभाग / Department of Physics
राष्ट्रीय प्रौद्योगिकी संस्थान
NATIONAL INSTITUTE OF TECHNOLOGY
वरंगल - 506004, तेलंगाना / Warangal - 506004, Telangana

Dr. J. Suryanarayana
Department of Physics
[J. SURYANARAYANA]

MODEL QUESTION PAPER

Nuclear Physics-II

Time:ThreeHours   Maximum: 100marks

Answer any 5 of the following

1. (a)DiscussFermi'stheoryofbetadecayandexplainthecontinuousbetaspectrum.
   (b).Whataretheselectionrulesforgammadecay?Illustratewithexamples.
2. (a)Describethereactordesignwithreferenceto
   i) Fuel
   ii) Moderators andReflectors
   iii) ReactorCoolants
   iv) ControlMaterials
   v) ReactorShielding

   (b) Explain constructions and working of proportional counter. Mention its applications

3. (a)DescribetheworkingandprincipleofaCyclotron.
   (b) Describe semi-conductor detectors, working of a Germanium detector.

4. (a)WritedetailednuclearenergystateschemeforthedecayofThCnuclide tothegroundstatewithemissionofalphaandgammaparticles.
   (b) Derive the expression for alpha disintegration energy?
5. Describetheinteractionofneutronwithmatterindetail.
6. (a)Explainthreeprocessesinvolvedininteractionofgammarayswithmatter
   (b) What is artificial radioactivity? Explain the alpha neutron reaction.
7. GiveanaccountonstudiesofnuclearstructureanddescribeINGAdetectorsetup.
8. Explainneutroncycleinanuclearreactor.Obtainthefourfactorformulafornuclearfission

Dr. G. SUNITA SUNDARI
Associate Professor & HOD
Department of Physics
KLEF, VADDESWARAM,
Guntur District. 522 502.

डा. डी. हरनाथ / Dr. D. Haranath
सह–आचार्य / Associate Professor
भौतिक विज्ञान विभाग / Department of Physics
राष्ट्रीय प्रौद्योगिकी संस्थान
NATIONAL INSTITUTE OF TECHNOLOGY
वरंगल - 506004, तेलंगाना / Warangal - 506004, Telangana

Dr. J. Suryanarayana
Department of Physics

[J. SURYANARAYANA]

Code: 21PHY205

PHY-PhD-10 LIQUID CRYSTALS-I

Unit – I: Chemical Construction:

Thermo tropic liquid crystals, Nematics, Smectics, Cholestrics, and Disc like molecules, linear molecules, lyotropic liquid crystals, monolayer and bilayer arrangements, monotropic and enatiotropic liquid crystals, bridging groups.

Unit – II: Microscopic investigations including basicconcepts:

Phenomenology and morphology –polymorpholism-boundary effects-textures-homogeneous and homeotropic textures of nematic and smecticphases.

Unit – III: Theories of liquid crystalline state:

Swan theory- Continuem theory -Maier-Sauté theory (Mean field theory) – Landau-de Gennes theory –Pre transitional effects-Mc Millan theory of septic A phase and its developments.

Unit – IV: Electric and Magnetic field effects:

Elastic deformations (Fredrick's deformation) – Magnetic field effects (temperature) on nematics and smetics – Electric field effects- Domains – DSM _ Loops –Electro hydrodynamic instabilities.

Unit – V: PolarizingMicroscopy:

The Polarizing Microscope, Basic Liquid Crystal Optics, Uniaxial Phases, Biaxiality, Conoscopy

Reference Books:

1. Introduction to Liquid Crystals:EditorsE.P.Priestley et. Al.,PlenumPress,N.Y.
2. Hand book of Liquid Crystals: Hans Kelker et. Al.
3. The molecular Physics of Liquid Crystals: G.W.Grayet.al.
4. Liquid Crystals: S.Chandrasekhar.
5. Textures of Liquid Crystals: IngoDierking

Dr. G. SUNITA SUNDARI
Associate Professor & HOD
Department of Physics
KLEF, VADDESWARAM,
Guntur District.

डा. डी. हरनाथ / Dr. D. Haranath
सह-आचार्य / Associate Professor
भौतिक विज्ञान विभाग / Department of Physics
राष्ट्रीय प्रौद्योगिकी संस्थान
NATIONAL INSTITUTE OF TECHNOLOGY
वरंगल - 506004, तेलंगाना / Warangal - 506004, Telangana

[J. SURYANARAYANA]
Dr. J. Suryanarayana
Department of Physics

MODEL QUESTION PAPER

Liquid Crystals – I

Time: 3Hours **Max. Marks: 100**

Answer any Five Questions

1. Explain the classification of liquid crystals with specificexamples.
2. Explain monolayer and bilayer arrangements in liquid crystals and discuss the effect of bridge groups.
3. Explain the homogeneous and homeotropic textures of the nematic and smectic phases in liquidcrystals.
4. Discuss the phenomenology and morphology of liquid crystals and describepolymorphism.
5. Discuss in detail about Landau-de Gennes theory of nematic LiquidCrystals
6. Explain Mc Millan theory of smectic liquid crystals and discuss itsdevelopments.
7. Explain the effect of magnetic field in liquidcrystals
8. Write about electric field effects, domains and DSM loops.

Dr. G. SUNITA SUNDARI
Associate Professor & HOD
Department of Physics
KLEF, VADDESWARAM,
Guntur District. 522 502.

डा. डी. हरनाथ / Dr. D. Haranath
सह–आचार्य / Associate Professor
भौतिक विज्ञान विभाग / Department of Physics
राष्ट्रीय प्रौद्योगिकी संस्थान
NATIONAL INSTITUTE OF TECHNOLOGY
वरंगल - 506004, तेलंगाना / Warangal - 506004, Telangana

Indian Institute of Technology
Dr. J. Suryanarayana
Department of Physics
[J. SURYANARAYANA]

Code: 21PHY305

PHY-PhD-10 LIQUID CRYSTALS-II

Unit – I: Thermodynamic Properties:

Theories of phase transitions-pre transitional phenomena – Calorimetric measurements – Molar heat – Transitional entropy and enthalpy.

Unit – II: Optical Properties:

Birefringence –Rayleigh's scattering – UV and Visible absorption spectroscopy.

Unit – III: Liquid Crystal displays:

Electro optic phenomena – Field induced birefringence – Twisted nematic – Guest – Host effect – Cholestrics to nematic trastion – Storage mode – Display life – Alignment of liquid crystal, homogeneous and homeotropic.

Unit – IV: Technical Applications:

Thermography – Elecro optic display devices – Holography – Interferometry and other a

Unit – V: Twist Grain BoundaryPhases:

The TGBA Phase, Textures of planar anchoring conditions, hometropic anchoring conditions, Suppression of TGBA texture, TGBC and TGBC$_A$ phases.

Reference Books:

1. Introduction to Liquid Crystals:EditorsE.P.Priestley et. Al., Plenum Press,N.Y.
2. Hand book of Liquid Crystals: Hans Kelker et. Al.
3. The molecular Physics of Liquid Crystals: G.W.Grayet.al.
4. Liquid Crystals: S.Chandrasekhar.
5. Textures of Liquid Crystals: IngoDierking

Dr. G. SUNITA SUNDARI
Associate Professor & HOD
Department of Physics
KLEF, VADDESWARAM,
Guntur District. 522 502.

डा. डी. हरनाथ / Dr. D. Haranath
सह–आचार्य / Associate Professor
भौतिक विज्ञान विभाग / Department of Physics
राष्ट्रीय प्रौद्योगिकी संस्थान
NATIONAL INSTITUTE OF TECHNOLOGY
वरंगल - 506004, तेलंगाना / Warangal - 506004, Telangana

[J. SURYANARAYANA]

Dr. J. Suryanarayana
Department of Physics

MODEL QUESTION PAPER

Liquid Crystals – II

Time: 3Hours **Max. Marks: 100**

Answer any Five Questions

1. Write about the chemical constitution of liquid crystals and describe the effect of bridging groups.
2. Explain in detail about pre-transitional phenomenon and calorimetricmeasurements.
3. Discuss the different theories of phasetransitions.
4. Explain in detail birefringence – RayleighScattering.
5. How the order parameter of nematic liquid crystals is determined by IRspectroscopy.
6. Discuss in detail Guest-host interactions in nematic liquidcrystals.
7. Write short note on a) Liquid Crystal Interferometers b) Entropy and enthalpy in liquid crystals
8. Discuss in detail thermographic applications of liquidcrystals.

Dr. G. SUNITA SUNDARI
Associate Professor & HOD
Department of Physics
KLEF, VADDESWARAM,
Guntur District. 522 502.

डा. डी. हरनाथ / Dr. D. Haranath
सह–आचार्य / Associate Professor
भौतिक विज्ञान विभाग / Department of Physics
राष्ट्रीय प्रौद्योगिकी संस्थान
NATIONAL INSTITUTE OF TECHNOLOGY
वरंगल - 506004, तेलंगाना / Warangal - 506004, Telangana

Dr. J. Suryanarayana
Department of Physics

[J. SURYANARAYANA]

Code: 21PHY306

PHY-PhD-7 THIN FILM TECHNOLOGY AND APPLICATIONS

Unit – I:

Preparation of Thin-films Kinetic aspects of Gases in a vacuum chamber - Classifications of vacuum ranges Production of vacuum - Pressure measurement in vacuum systems - Physical vapour deposition - Evaporation Techniques - Sputtering (RF & DC) - Pulsed Laser deposition- Liquid Phase Epitaxy- Vapour Phase Epitaxy- Molecular Beam Epitaxy.

Unit – II:

Film growth and measurement of thickness, Thermodynamics and Kinetics of thin film formation - Film growth – five stages - In corporation of defects and impurities in films - Deposition parameters and grain size - structure of thin films - Microbalance technique - quartz crystal monitor photometric - Ellipsometry and interferometers - Measurement of rate of deposition using ratemeter - cleaning ofsubstrate.

Unit – III:

Characterization, X-ray Diffraction(XRD) - SEM, Photoluminescence(PL) - Raman Sepectroscopy, UV-Vis-IR Spectrophotometer – AFM - Hall effect – SIMS - X-ray Photoemission Spectroscopy (XPS) - Vibrational Sample Magnetometers, Rutherford Back Scattering (RBS).

Unit – IV:

Properties of thin films Dielectric properties - Experimental techniques for dielectric film - annealing effect, effect of film thickness on dielectric properties – determination of optical constants – Experimental techniques for determination of optical parameters - Magnetic and mechanical properties - Hall effect compilations - Adhesion, stress, strength, Raleigh surface waves - Ferromagnetic properties of Thin films - Experimental methods for measurement of mechanical properties of thin films.

Unit – V:

Applications, Micro and optoelectronic devices, quantum dots, Data storage, corrosion and wear coatings - Polymer films, MEMS, optical applications - Applications in electronics – electric contacts, connections and resistors, capacitors and inductances - Applications of ferromagnetic and super conducting films - active electronic elements, micro acoustic elements using surface waves - integrated circuits - thin films in optoelectronics and integrated optics.

Dr. G. SUNITA SUNDARI
Associate Professor & HOD
Department of Physics
KLEF, VADDESWARAM,
Guntur District. 522 502.

डा. डी. हरनाथ / Dr. D. Haranath
सह–आचार्य / Associate Professor
भौतिक विज्ञान विभाग / Department of Physics
राष्ट्रीय प्रौद्योगिकी संस्थान
NATIONAL INSTITUTE OF TECHNOLOGY
वरंगल - 506004, तेलंगाना / Warangal - 506004, Telangana

Indian Institute of Technology
Dr. J. Suryanarayana
Department of Physics

[J. SURYANARAYANA]

Reference Books

1. K.L. Chopra, Thin film phenomena, McGraw- Hill book company New York,1969
2. LudminlaEckertova, 'Physics of thin films', Plenum press, New York1977.
3. A. Goswami, Thin Film Fundamentals, New Age international (P) Ltd. Publishers, New Delhi (1996).

Dr. G. SUNITA SUNDARI
Associate Professor & HOD
Department of Physics
KLEF, VADDESWARAM,
Guntur District. 522 502.

डा. डी. हरनाथ / Dr. D. Haranath
सह–आचार्य / Associate Professor
भौतिक विज्ञान विभाग / Department of Physics
राष्ट्रीय प्रौद्योगिकी संस्थान
NATIONAL INSTITUTE OF TECHNOLOGY
वरंगल - 506004, तेलंगाना / Warangal - 506004, Telangana

[J. SURYANARAYANA]
Dr. J. Suryanarayana
Department of Physics
Indian Institute of Technology

MODEL QUESTION PAPER

THIN FILM TECHNOLOGY AND APPLICATIONS

Time:3hrs **MaxMarks:100**

Answer any 5 of the following

1. Discuss about different Vacuumtechniques.
2. DiscussaboutKineticsofthinfilmformationandFilmgrowth.
3. Explain the Thin film characterization technique and discuss about optical characterization.
4. Explain the physical properties of thinfilms.
5. Explain the optoelectronic properties of TCO thinfilms.
6. Discuss the magnetic and electrical properties of thinfilms.
7. Discuss about experimental methods for measurement of mechanical properties of thin films.
8. Discuss about Sputtering (RF), Pulsed Laser deposition, Liquid Phase Epitaxy, Molecular BeamEpitaxy.

Dr. G. SUNITA SUNDARI
Associate Professor & HOD
Department of Physics
KLEF, VADDESWARAM,
Guntur District. 522 502.

डा. डी. हरनाथ / Dr. D. Haranath
सह–आचार्य / Associate Professor
भौतिक विज्ञान विभाग / Department of Physics
राष्ट्रीय प्रौद्योगिकी संस्थान
NATIONAL INSTITUTE OF TECHNOLOGY
वरंगल - 506004, तेलंगाना / Warangal - 506004, Telangana

Dr. J. Suryanarayana
Department of Physics
[J. SURYANARAYANA]

Code: 21PHY307

PHY-PhD-12 Molecular Modeling

Unit – I:
AnIntroductiontoComputationalQuantumMechanics: One-electronAtoms,PolyelectronicAtomsand Molecules, Molecular Orbital Calculations, The Hartree-Fock Equations, Basis sets, Calculating Molecular PropertiesUsingabinitioQuantumMechanics,ApproximateMolecularOrbitalTheories,Semi-empirical Methods,HuckelTheory,PerformanceofSemi-empiricalMethodsAdvancedabinitioMethods,Density functionaltheoryandsolid-statequantumMechanics:Opens-shellsystems,ElectronCorrelation, PracticalConsiderationswhenperformingabinitioCalculations,EnergyComponentAnalysis,Valance BondTheories,DensityFunctionalTheory,Quantummechanicalmethodsforstudyingthesolidstate, Thefutureroleofquantummechanics:TheoryandExperimentworkingtogether

Unit – II: Empirical Force Field Models: MolecularMechanics: General features of molecular mechanics, Bond stretching,Anglebending,Torsional Terms, Improper Torsions and out-of-plane bending motions, Cross terms,Non-bonded interactions, Electrostatic Interactions, VanderWaals Interactions, Many-body effects in empirical potentials,effective pairpotentials , Hydrogenbonding inmolecular mechanics, Force field Models for the simulation of liquid water, united atoms force fields and reduced representations, derivatives of the molecular mechanics energy function, Calculating thermodynamic properties,Force field parametrisation,Transferability of force field parameters, delocalized pi systems, force fields for inorganic molecules and solid state systems, empirical potentials for metals and semiconductors.

Unit – III:
Energy minimization and related methods for exploring the energy surface: Non-derivative and derivative minimization methods, First order minimization methods, Second derivative methods: NewtonRaphsonMethod,Quasi-Newton Methods, Applications of energy Minimization, Determination of Transition structures and reaction pathways, Solidstate systems: Lattice statics and lattice dynamics. Conformational analysis: Systematic methods for exploring conformational space,mode-building approaches, random search methods, distance geometry, exploring conformational space using simulation methods,Variations on the standard methods, Finding the Global energy minimum, Solving protein structures using restrained MD and simulated annealing, Structural databases, Molecular fitting, Clustering algorithms and pattern recognition techniques, reducing the dimensionality of dataset, coveringconformationalspace:Poling,predictionofcrystalstructures.

Dr. G. SUNITA SUNDARI
Associate Professor & HOD
Department of Physics
KLEF, VADDESWARAM,
Guntur District. 522 502.

डा. डी. हरनाथ / Dr. D. Haranath
सह–आचार्य / Associate Professor
भौतिक विज्ञान विभाग / Department of Physics
राष्ट्रीय प्रौद्योगिकी संस्थान
NATIONAL INSTITUTE OF TECHNOLOGY
वरंगल - 506004, तेलंगाना / Warangal - 506004, Telangana

Dr. J. Suryanarayana
Department of Physics
[J. SURYANARAYANA]

Uint – IV:

Protein structure prediction, sequence analysis and protein folding: Some basis principles of protein structure, First principles methods for predicting protein structure, comparative modelling sequence alignment, Constructing and evaluating a comparative model, predicting protein structures by 'Threading', A comparison of protein structure prediction methods: CASP,protein folding and unfolding.

Unit – V:

FourChallengesinmolecularmodelling: Freeenergies,solvation,reactionsandsolid-statedefects:Free energycalculationsandfreeenergydifferences,applicationofmethodsforcalculatingfreeenergy differences,Calculationofenthalpyandentropydifferences,Partitioningthefreeenergy,Potential pitfallswithfreeenergycalculations,PotentialsofMeanforce,Approximate/rapidfreeenergymethods, continuumrepresentationsofsolvent,theelectrostaticcontributiontothefreeenergysolvation-The BornandOnsagermodels,Modellingchemicalreactions,Modellingsolidstatedefects.

Reference Books

1. Molecularmodelling: Principles and Applications, AndrewR.Leach,PEARSON EducationLtd.
2. Modern quantum chemistry Introduction to advances electronic structure theory by Attilloszabo, NeilS. Ostlund, Dover publications, Inc.Mineola, NewYork.
3. Molecular quantum mechanics,4thedition,peterAtkins,RonaldFriedman,oxford university press.

Dr. G. SUNITA SUNDARI
Associate Professor & HOD
Department of Physics
KLEF, VADDESWARAM,
Guntur District. 522 502.

डा. डी. हरनाथ / Dr. D. Haranath
सह-आचार्य / Associate Professor
भौतिक विज्ञान विभाग / Department of Physics
राष्ट्रीय प्रौद्योगिकी संस्थान
NATIONAL INSTITUTE OF TECHNOLOGY
वरंगल - 506004, तेलंगाना / Warangal - 506004, Telangana

Indian Institute of Technology
Dr. J. Suryanarayana
Department of Physics
[J. SURYANARAYANA]

MODEL QUESTION PAPER

Molecular Modeling

Time:3hrs **MaxMarks:100**

Answer any 5 of the following

1. Explain the following
   a) Many electron problem b) Born-Oppenheimer approximation
2. Discuss briefly about the following
   a) Slaterdeterminants b) Basis functions and basissets
3. Discuss Hartree-Fock theory and minimal basis H_2model?
4. Write in detail about the following
   a) Open shell systems b) density functional theory
   c) Many Perturbation theory
5. Describe the general features of molecular mechanics force fields, bond stretching, angle bending and torsionalterms.
6. What are various energy minimization methods and explain them in detail with suitable examples.
7. Explain various conformational searching methods
8. Explain basic principles of protein structures prediction methods.

Dr. G. SUNITA SUNDARI
Associate Professor & HOD
Department of Physics
KLEF, VADDESWARAM,
Guntur District. 522 502.

डा. डी. हरनाथ / Dr. D. Haranath
सह–आचार्य / Associate Professor
भौतिक विज्ञान विभाग / Department of Physics
राष्ट्रीय प्रौद्योगिकी संस्थान
NATIONAL INSTITUTE OF TECHNOLOGY
वरंगल - 506004, तेलंगाना / Warangal - 506004, Telangana

Dr. J. Suryanarayana
Department of Physics
[J. SURYANARAYANA]

Code: 21PHY308

PHY-PhD-13 AERONOMY

UNIT – I : NEUTRAL ATMOSPHERE

Structure and Composition Nomenclature-Thermal structure of the atmosphere. Hydrostatic equation of the atmospheric structure. Scale height and geopotential height. Exosphere.4 Hrs. Atmospheric composition. Dissociation and diffusive separation and thermospheric composition. Heat balance and temperature profile of thermosphere.6Hrs.

UNIT – II: Chemical concepts in Atmosphere

Thermodynamic considerations – Enthalpy . Elementary chemical kinetics- Reaction rate constants and chemical life time of species. Unimolecular, bimolecular and termolecular reactions. 8 Hrs. Effect of dynamics on chemical species.2 Hrs.

UNIT – III: IONIZED ATMOSPHERE

Photochemical processes in the ionosphere Introduction to ionosphere – discovery. Continuity equation and photochemical equilibrium. Theory of photo-ionization and Chapman production function. Chemical recombination and electron density. 5 Hrs. Solar radiation and production of ionospheric layers.3 Hrs.

UNIT – IV: IONIZED ATMOSPHERE

Loss reactions Different types of recombination processes. Chemistry of E and F1 regions. D region balance equations. D region chemistry – formation of water cluster ions. Electron attachment and negative ions. Positive and negative ion schemes of D region.6Hrs. Linear and square law loss formulae and splitting of F layer. Vertical transport, ambipolar diffusion and F2 peak. Diffusion between ionosphere and protonosphere.4 Hrs.

Airglow.4 Hrs.

UNIT – V: Morphology

Geographical and temporal structure of the ionosphere – Diurnal, seasonal and solar cycle variations of D, E and F regions and F region anomalies.6 Hrs. Solar flare effects Sudden Ionospheric Disturbances (SIDs)2 Hrs.

REFERENCE BOOKS

1.”Introduction to Ionospheric Physics” by H.Rishbeth&O.K.Garriott
2.”Aeronomy of the Middle Atmosphere” by Guy Brasseur &S.Solomon.

Dr. G. SUNITA SUNDARI
Associate Professor & HOD
Department of Physics
KLEF, VADDESWARAM,
Guntur District. 522 502.

डा. डी. हरनाथ / Dr. D. Haranath
सह–आचार्य / Associate Professor
भौतिक विज्ञान विभाग / Department of Physics
राष्ट्रीय प्रौद्योगिकी संस्थान
NATIONAL INSTITUTE OF TECHNOLOGY
वरंगल - 506004, तेलंगाना / Warangal - 506004, Telangana

Dr. J. Suryanarayana
Department of Physics

[J. SURYANARAYANA]

MODEL QUESTION PAPER

Aeronomy

Time:3hrs **MaxMarks:100**

Answer any 5 of the following

1. A) Explain the neutral atmosphere Structure and Composition.
   B) Describe Dissociation and diffusive separation and thermospheric composition.

2. A) Discuss the enthalpy and chemical kinetics.
   B) Explain the effect of dynamics on chemical species.

3. A) Explain the photochemical processes and photochemical equilibrium ofionosphere.
   B) Describe the Solar radiation and production of ionosphericlayers.

4. A) Discuss different types of recombination processes of ionizedatmosphere.
   B) Explain the diffusion between ionosphere and protonosphere

5. A) Explain the geographical and temporal structure of theionosphere. B). Explain the Sudden Ionospheric Disturbances(SIDs).

Dr. G. SUNITA SUNDARI
Associate Professor & HOD
Department of Physics
KLEF, VADDESWARAM,
Guntur District.

डा. डी. हरनाथ / Dr. D. Haranath
सह–आचार्य / Associate Professor
भौतिक विज्ञान विभाग / Department of Physics
राष्ट्रीय प्रौद्योगिकी संस्थान
NATIONAL INSTITUTE OF TECHNOLOGY
वरंगल - 506004, तेलंगाना / Warangal - 506004, Telangana

[J. SURYANARAYANA]
Dr. J. Suryanarayana
Department of Physics
Indian Institute of Technology

Code: 21PHY206

PHY-PhD-14: PHYSICS OF SOLAR CELLS

Unit – I: FUNDAMENTALS OF SOLAR CELLS

Energy scenario - Renewable Energy sources - Economic Analysis of Renewable Energy System - Solar radiation: Solar constant - Solar Spectra - Air Mass - Global radiation -Position of the Sun.

Insolation Physics of Solar cells: Fundamental Properties of Semiconductors - conversion of solar energy, photochemical conversion of solar energy - photovoltaic conversion - photo physics of semiconductors - photocatalysis - Band model - Doping - Semiconductor types - absorption of light - recombination - p-n junction - Solar cells - Solar cell parameters - Spectral response - Upper limits of cell parameters - Thermodynamic limit-the Schokley-Quiesser limit - effect of temperature - effect of parasitic resistances.

Unit – II: GOVERNING DIFFERENTIAL EQUATIONS AND DISCRETISATION TECHNIQUES

Necessity of energy storage – types of energy storage – comparison of energy storage technologies – Applications - Basics of Heat Transfer, Fluid flow – Mathematical description of fluid flow and heat transfer – Classification of partial differential equations – Initial and Boundary Conditions – Taylor's Series - Uniform and non-uniform Grids - Numerical Errors.

Unit – III: SOLAR PV TECHNOLOGIES (qualitative):

Description of the photovoltaic effect – Electrical characteristics calibration and efficiency measurement.

First generation: Silicon wafer-based technology: Design of Crystalline Silicon Solar Cells - loss mechanism - silicon feed stock - production of silicon wafers - Manufacturing process of c-Si solar cells - high efficiency approaches - PERL and PERC cells - interdigitated back contacts – TOP Con - heterojunction solar cells - lab to industry requirements.

Second generation: Thin film technologies: Merits and demerits of thin film technologies - Transparent conducting oxides - GaAs, amorphous-Si, CdTe and CIGS solar cells, a-Si and Tandem solar cells, Multi-junction cells, Emerging PV: DSSC - Organic solar cells -Perovskite -Quantum Dots.

Third generation/emerging PV technologies: Organic PV - organic-inorganic hybrid solar cells - Quantum-dot - Hot-carrier - Up conversion and down conversion

Unit – IV: HIGH EFFICIENCY CONCEPTS IN SOLAR CELLS:

Heterojunction solar cells Second generation technology: Thin film solar cells - merits and demerits - Transparent conducting oxides - the III-V PV technology - thin film Si technology - Chalcogenide solar cells - Organic and inorganic photovoltaics - efficiency of DSSCs.

Hybrid organic-inorganic solar cells Third generation concepts: Multi junction solar cells - Spectral conversion - Multi- exciton generation - Intermediate band solar cells - Hot carrier solar cells Module manufacturing: Interconnection of cells series and parallel connections- silicon module production - PV systems: Standalone systems - grid-connected systems - hybrid systems - micro grids - smart grids - specific applications

Unit – V: ENERGY LEVELS AND SPECTRA - CHARACTERISTICS:

Basic characteristics solar cell light intensity - temperature and light spectra the short-circuit current (I_{SC}) - open-circuit voltage (V_{OC}) - fill factor (FF) - solar energy conversion efficiency (η) - Influence of the series resistance (R_s) - parallel resistance (R_p) - Principle work with various kinds of load resistances - function pyranometer - quantum efficiency in solar cells - Errors in measurements - Statistical analysis of data - Regression analysis – correlation - estimation of uncertainty data - experiments factors and protocols.

Polarization rotation - Effective band gap engineering -Vibrations - Rotational Energy of Spherical - Rotational Raman - IR Spectra of linear molecules - Influence of Nuclear Spin on Rotational Raman

Spectrum – Rotation - **Software for fitting:** Peak fit, Origin, **Software for spectra and vibration analysis:** Crystal sleuth, Raman and IR mode calculation, Vibration analysis.

TEXT BOOKS:

1. Duffie, J.A., and Beckman, W.A. Solar Energy Thermal Process - 4 th Edition (2013), John Wiley and Sons, New York, ISBN: 978-0-470-87366-3, Solar Energy Laboratory, University of Wisconsin-Madison, pp. 944.
2. M. Stix, The Sun, An Introduction, Second Edition, Springer 2002.
3. Jenny Nelson, The Physics of Solar Cells. Imperial College Press, 2003
4. Chetan Singh Solanki, Solar Photovoltaics: Fundamentals, Technologies and Applications (2011), 2nd edition, PHI Publications, pp. 512.
5. Sukhatme S.P. J K Nayak, Solar Energy, Tata McGraw Hills P Co., ISBN: 9789352607112, 4th Edition, 2017, pp. 568.
6. C. Julian Chen, Physics of Solar Energy (2011), ISBN: 978-1-118-04832-0, pp. 352.
7. K. Mertens, Photovoltaics: Fundametals, Technology and Practice, John Wiley & Sons Ltd (2014)
8. Handbook of Photovoltaic Science and Engineering 2nd Ed. , A. Luque, S. Hegedus (editors), John Wiley & Sons Ltd (2011)
9. A. Smets, K. Jager, O. Isabella, R. V. Swaaij, M. Zeman, Solar Energy: The physics and engineering of photovoltaic conversion, technologies and systems, UIT Cambridge Ltd. (2016).
10. S.R. Wenham, M. Green, M.E. Watt, R. Corkish, A. Sproul, Applied Photovoltaics ? 2nd Edition (2009)
11. Chetan Singh Solanki, Solar Photovoltaics: Fundamentals, Technologies and applications, 3rd Edition, PHI Learning Pvt. Ltd. (2019).
12. Jenny Nelson, The Physics of Solar Cells, Imperial College Press (2003).
13. Peter Wurfel, Physics of solar cells: from principles to advanced concepts, 2nd Edition, WileyVCH (2009).

Reference Books:

1. Chemical Applications of Group Theory : F.A. Cotton.
2. Fundamentals of Molecular Spectroscopy : C.N. Banwell.
3. Introduction to Molecular Spectroscopy : G.M. Barrow.
4. Modern Spectroscopy : J.M. Hollas.
5. D. A. Neamen and D. Biswas, Semiconductor Physics and Devices
6. R.F. Pierret, Semiconductor Device Fundamentals
7. SM Sze and Kwok K Ng, Physics of semiconductor devices, third edition ,John Wiley & Sons (2007)

Dr. G. SUNITA SUNDARI
Associate Professor & HOD
Department of Physics
KLEF, VADDESWARAM,
Guntur District. 522 502.

डा. डी. हरनाथ / Dr. D. Haranath
सह-आचार्य / Associate Professor
भौतिक विज्ञान विभाग / Department of Physics
राष्ट्रीय प्रौद्योगिकी संस्थान
NATIONAL INSTITUTE OF TECHNOLOGY
वरंगल - 506004, तेलंगाना / Warangal - 506004, Telangana

Dr. J. Suryanarayana
Department of Physics
Indian Institute of Technology
[J. SURYANARAYANA]

MODEL QUESTION PAPER

PHYSICS OF SOLAR CELLS

Time:3hrsMax. **Marks: 100**

Answer any five of the following

1. Explain the effect of various approaches on utilizing solar energy and approach the blackbody radiation field energy density and radiation spectrum?
2. Describe the effect of Planck's formula in energy unit with maximum spectral density?
3. Derive the Einstein's derivation of the black-body formula in wien displacement law, Stefan - Boltzmann law and the Photoelectric effect of Einstein's theory of photons?
4. Explain the energy levels of measurement the solar constant with rotation and orbital motion of the Earth around the Sun source?
5. Explain the Solar time, sidereal time, universal standard time, local standard time and Equation of time?
6. Distinguish between Intensity of sunlight on an arbitrary surface at any time and Interaction with the atmosphere? Explain the Rayleigh and Mie scattering, absorption methods?
7. Discus the space charge and internal field with Quasi - Fermi levels and application of a Shockley diode equation methods?
8. Explain the crystalline silicon solar cells, Thin film solar cells and Emerging PV?

Dr. G. SUNITA SUNDARI
Associate Professor & HOD
Department of Physics
KLEF, VADDESWARAM,
Guntur District. 522 502.

डा. डी. हरनाथ / Dr. D. Haranath
सह–आचार्य / Associate Professor
भौतिक विज्ञान विभाग / Department of Physics
राष्ट्रीय प्रौद्योगिकी संस्थान
NATIONAL INSTITUTE OF TECHNOLOGY
वरंगल - 506004, तेलंगाना / Warangal - 506004, Telangana

Dr. J. Suryanarayana
Department of Physics

[J. SURYANARAYANA]

Code: 21PHY309

PHY-PhD-15: ADVANCED SOLAR ENERGY STORAGE TECHNOLOGIES

Unit – I: ENERGY STORAGE
Necessity of storage for solar energy - Chemical energy storage - Thermal energy storage - Thermal Flywheels - Compressed air energy storage- Rechargeable batteries - Thermal Storage Concepts - Materials for Sensible and Latent Heat Energy Storage. Organic, Inorganic Eutectic Materials, Materials for Low and High Temperature Storage Applications. Chemical storage Concepts - Rechargeable Batteries – Types, Operating range, Comparison and suitability for various applications - Super Capacitors

Unit – II: SOLAR WATER HEATING SYSTEMS
Thermal storage – Types – Modelling of thermal storage units – Modelling of phase change storage system - Modelling using porous medium approach - Integral Collector Storage System - Thermosyphon System - Open Loop, Drain Down, Drain Back, Antifreeze Systems - Refrigerant Solar Water Heaters - Solar Heated Pools - Solar Heated Hot Tubs and Spas. Basics of absorption cooling - Principle of absorption cooling - Solar operation of vapour absorption refrigeration cycle - Open cycle absorption / desorption solar cooling alternatives – Lithium Bromide- Water absorption System – Aqua-ammonia absorption system – Intermittent absorption refrigeration System - Refrigerant storage for solar absorption cooling systems.

Unit – III: SOLAR SPACE CONDITIONING SYSTEMS
Liquid Type Solar Heating System With / Without Storage - Heat Storage Configurations – Heat Delivery Methods - Air-Type Solar Heating Systems - Solar Refrigeration and Air Conditioning. Solar Parabolic trough - Basic definition of Pollution Indicators – Noise Pollution - Transformation Technologies for Waste Treatment – Classification and characteristics of Composite materials – Biomass pyrolysis – Bio-energy.

Unit – IV: OTHER SOLAR APPLICATIONS
Principle of working, types, design and operation of - Solar heating and cooling systems - Thermal Energy storage systems – domestic, community – Solar pond – Solar drying-solar chimney-solar thermal electricity conversion.
Introduction – Necessity for desalination – Study on various desalination techniques – Comparison between conventional and solar desalination – Basics of solar still - Simple solar still – Material problems in solar still – Solar disinfection and its methods – Case studies on various desalination techniques.
Introduction – Types of solar cookers – Advantages and disadvantages - Box type – Parabolic dish cooker - Performance evaluation of solar cookers – Testing of a solar cooker – Applications of solar cooking - Case studies

Unit – V: SOLAR PASSIVE ARCHITECTURE
Thermal comfort - bioclimatic classification – passive heating concepts: direct heat gain – indirect heat gain - isolated gain and sunspaces - passive cooling concepts: evaporative cooling - Radiative cooling - application of wind, water and earth for cooling; shading - paints and cavity walls for cooling - roof radiation traps - earth air-tunnel. – energy efficient landscape design - thermal comfort - Application of economic methods

Text Books:

1. Versteeg and Malalasekera, N, “An Introduction to computational Fluid Dynamics the Finite Volume Method,” Pearson Education, Ltd., Second Edition, 2014.
2. Anderson, D.A., Tannehill, J.I., and Pletcher, R.H., “Computational fluid Mechanics and Heat Transfer “ Hemisphere Publishing Corporation, New York, USA,1984
3. Subas, V.Patankar, “Numerical heat transfer fluid flow”, Hemisphere Publishing Corporation, 1980.
4. Tapan K. Sengupta, “Fundamentals of Computational Fluid Dynamics” Universities Press, 2011.

5. Muralidhar, K., and Sundararajan, T., “Computational Fluid Flow and Heat Transfer”, Narosa Publishing House, New Delhi, 1995.
6. HP Garg and J Prakash: Solar Energy: Fundamentals and Applications, Tata McGraw Hill, 2010.
7. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2002.
8. Mills .A.F, Ganesan V.,” Heat Transfer”, 2nd ed., Pearson, 2009.
9. Minkowycz .W.J, Sparrow .E.M, Murthy J.Y, “Handbook of Numerical Heat Transfer”, 2nd ed., Wiley, 2006.
10. Kreith .F, Bohn .M.S, “Principles of Heat Transfer”, 6th ed., Thomson, 2001.
11. Venkateshan .S.P, “Heat Transfer”, Ane Books Pvt Ltd , New Delhi. 2009.

REFERENCE BOOKS:

1. Goswami, D.Y., Kreider, J. F. and & Francis., Principles of Solar Engineering, Taylor and Francis, 2000
2. Chetan Singh Solanki, Solar Photovoltatics – Fundamentals, Technologies and Applications, PHI Learning Private limited 2011
3. Sukhatme S P, J K Nayak, Solar Energy – Principle of Thermal Storage and collection, Tata McGraw Hill, 2008.
4. Solar Energy International, Photovoltaic – Design and Installation Manual – New Society Publishers, 2006
5. Roger Messenger and Jerry Vnetre, Photovoltaic Systems Engineering, CRC Press, 2010.

6. Das .S.K, “Fundamentals of Heat and Mass Transfer”, Narosa, 2010.
7. Duffie .J.A, Beckman W. A. “Solar Engineering of Thermal Processes”, 3rd ed., Wiley, 2006.
8. Sachdeva .R.C, “Fundamentals of Heat and Mass Transfer”, 4th ed., New Age, 2010.
9. Ghoshdastidar .P.S, “Heat Transfer”, Oxford University Press, 2004.

Dr. G. SUNITA SUNDARI
Associate Professor & HOD
Department of Physics
KLEF, VADDESWARAM,
Guntur District. 522 502.

डा. डी. हरनाथ / Dr. D. Haranath
सह–आचार्य / Associate Professor
भौतिक विज्ञान विभाग / Department of Physics
राष्ट्रीय प्रौद्योगिकी संस्थान
NATIONAL INSTITUTE OF TECHNOLOGY
वरंगल - 506004, तेलंगाना / Warangal - 506004, Telangana

Dr. J. Suryanarayana
Department of Physics
[J. SURYANARAYANA]

MODEL QUESTION PAPER

ADVANCED SOLAR ENERGY STORAGE TECHNOLOGIES

Time:3hrs **MaxMarks:100**

Answer any 5 of the following

1. Explain the based-on energy storage? How many types of energy storage methods and comparison of energy storage technologies and its applications?
2. List three possible limitations of heat transfer, fluid flow and also discuss theirimplication in mathematical description of fluid flow and heat transfer?
3. Derive the partial differential equations based on conservation energy process with Initial and boundary conditions process?
4. Describe the discretization techniques using finite difference methods and Taylor's Series and discuss the independence Test on Flat plates?
5. Explain the type of thermal energy storage units and explain the phase change storage system with porous medium approach?
6. Discuss the integral Collector Storage thermosyphon System and refrigerant Solar Water Heaters. What is the absorption cooling types of cycles?
7. interaction between the liquid type of solar heating storage configurations systems and heat delivery methods?
8. Explain the solar refrigeration in air conditioning and function of solar parabolic trough methods?

Dr. G. SUNITA SUNDARI
Associate Professor & HOD
Department of Physics
KLEF, VADDESWARAM,
Guntur District.

डा. डी. हरनाथ / Dr. D. Haranath
सह-आचार्य / Associate Professor
भौतिक विज्ञान विभाग / Department of Physics
राष्ट्रीय प्रौद्योगिकी संस्थान
NATIONAL INSTITUTE OF TECHNOLOGY
Warangal - 506004, Telangana

[J. SURYANARAYANA]
Dr. J. Suryanarayana
Department of Physics