

# Syllabi for Comprehensive Examination of Eligible Ph. D Scholars

(Only for the Courses relating to Research Domains for both Full Time & Sponsored Part Time)

Department: Physics

## 1) Research/Specialization Group: 1

(Name of the Group) \_\_\_\_\_ Energy Harvesting and Devices \_\_\_\_\_

Course Code & Course Name: \_\_\_PH701: Characterization Techniques And Non-Equilibrium Thermodynamics, PH542: Science and Technology of Thin Films, PH 503: Condensed Matter Physics

Student Name: Dipta Suryya Mahanta (P22PH007)

**Unit 1:** Characterization Techniques X-ray Diffraction, X-ray fluorescence, X-ray photoelectron spectroscopy UV-Visible- IR spectroscopy, FTIR spectroscopy, Raman spectroscopy, Photoluminescence spectroscopy, Scanning Electron Microscopy, Tunneling Electron Microscopy, Atomic Force Microscopy, Impedance spectroscopy, Electronic (resistivity, Hall effect) studies. [50% weight age]

**Unit 2:** Kinetic theory of gases, effusion, Hertz Knudsen equation; mass evaporation rate; Knudsen cell, directional distribution of evaporating species, evaporation of elements, compounds, alloys, Raoult's law. Physical Vapor Deposition, Thermal, e-beam, pulsed laser and ion beam evaporation, glow discharge and plasma, sputtering - mechanisms and yield, dc and rf sputtering, bias sputtering, magnetically enhanced sputtering systems, reactive sputtering. [25% weight age]

**Unit 3:** Space lattice and unit cells, crystal system, symmetry operation, point groups and space groups, plane lattices and their symmetries. Miller Indices, representation of directions and planes, X-ray diffraction by crystals. Laue theory, interpretation of Laue equations, Bragg's law, reciprocal lattice. Vibrations of one-dimensional monatomic and diatomic lattices. Normal modes and phonons. Frequency distribution function. Review of Debye's theory of lattice specific heat. Anharmonic effects. Formation of bands, band gap, intrinsic carrier concentration, concept of a hole, impurity conductivity, Fermi level, direct and indirect band gap, p-n junction, drift current, diffusion current. [25% weight age]

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## 2) Research/Specialization Group: 2

(Name of the Group) \_\_\_\_\_ Smart Materials \_\_\_\_\_

Course Code & Course Name: \_\_\_PH701: Characterization Techniques And Non-Equilibrium Thermodynamics, PH542: Science and Technology of Thin Films, PH 521: Light-Matter Interaction \_\_\_\_\_

Student Name: Sandeep Ghosh (P22PH009)

**Unit 1:** Characterization Techniques X-ray Diffraction, X-ray fluorescence, X-ray photoelectron spectroscopy UV-Visible- IR spectroscopy, FTIR spectroscopy, Raman spectroscopy, Photoluminescence spectroscopy, Scanning Electron Microscopy, Tunneling Electron Microscopy, Atomic Force Microscopy, Impedance spectroscopy, Electronic (resistivity, Hall effect) studies. [50% weight age]

**Unit 2:** Kinetic theory of gases, effusion, Hertz Knudsen equation; mass evaporation rate; Knudsen cell, directional distribution of evaporating species, evaporation of elements, compounds, alloys, Raoult's law. Physical Vapor Deposition, Thermal, e-beam, pulsed laser and ion beam evaporation, glow discharge and plasma, sputtering - mechanisms and yield, dc and rf sputtering, bias sputtering, magnetically enhanced sputtering systems, reactive sputtering. [25% weight age]

**Unit 3:** Ultrafast Optics : Definition of ultrashort pulses, propagation of ultrashort optical pulses through dispersive optical elements, femtosecond lasers and their applications, characterization of ultrashort pulses, temporal lens , introduction to coherent control. [25% weight age]

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**Course Code & Course Name:** \_\_\_ PH701: Characterization Techniques And Non-Equilibrium Thermodynamics, PH542: Science and Technology of Thin Films, PH 546: Physics of Liquid Crystals

**Student Name: Adrish Chakraborty (P22PH004) & Rimpee Kumari Sah (P22PH008)**

**Unit 1:** Characterization Techniques X-ray Diffraction, X-ray fluorescence, X-ray photoelectron spectroscopy UV-Visible- IR spectroscopy, FTIR spectroscopy, Raman spectroscopy, Photoluminescence spectroscopy, Scanning Electron Microscopy, Tunneling Electron Microscopy, Atomic Force Microscopy, Impedance spectroscopy, Electronic (resistivity, Hall effect) studies. [50% weight age]

**Unit 2:** Kinetic theory of gases, effusion, Hertz Knudsen equation; mass evaporation rate; Knudsen cell, directional distribution of evaporating species, evaporation of elements, compounds, alloys, Raoult's law. Physical Vapor Deposition, Thermal, e-beam, pulsed laser and ion beam evaporation, glow discharge and plasma, sputtering - mechanisms and yield, dc and rf sputtering, bias sputtering, magnetically enhanced sputtering systems, reactive sputtering. [25% weight age]

**Unit 3:** Nature of phase transitions and critical phenomenon in liquid crystals, hard particle, Maier-Saupe and van der Waals theories for nematic-isotropic and nematic-smectic A transitions Landau theory, essential ingredients applications to nematic-isotropic and nematic-smectic A transitions and transitions involving smectic phases. The equations of nemato-dynamics, laminar flow, molecular motions, optical properties of cholesterics, optical properties of ideal helices, agent influencing the pitch, liquid crystal display. [25% weight age]

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**Course Code & Course Name:** \_\_\_ PH701: Characterization Techniques And Non-Equilibrium Thermodynamics, PH403: Quantum Mechanics-I, PH 503: Condensed Matter Physics

**Student Name: Dhiraj Sarma (P22PH006)**

**Unit 1:** Characterization Techniques X-ray Diffraction, X-ray fluorescence, X-ray photoelectron spectroscopy UV-Visible- IR spectroscopy, FTIR spectroscopy, Raman spectroscopy, Photoluminescence spectroscopy, Scanning Electron Microscopy, Tunneling Electron Microscopy, Atomic Force Microscopy, Impedance spectroscopy, Electronic (resistivity, Hall effect) studies. [50% weight age]

**Unit 2:** Separation of variables in spherical polar coordinates, orbital angular momentum, parity, spherical harmonics, free particle in spherical polar coordinates, square well potential, hydrogen atom Identical particles, indistinguishability, symmetric and antisymmetric wave functions, incorporation of spin, Slater determinants, Pauli exclusion principle. [25% weight age]

**Unit 3:** Basic of dielectrics, Mechanisms of electric polarization, Microscopic approach, Determination of local field, Analytical treatment of Polarizability, Effect of alternative field in dielectric materials, Frequency dependence of dielectric properties, Dipolar relaxation, Circuit models in dielectric and impedance analysis, Impedance spectroscopy, Dielectric Breakdown, and its basic mechanisms, Application of dielectric materials. Nonlinear Dielectric Property: Classification, Ferroelectric, Piezoelectric and Pyroelectric ceramics. [25% weight age]

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### 3) Research/Specialization Group: 3

(Name of the Group) \_\_\_\_\_ Theoretical Physics \_\_\_\_\_

**Course Code & Course Name:** \_\_\_ PH701: Characterization Techniques And Non-Equilibrium Thermodynamics, PH505: Nuclear & Particle Physics, PH 553: Quantum Field Theory

**Student Name: Hriditi Howlader (P22PH005)**

**Unit 1:** Characterization Techniques X-ray Diffraction, X-ray fluorescence, X-ray photoelectron spectroscopy UV-Visible- IR spectroscopy, FTIR spectroscopy, Raman spectroscopy, Photoluminescence spectroscopy, Scanning Electron Microscopy, Tunneling Electron Microscopy, Atomic Force Microscopy, Impedance spectroscopy, Electronic (resistivity, Hall effect) studies. [50% weight age]

**Unit 2:** Deuteron, proton-proton and neutron-neutron interaction, properties of the nuclear force, exchange force model, shell model, even-Z, even-N nuclei and collective structure, realistic nuclear models. Particle Physics

Alexia Chandra Nayak

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Yukawa's hypothesis, properties of mesons, symmetries and conservation laws, Standard model, particle classification, quark model, colored quarks, gluons and strong interaction. [25% weight age]

**Unit 3:** Lagrangian Field, The Klein-Gordon Field and The Dirac Field. The S-Matrix Expansion, Feynman Diagrams and Rules in QED, Feynman Diagrams in Configuration Space and Momentum Space. [25% weight age]

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**Signatures and Names of DRC Members:**

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|--------------------------------|---------------------|
| 1. <u>U. Senthil Kumar</u>     | 4. <u>Nakshatra</u> |
| 2. <u>Abhishek</u>             | 5. _____            |
| 3. <u>Alexha Chandra Nayak</u> | 6. _____            |

for U. Senthil Kumar  
Signature of DRC Chairman  
Date 20.7.23