Materials Science with Heavy Ions in Solids, Nuclear Physics, Computers in Control and Data Acquisition

**Course Schedule**

**SEMMESTER-I, August 2014 - December 2014**

**MATERIALS SCIENCE WITH HEAVY IONS IN SOLIDS**

1. **ENERGY LOSS OF MEV IONS IN SOLIDS**: Interaction of an energetic charged particle with a free electron gas, local density approximation in stopping power theory, electronic stopping cross section, nuclear energy loss, energy transfer and simulation of range distribution by Monte-Carlo methods, channeling and Experimental methods for measurement of stopping power.

2. **FUNDAMENTAL LATTICE DEFECTS IN SOLIDS**: Points defects, concentration of point defects, formation energy, line defects, color centers, columnar defects, coulomb explosion, thermal spike, elastic field concepts, planar defects, dislocation boundaries, twins and stacking fault, conditions leading to formation of defects using ion beams.

3. **ION BEAMS IN MATERIALS SCIENCE**: Ion implantation, radiation damage and structure change, sputtering, phase transformations, ion beam mixing, radiation enhanced diffusion, diffusion by vacancies, self-diffusion and impurity diffusion, impurity incorporation, silicide formation.

4. **ION BEAMS IN SEMICONDUCTING MATERIALS AND DEVICES**: Semiconductor band structure, junctions, ion induced epitaxial crystallization, artificially structured materials, buried layers and band structural engineering for new functional devices.

5. **ION BEAMS IN SUPERCONDUCTORS**: Special features of the superconducting state – magnetization M(H), specific heat, energy gap, penetration depth and coherence length, superconductivity and magnetism, irreversibility line and relationship to Jc, Bean model, columnar defects and modification of superconducting properties.

**COMPUTERS IN CONTROL AND DATA ACQUISITION**

1. **PROGRAMMING TECHNIQUES**: Basic structure of a Fortran program, modular programming, optimization of program, introduction to assembly and other languages, e.g. C.

2. **NUMERICAL ANALYSIS**: Concept of errors and their propagation, interpolations, numerical integration and differentiation, matrix inversion and diagonalization, solution of linear and non-linear equations, solution of differential equations, concept of Monte-Carlo methods.


4. **COMPUTER ARCHITECTURE**: Basic concepts, microprocessors, standard buses, operating systems, multitasking, networking, ethernet TCP/IP.

5. **DATA ACQUISITION SYSTEM**: Real time and time sharing, interrupt driven system, methods of improving throughput, computations for nuclear experiments, current trends in data acquisition, networked systems.

**NUCLEAR PHYSICS**

1. **ANGULAR MOMENTUM AND SYMMETRIES**: Angular momentum and rotation groups, Addition of angular momentum, Clebsch-Gordan coefficients, Rodrigues Coefficients and 9-J symbols, Irreducible spherical tensors and Wigner-Eckert theorem, General Symmetries in nuclei with special reference to isospin and parity.

2. **NUCLEAR MODELS-I**: Two body forces, Infinite nuclear matter, Effective interactions (pairing + Quadrupole, Skyrme etc.). Single particle motion, Shell model with configuration mixing, Nilsson model, Strutinsky and shell corrections.

3. **NUCLEAR MODELS-II**: Liquid drop model and collective motion, Rotation and vibration with particle coupling, Cranking models, Hartree-Fock models, Hartree-Fock-Bogoliubov and quasi particles, Pairing and BCS equations.

4. **NUCLEAR REACTIONS**: Kinematics, optical model of elastic scattering, direct and compound nuclear reactions, Hauser- Feshbach description of compound nuclear reactions, inelastic scattering and transfer reactions and their descriptions in distorted-waves Born Approximation and in coupled channels formalism, resonances (Isobaric Analogue, Giant and Molecule) break-up reactions.

5. **HEAVY ION REACTIONS**: Special features of heavy ion scattering (Q and L-window), semi classical models, deflection functions, rainbow and Glory scattering, quasi elastic and transfer reactions, deep inelastic scattering, complete and incomplete fusion, fission.

**DETAILS OF COURSE MODULE**

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<tr>
<th>Period</th>
<th>Course Module</th>
<th>Lecturer</th>
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<tr>
<td>2. 8th Sept. - 26th Sept. 2014</td>
<td>Fundamental Lattice Defects in Solids</td>
<td>Prof. V. D Vankar, Ex IIT Delhi</td>
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<td>3. 7th Oct. - 24th Oct. 2014</td>
<td>Ion Beams in Materials Science</td>
<td>Dr. Ambuj Tripathi, IUAC</td>
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<tr>
<td>4. 27th Oct. - 14th Nov. 2014</td>
<td>Ion Beams in Semi-conductor Materials and Devices</td>
<td>Dr. D. Kabiraj, IUAC</td>
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<tr>
<td>5. 17th Nov. - 5th Dec. 2014</td>
<td>Ion Beams in Superconductors</td>
<td>Prof. S. Patnaik, JNU, Delhi</td>
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Special Lectures: Additional special lectures may be arranged. Details will be announced later.

**INTER-UNIVERSITY ACCELERATOR CENTRE**

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