Implemented From Academic Year 2015- 16 onwards

Syllabus for M. Sc (Physics) Choice Base Credit System
(Under Academic Flexibility Scheme)

M.Sc. (Physics) (Semester-III)
Paper Code: SSP-2
Paper title: SOLID STATE PHYSICS-II, Semiconductor Physics

UNIT I : Energy Bands and Charge Carriers in Semiconductors: (15)

Bonding forces and energy bands in solids, Direct and Indirect semiconductors, variation of energy bands with alloy composition, Charge carriers in semiconductors: electrons and holes, effective mass, intrinsic and extrinsic materials, electrons and holes in quantum wells, The Fermi level, carrier concentration at equilibrium, temperature dependence, space charge neutrality, conductivity and mobility, Drift and resistance, effects of temperature and doping on mobility, High field effects.

UNIT II: Excess Carriers in Semiconductors: (15)

Optical absorption, Luminescence, Direct recombination of electrons and holes, Indirect recombination and trapping, steady state carrier generation and Quasi Fermi levels, Diffusion processes, Diffusion and Drift of carriers, built-in fields, The continuity equation, steady state carrier injection, diffusion length, The Haynes-Shockley experiment.

UNIT III: Junctions-I (15)

Fabrication of p-n junctions; Thermal oxidation, diffusion, Rapid thermal processing, Ion implantation , CVD, Photolithography, etching, metallization, The contact potential, Space charge at a junction, qualitative description of current flow at a junction, Carrier injection, reverse-bias breakdown, Zener and Avalanche breakdown.

UNIT IV: Junctions-II (15)

Capacitance of p-n junctions, the Varactor diode, effects of contact potential on carrier injection, recombination and generation in the transition region, ohmic losses, graded junctions, shottky barriers, rectifying contacts, ohmic contacts, heterojunctions, AlGaAs-GaAs heterojuction.

References:

1. Solid state electronic devices by B. G. Streetman.
2. Physics of semiconductor devices by S. M. Sze.
3. Solid State and Semiconductor Physics by Mc Kelvey.
4. Principles of Elecronic Materials and Devices by S.O. Kasap

Syllabus for M. Sc (Physics) Choice Base Credit System
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M.Sc. (Physics) (Semester-IV)
Paper Code: SSP-2
Paper title: SOLID STATE PHYSICS-II, Energy Conversion and Storage Devices

UNIT I: Solar Photovoltaics (15)

P-N junction under illumination, Light generated current, I-V equation, Characteristics, Upper limits of cell parameters, losses in solar cells, equivalent circuit, effects of various parameters on efficiency, Solar cell design, Design for high Isc, Antireflective coating (ARC), Design for high Voc and fill factor, Analytical techniques; solar simulator, Quantum efficiency, Minority carrier life time and diffusion length measurement. Thin film solar cells: Advantages, materials, a-Si, CdTe, CIGS

UNIT II: Sensitized and Polymer Photovoltaics (15)

Dye sensitized solar cells, advantages and disadvantages, Quantum dot sensitized solar cells, Perovskite sensitized solar cells, Planar and bulk heterojunction polymer solar cells, Exciton generation and dissociation, Advantages, disadvantages and types of materials.

UNIT III: Batteries and Fuel cells (15)

Primary batteries, Rechargeable batteries, Electrochemical energy storage: cell reaction, Laws, Parameters, thermodynamics parameters, kinetic parameters, Polarization, Heat effects, Types of batteries (Lead-acid, Ni/Cd, Ni/metal hybrid), charging methods and techniques, characteristic curves, Lithium batteries, chemistry and Physics of lithium batteries, anode and cathode materials, applications, Introduction to fuel cells.

UNIT IV: Supercapacitors (15)

Similarities and differences between supercapacitors and batteries, Energetics, Double layer electrostatic capacitor, Pseudocapacitance, origin, kinetic theory, RuO_2 as a material for electrochemical capacitors, Regon plot, electrolyte factor, energy density and power density, Impedance of a pseudocapacitance, Technology development, various oxides as pseudocapacitors.

References:

1. Solar photovoltaics, Fundamentals, Technologies and Applications by Chetan Singh Solanki, PHI Learning Private Limited, Delhi-110092.
2. Polymer photovoltaics, a practical approach by Fredrik C. Krebs, Spie Press, Bellingham, Washington USA.
3. Organic Solar Cells, Theory, Experiment, and Device Simulation by Wolfgang Tress, Springer.
4. Dye Sensitized Solar Cells by K. Kalyansundaram, EPFL Press, A Swiss academic publisher distributed by CRC press.
5. Solar cells- Dye-sensitized Devices by Leonid A. Kosyachenko, Published by Intech, Janeza Trdine 9, 51000 Rijeka, Croatia.
6. Battery Technology Handbook by H. A. Kiehne , Marcel Dekker, Inc. , New York, Basel.
7. Electrochemical Supercapacitors, Scientific fundamentals and Technological Applications by B. E. Conway, Kluwer Academic/ Plenum Publishers, New York, Boston, Dordrencht, London, Moscow.