Approval: 5th Senate Meeting

Course Name : Molecular- and Bio-electronics
Course Number : CY-642
Credit : 3-0-0-3
Prerequisites : IC130 and IC241 /or permission from instructor
Students intended for : B.Tech. (All branches), M.S. and Ph.D. Elective or
Compulsory : Elective
Semester : Odd/Even
Course Description

In the recent years, we have witnessed the miniaturization of several electronic devices and they continue to shirk in size over the years. In few years down the lane, nano-circuits comprising of organic molecules, biomaterials and nanostructures will dominate the field of molecular electronics. Hence, it is important to acquire knowledge on this fast growing field and understand how this new field is slowly creating a revolution through its varied applications. This course will provide the basic concepts and the relevant applications of molecular- and bio-electronics. In addition, current research topics will be reviewed to exemplify the progress and challenges in this field.

Course Contents

Unit 1: Molecular electronics [8 hours]

Moore's laws and beyond; metallic atom-size contacts; transport through molecular junctions, plastic electronics; liquid crystal devices; single electron devices; logic gates; device fabrication strategies (in detail); tools for molecular electronics

Unit 2: Organic electronics [8 hours]

Pi-conjugated molecules; electroactive organic compounds; organic semiconductors; structure-electronic property relationships; organic electronic devices (OLED, OPV, OPD, OTFT, OFET); gate dielectrics; flexible polymeric substrates; printed organic electronics; novel processing techniques; device performance and characterization.

Unit 3: Nanoelectronics [8 hours]

Nanowires, nanotubes and nanostructures – synthesis, characterization and uses (in brief); nanowire integrated circuitry; nanostructure enabled chemical sensing; supra molecular bioelectronics nanostructures; quantum dot devices; electromechanical actuators

Unit 4: Bioelectronics [10 hours]

Introduction; electron transfer through proteins; biosensors and biofuel cells; enzyme electrodes; electrochemical DNA sensors; biomolecules-semiconductor interfaces for sensing and detection; bio-nano hybrid systems for electronic devices; DNA- templated electronics; S-layer proteins in bioelectronics; computing with nucleic acids

Unit 5: Current research [8 hours]

Review of recent literature through high-impact journal articles on relevant topics; guest lecturers (2-3) by eminent scientists/professors from abroad through video conference (using NKN facilities); few simple hands-on experiments will be demonstrated/ performed

Reference Books:

1. M. C. Petty, Molecular Electronics: From Principles to Practice, John Wiley & Sons (2008). [2] J. C. Cuevas, E. Scheer, Molecular Electronics: An Introduction to Theory and Experiment, World Scientific Publishing Company (2010).
2. H. Klauk, Organic Electronics: Materials, Manufacturing, and Applications, Wiley-VCH (2006). [4] H. Klauk, Organic Electronics II, Wiley-VCH (2006). [5] K. Iniewski, Nanoelectronics: Nanowires, Molecular Electronics, and Nanodevices, McGraw-Hill (2010).
3. I. Willner, E. Katz, Bioelectronics: From theory to applications, Wiley-VCH (2005).