22SC801 NANOPHOTONICS 4 -0-0 4

AIM

To enable the students to get a thorough knowledge about the principle, mechanism and applications of various nano- optical phenomenon

COURSE OUTCOMES

Module No	Outcome Statement
1	The student will have a thorough knowledge about the fundamentals of nanophotonics
2	Students will have a thorough understandings of nanophotonic interaction dynamics.
3	Student will get an exposure to various mechanisms and factors affecting efficiency UC and its applications.
4	Student will have an in-depth knowledge about the different computational methods used in nanophotonics
5	Student will be able to develop skills in designing and developing new nanophotonic materials for diverse application.

MODE OF TRANSACTION

Lecture cum discussion, demonstration, group presentations, seminars, debates, assignments, brain storming sessions, peer group discussion, interaction with community, case study, survey and dialogue, ICT based teaching and learning.

COURSE OUTLINE

Module 1 : Introduction to Nanophotonics

Foundations of nano-photonics: - Confinements approaches, Photons and electrons: a comparison of their similarities and dissimilarities, Confinement of photons and electrons, Confinement of optical interactions at the nanoscale, Axial nanoscopic localization - Evanescent Wave, Surface Plasmon Resonance (SPR). Lateral nanoscopic localization. Nanoscale confinement of electronic interactions: - Quantum confinement effects, Quantum-confined stark effect, Dielectric confinement effects.

Module 2 : Nanoscopic interaction dynamics

New cooperative transitions- Cooperative emission, Nanoscale electronic energy transfer. The down-conversion and up-conversion photoluminescence-Photon upconversion, Physical mechanisms behind photon upconversion-Sensitized triplet-triplet annihilation, energy transfer upconversion (ETU), excited-state absorption (ESA) and photon avalanche (PA). Upconverting nanoparticles:- Lanthanide-doped nanoparticles, Semiconductor nanoparticles, upconversion through interfacial energy transfer (IET). Upconversion nanocapsules for differential cancer bioimaging in vivo.

Module 3: Computational nano-photonics

Standard problems and numerical methods**: -** Finite differences in time domain (FDTD), Finite elements (FE), Volume integral methods, Surface integral methods, Other methods: - Finite integration technique, T-matrix system, Multiple multipole approaches, RCWA approach.

Module 4: Active nano-photonic devices

New gain materials:- Dielectric nanoparticles, optical parametric amplification (OPA), coherent amplification. Material gain parameters. Nanolasers :- 2DTMDCs, Organic – inorganic perovskites, MOF materials. Nonlinear optics in plasmonic nanostructures :- surface plasmon polaritons (SPP's), Population inversion of emitters (QD's, fluorophore's), nano-resonators . Nonlinear plasmonic metamaterials, Quantum dot lasers and optical amplifiers. Metametrials.

Module 5: Nanophotonics: applications

Biomaterials and nanophotonics, Nanophotonics for biotechnology and nanomedicine, Optical nanomaterials- Optical diagnosis. Optoelectronics and microelectronics, Solar cells, Controlled release of anti-cancer therapeutics, Spectroscopy, Microscopy, Optical data storage, Band-gap engineering.

References/Text Books

1. Fundamentals and Applications of Nanophotonics , Joseph W. Haus , Woodhead Publishing, 2016
2. Nanophotonics: Fundamentals, Challenges, Future Prospects and Applied Applications DOI: http://dx.doi.org/10.5772/intechopen.98601
3. Lembrikov, B (ed.). 2022, Nonlinear Optics - Nonlinear Nanophotonics and Novel Materials for Nonlinear Optics, IntechOpen, London. 10.5772/intechopen.94637
4. Raymond Bonnett , Chemical Aspects of Photodynamic Therapy, CRC Press, 2000

SCHEME OF EVALUATION

<table>
<tr><th>Sl No.</th><th colspan="2">In- semester assessment</th><th colspan="2">End – semester assessment</th></tr>
<tr><td>1</td><td>Periodical test</td><td>30 marks</td><td rowspan="3">End Semester Examination</td><td rowspan="3">50 mark</td></tr>
<tr><td>2</td><td>Assignment</td><td>10 marks</td></tr>
<tr><td>3</td><td>Seminar</td><td>10 marks</td></tr>
<tr><td>4</td><td>Sub total</td><td>50</td><td colspan="2">50</td></tr>
<tr><td></td><td colspan="2">Grand total</td><td colspan="2">100</td></tr>
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ACTIVITIES/ CONTENT WITH DIRECT BEARING ON EMPLOYABILITY/ ENTERPRENEURSHIP/ SKILL DEVELOPMENT (based on NAAC Criteria):

The learner will get a clear understanding of the concepts and ideas regarding the technical and theoretically relevant area which is explored in the course. This course will equip the learner to build a career as a Faculty in Chemistry, Research Scientist in the respective field.