# OPTICAL SENSORS

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IIT Roorkee

**TYPE OF COURSE** : Rerun | Elective | UG/PG
**COURSE DURATION** : 4 weeks (24 Jan' 22 - 18 Feb' 22)
**EXAM DATE** : 27 Mar 2022

**PRE-REQUISITES :** Basic knowledge of Optics (Geometrical optics, Interference, Diffraction, polarization, etc.)

**INTENDED AUDIENCE :** Physics, Nanotechnology, Biosciences, Electrical Engineering, Electrooptic Engineering, Photonics

**INDUSTRIES APPLICABLE TO :** Photonic System

**COURSE OUTLINE :**

This course provides detailed insight of the field of optical biosensors and their basic working principles. Staring with the introduction of basic components, characteristics, performance parameters and fabrication techniques , this course brings the learner to the mesmerizing field of sensors based on basic principles of optics. The basic optical phenomena/characteristics and their sensing applications have been discussed in detail. The optical properties of tissues and optics in the biomaterials has been discussed providing some further insights into optical biosensing applications. The course also ends with notes on terahertz sensing applications and future directions of research.

**ABOUT INSTRUCTOR :**

Prof. Srivastava is an Assistant Professor in Physics Department of IIT Roorkee. He has more than 10 years of research experience in various dimensions of optical biosensors, starting from evanescent waves, SPR, SERS, EOT, LSPR, SEF, ESP-LSP coupling, GMR and other optical phenomena. He teaches applied Physics course at IIT Roorkee and has taught Basic optics course at AcSIR. Apart from aforementioned details, he worked as In-charge of technical operations of Photonicsys company in Asia. He is a member of Optical Society of America (OSA) Optical Biosensors and OSA- Nanophotonics executive committees.He is also an Editor of the “Journal of Sensors”.

**COURSE PLAN :**

**Week 1 :** Lecture 1: Introduction to sensors and biosensors:Characteristics and components of optical biosensors,various transduction mechanisms, Optical probing parameters
Lecture 2: Performance parameters, Fabrication and functionalization methods of optical biosensors
Lecture 3: Basic optics for optical biosensing-I:Electromagnetic waves in free space: –Maxwell’s equations, EM Wave equations, Power density, Polarization, Scattering

**Week 2 :** Lecture 4: Basic optics for optical biosensing-II: Electromagnetic waves in matter Dielectrics, Reflection and transmission at interface: Fresnel equations, Polarization by reflection – Brewster angle sensor
Lecture 5: Basic optics for optical biosensing-III: Electromagnetic waves in matter Total internal reflection-TIR sensors, Evanescent wave sensing, factors affecting performance, importance of penetration depth, waveguide sensors using TIR
Lecture 6: Basic optics for optical biosensing-IV: Electromagnetic waves in matter Absorption and dispersion, conductors: Drude model for the metal dielectric function and introduction to plasmons

**Week 3 :** Lecture 7: Plasmonic sensors: Propagating versus localized plasmons, Optimized sensor configurations, Electromagnetic field enhancements, plasmon enhanced sensors
Lecture 8: Basic optics for optical biosensing-V: Interference and diffraction Interference and interferometry, Airy function for single layer, Mach Zehnder Interferometer for sensing, Fabry Perot Interferometer for sensing.

**Week 4 :** Lecture 9: Review of biomaterial optics:Biomaterial Structures EM Waves Absorption in Tissue, Chirality, polarization rotation and dichroism,
Lecture 10: Review of sensing applications: Scattering–Elastic (Rayleigh), –Inelastic (Raman); Fluorescence, Some real life optical biosensors, Sensing at terahertz.