Course Code	Course Name	Credits
26PH608	BIOELECTRONICS AND BIOSENSORS	04

Course Objectives

- Extend principles of engineering to the development of biosensors and bioelectronic devices.
- Demonstrate appreciation for the technical limits of performance.
- Make design and selection decisions in response to measurement and actuation problems amenable to the use of biosensors and bioelectronic devices.
- Be able to evaluate novel trends in the field.

Learning Outcomes

Upon successful completion of this course it is intended that a student will be able to:

- Analyze and evaluate the energy and kinetic parameters of the electron transfer.
- Understand and use the functionalization methodologies of different types of surfaces and to perform their characterization.
- Understand how a variety of biosensors and for sustainable power generation devices work.

Unit 1 – Introduction (12 Hrs.)

Nature of Biomedical signals; Bio Electronic potentials; Necessity of Bio Electronics; Components; Scope and Application; Basics of cell biology; Structure of the cell, the nervous system and the neuron; function of enzymes; nucleus and role of DNA and RNA, adhesion of cell to surfaces.

Unit 2 – Bio Electronic Device Production (12 Hrs.)

Elements in contact with the surface of a biomaterial: blood composition, plasma proteins, cells, tissues – Phenomena at the bio interfaces. Molecular and cellular processes with living environment, blood-materials interaction, short and long term reactions to the body – Testing of biomaterials: in vitro, in vivo preclinical and in vivo clinical tests.

Unit 3 - Materials In Clinical Devices (12 Hrs.)

Metals: Sulzer recall of prosthetic hip implant – Composition of stainless steel and Fe/Co/Ti alloys; Mechanical – properties – Hard Materials: Bio ceramics and Bio glasses, Carbons, Polymers as Biomaterials Composites. Biological reactions to implants – Natural Biomaterials -development of molecular arrays as memory stores – molecular wires and switches; mechanisms of unit assembly.

Unit 4 – Biosensors (12 Hrs.)

Introduction to Biosensors – Types of sensors – target analytes – various recognition – signals and device types – basic design consideration – calibration – dynamic range – signal to noise – sensitivity – selectivity – interference Bio MEMS – nano wires – Quantum dots – magnetic beads, PEBBLE sensors.

Unit 5 - Electrical Signal Transduction (12 Hrs.)

Seismic (mass) and thermal sensors: Electromechanical resonance – electrochemical forces – Henry's and ideal gas laws – Surface acoustic wave (SAW) devices – atomic force microscopy – manometric sensors – thermometric detection – Electrochemical sensors: Redox potentials, membrane potential, Gauss's Law, basic electrochemistry-amperometric sensors; Charge sensing with FET. Link equation, Link budget – INSAT Communications Satellites.

Reference Books:

1. ItamarWillner and Eugenii Katz, Bioelectronics: From Theory to Applications, John Wiley (2005).
2. S. Bone and B. Zebba, Bioelectronics, Wiley (2012).
3. B. D. Ratner and A. S. Hoffman, Biomaterials Science: An Introduction to Materials in Medicine, Academic Press, New York (1996).
4. B.R. Eggins, Chemical Sensors and Biosensors, John Wiley and Sons (2002).

Websites and eLearning Sources:

1. https://nptel.ac.in/courses/115107122
2. https://youtu.be/Qq3t01LytkU?si=I3aCxjxZ4NLgqmjN
3. https://youtu.be/11-8ecpwOXs?si=PAtiOWlmJap0-tCf

COs and Bloom's Taxonomy Mapping – 26PH608		
Course Outcomes	**On successful completion of this course, students will be able to**	**BTL**
CO1	Recall and explain the fundamentals of biomedical signals, cell biology, and bioelectronic systems.	K1, K2
CO2	Apply principles of biomaterials and biointerfaces to understand interactions between biological systems and electronic devices.	K3
CO3	Analyze materials used in clinical devices including metals, ceramics, polymers, and composites.	K4
CO4	Analyze biosensors and signal transduction mechanisms including electrochemical and MEMS-based systems.	K5
CO5	Evaluate and design bioelectronic devices and biosensing systems for medical and healthcare applications.	K6

BTL (Bloom's Taxonomy Level) - K1 – Remembering, K2 – Understanding, K3- Applying, K4 – Analyse, K5- Evaluate and K6 - Create

Relationship Matrix – 26PH608

Course Outcomes	Programme Outcomes (POs)						Programme Specific Outcomes (PSOs)						Mean Score of Cos
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	
CO1	3	2	1	1	1	1	3	2	1	1	1	1	1.58
CO2	3	3	2	2	1	1	2	3	2	2	2	1	2.00
CO3	3	3	3	2	1	1	2	3	3	2	2	2	2.25
CO4	3	3	3	2	2	1	2	3	3	2	2	2	2.33
CO5	3	3	3	3	2	2	3	3	3	3	2	2	2.58
												Total	2.15

Mean Score: 3- High, 2- Medium/Moderate, 1-Low