Approved in 44th BoA Meeting (24-11-2021)

Course number	**: BE503**
Course Name	**: Biosensing and Bioinstrumentation**
Credit Distribution	**: 3-0-2-4**
Intended for	**: B.Tech M.Tech Integrated Dual Degree Programme in Bioengineering (B.Tech Core course), elective for others**
Prerequisite	**: IC161 (Applied Electronics) and IC161P (Applied Electronic Lab) or equivalent, IC260 (Signals and Systems) or equivalent**
Mutual Exclusion	**: None**

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1. Preamble:

The course aims at studying techniques of measurement, obtaining signals from biological systems and processing those signals for estimating various biological parameters. The general principles of measurements , sensing and instrumentation will be applied in various bio-instruments. The students will also have a current background on the basic principles of key analytical biotechnologies, and how these technologies allow sensitive and accurate detection, purification, and characterization of biomolecules.

2. Course Modules with quantitative lecture hours:

Topic 1: Measurement – SI units, systematic and random errors in measurement, expression of uncertainty - accuracy and precision index, propagation of errors, DC potentiometer; bridges for measurement of R, L and C, Q-meter, signal-to-noise ratio, responsivity of a sensor (Transformation of Input-to-output signal). **(4 Hours)**

Topic 2: Biosignals – Origin, nature, and types of Biosignals, Principles of sensing physiological parameters from plants and animals, Bioelectric signals and their characteristics. Chemical and electrochemical biosignals. **(3 hours)**

Topic 3: Sensors - Classification of transducers and their characteristics, viz. Voltage sensors, Optical sensors, Displacement/Pressure sensors and accelerometers, Chemical sensors, Acoustic sensors – basic principles, signal conditioning considerations, examples (e.g. biopotential electrodes, pulse oximeter, glucose monitor, hearing aid, etc.); Physical

biosensors and associated signal conditioning circuits; Chemical biosensors; Antibody based biosensors, DNA based biosensor, Immunoassays for plant and animal pathogen detection, Enzyme linked immune-sorbent assays (ELISA), bio-luminioscent technologies for pathogen detection; Optical sources and detectors: LED, Photo-diode, p-i-n and avalanche photo diode, optical nterferometers: applications in metrology; basics of optical sensing and LASER; basics of magnetic sensing.
(16 Hours)

Topic 4: Bioinstrumentation – Biopotential Amplifiers, Noise and artefacts and their management, Electrical Isolation (optical and electrical) and Safety of bio-instruments. Generation, Acquisition, and signal conditioning and analysis of biosignals. Principles of measuring blood pressure, bioamperometric enzyme electrode. (**15 hours**)

Topic 5: Analytical bio-techniques - Principles and applications of UV-Visible-NIR spectroscopy, fluorescence spectroscopy, MR spectroscopy, basics of chromatographic techniques, imaging techniques – principles and applications of microscopy. **(4 hours)**

Laboratory/practical/tutorial Modules: Design of measurement circuits, ELISA test, extraction of bio-signals, amplification and isolation of bio-signals, phase contrast microscopy, chemoluminiscence, fluorescence spectroscopy, MR spectroscopy, spectrophotometry, Pulse oximeter, blood pressure measurement device

3. Text books:

1. A.G. Webb, Principles of Biomedical Instrumentation, Cambridge University Press, United Kingdom, 2018.
2. J. G. Webster, Medical Instrumentation – Application and Design, 4e, John Wiley and Son, USA, 2020.

4. References:

1. R.S. Khandpur, Biomedical Instrumentation – Technology and Applications, Tata McGrawHill, India, 2017.
2. S.C. Mukhopadhyay, A.L. Ekuakille, Advances in Biomedical Sensing, Measurements, Instrumentation and Systems, Springer-Verlag, Germany, 2018.
3. J. R. Lakowicz, Principles of Fluorescence Spectroscopy, Springer Science & Business Media, 2013.
4. H. H. Willard, L. L. Merritt, J. A. Dean, F. A. Settle, Instrumental Methods of Analysis, CBS publishers and Distributors, 2015.

5. Similarity with the existing courses:
(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.	Bioelectric Systems Modelling	BE302	Bioelectric signals and their characteristics, Generation, Acquisition, and signal conditioning and analysis of biosignals	7%
2.	Analytical Biotechniques	BY514	Brief introduction to different analytical techniques	5%

6. Justification of new course proposal if cumulative similarity content is >30%:

Not applicable