



IIT Mandi Proposal for a New Course

Course number : BE-309
Course Name : Biosensing and Bioinstrumentation
Credit : 3
Distribution : 2-0-2-3
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: Not applicable

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, systems approaches for bioinstrumentation (Transformation of Input-to-output signal). **(3 Hours)**

Topic 2: Biosignals – Origin, nature, and types of Biosignals, Bioelectric signals - ECG, EMG, EEG; Biomechanical signals, Biomagnetic signals. **(6 hours)**

Topic 3: Sensors – Static and dynamic characteristics of sensors, Sensing principles – e.g. Chemical, Mechanical/MEMS, Voltage/Resistance, Strain, Piezoelectric, Optical, Acoustic, Thermal, etc. Specific examples – e.g. Electrodes, Strain gauge, Piezoelectric

pressure sensor, pulse oximeters, thermocouples, accelerometers, antibody based sensors, Immunoassays, ELISA, etc. (9 Hours)

Topic 4: Bioinstrumentation – Foundational principles – KCL, KVL, Ohm’s law, Loading effects, noise, SNR; Signal conditioning principles – operational and instrumentation amplifiers, passive and active filters, noise isolation and electrical hazards safety; Signal analysis – introduction to time series and frequency domain approaches; Bioinstrumentation systems design approaches. (6 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 Modules: Design of measurement circuits, extraction of bio-signals, amplification of bio-signals, signal conditioning, circuit isolation principles (e.g. optical, magnetic), systems design; lab visits for demonstration of state-of-art microscopy, spectroscopy, wet-lab approaches, etc.

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	Approx. % of Content
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			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