Birla Institute of Technology & Science, Pilani
Hyderabad Campus

SECOND SEMESTER 2023-2024
Course Handout (Part II)

Date: 09/01/2024

In addition to part I (General Handout for all courses appended to the time table) this portion gives further more specific details regarding this course.
Course No. : CHEM F414
Course Title : BIO and CHEMICAL SENSORS
Instructor-in-charge: Jayanty Subbalakshmi
Instructors: Jayanty Subbalakshmi

1. **Scope and Objective of the Course**: The main objective of this course is to introduce students to chemical sensors and biosensors and familiarize them with various types of sensors, their properties, and their applications. This course, further deals with the facets of sensors and the principles on which they are established. Students will gain knowledge on the sensitivity, and selectivity features of the sensor and focus on the performance factors such as how long a sensor can be used, to what level it can detect etc. Classification of biological sensors like enzymes, antibodies, antigens etc. will be taught. The understanding of olfactory system through chemical sensors shall be dealt with. Knowledge, definition, and design of various electrochemical sensors, mass sensors, thermal sensors, optical sensors accompanied by the mechanism of their sensitivity, and selectivity will also be highlighted. Finally, a comprehensive perspective of recent advances and technological applications of bio and chemical sensors with examples covering real case studies will be enlightened to get a complete perspective of sensors.

2. **Text Books**:

T1: Brian R. Eggins, "Chemical Sensors and Biosensors" 2007, John Wiley & Sons Ltd.
T2: Jiri Janata, "Principles of Chemical Sensors" 2009, 2nd Ed., Springer.

3. **Reference Book:**

R1: Florinel-Gabriel Bănică, "Chemical Sensors and Biosensors" 2014, Wiley publishers.

The syllabus also includes lectures and tutorial class notes.

4. Course Plan:

No. Lectures	Learning Objectives	Contents to be covered	Learning Outcomes of the lectures	Chapter
1-3	Introduction	Definitions, Introduction to recognition methods, transduction elements, sensor fabrication, and calibration.	Define fundamental terms in sensors Draw/label, a sketch of the sensor device Methodology to, in general, fabricate and calibrate sensors	T1: Chapter 1
4-7	Performance Factors	Selectivity, Sensitivity, time factors, detection and quantification	Gain knowledge on the selectivity feature of the sensor and focus on the performance factors such as time factors, detection limit, etc. Overall,	T1: Chapter 4

		capabilities, different transducers.	we learn about the execution capability of the sensor and factors affecting the performance of the sensors. Lab component 1: Estimation of fluoride in toothpaste using Ion selective electrode (ISE sensor)	
8-12	Electrochemi-cal Sensors	Methods and materials, potentiometric, amperometric, conductometric sensors and Biosensors. Applications of Field-effect transistor sensors.	Knowledge, definition, and design of various electrochemical sensors, mechanism of their sensitivity, and selectivity. Calculation of selectivity parameter. Lab component 2: Using standard addition method for the detection of Pb^{+2} ion (Optical sensor)	T1: Chapter 5 T2: Chapter 5 R1: Chapter 10, 13, 14
13-17	Mass sensors	Piezoelectric effect-principles and applications, QCM. Non-piezoelectric mass sensors.	A detailed study on mass sensors by getting key insight about the piezoelectric property. Design of Quartz crystal microbalance, Resonant cantilevers.	T2: Chapter 4
18-21	Biological Recognition Agents	Sensing elements. Enzymatic sensors, antibodies, chemical noses and tongues	Concept of recognition, visualization and classification of biological sensors like enzymes, antibodies, antigens, etc. The understanding olfactory system through chemical sensors. Molecular recognition, Immobilization of biological components.	T1: Chapter 3
22-25	Sensors based on Nanomaterials	Carbon nanotubes (CN), metallic nanoparticles, semiconductor nanocrystals, Silica NPs, Dendrimers	To know the molecular structures, synthesis and utilization, and application of carbon nanotubes, silica, dendrimers, and semiconductor-based nanoparticles as molecular sensors.	R1, T1, Research papers etc.
26-29	Thermal Sensors	Temperature transducers, Enzymatic thermal sensors, thermo catalytic sensors, thermistors, structure and applications	Differentiate between sensors and transducers. Thermal and thermo catalytic sensors. Design of thermistor and its sensitivity study. Applications of thermal sensors. Lab component 3: Demonstration of cyclic voltammetry (Electrochemical transducer)	T1: Chapter 7 R1: Chapter 9
30-33	Optical Sensors	Optical waveguide in chemical sensors, spectrochemical transduction methods, fiber optic sensor array, applications	Introducing various optical properties. Understanding the concept of waveguide with diagram. Detailed knowledge of chemical sensors. Design of fiber optic array. Knowing about Mach-Zehnder Interferometer, Resonant mirror etc.	R1: Chapter 18,19
34-37	Optical	Nanomaterial	Usage of nanomaterials like	T2: Chapter 9

	Sensors: Applications	Applications in Optical Transduction	lanthanide compounds, porous silicon, etc. in optical transduction and optical sensing. Lab component 4: Demonstration of confocal microscopy-bioimaging application (Biosensor)	R1: Chapter 20
38-40	Specific Applications	Specific Applications: Case Studies	Comprehend the recent advances and technological applications of bio and chemical sensors with examples covering case studies such as determination of glucose in blood, simultaneous determination of several metal ions etc.	T1, T2, R1, **Research articles,** Class Notes etc.

5. Evaluation Scheme:

Component	Duration	Weightage %	Date, Day & Time	Nature of Component
Mid-Semester Test	90 min	30%	12/03 - 4.00 - 5.30PM	Closed Book
Assignments/lab component/ Quiz/small projects	-	25%	-	Open Book
Comprehensive Examination	120 min	45%	09/05 AN	Closed Book

Note: Lab will be conducted during the class hours or during extra class based on the requirements

6. Chamber consultation hours: Wednesday 4.00 pm to 5.00 pm

7. Notices: Notices concerning the course will be displayed on the CMS.

8. Academic Honesty and Integrity Policy: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

9. Make-up-policy: Makeup would be considered only for very genuine reasons (*such as institute deputation outside for sports/cultural fest, hospitalization (with appropriate documentary proof)*, and in case of any other extreme emergency situations.

Instructor-in-charge

Prof. Jayanty Subbalakshmi