Roll No. | | | | | | | | | | |

ANNA UNIVERSITY (UNIVERSITY DEPARTMENTS)

B.E. /B.Tech / B. Arch (Full Time) - END SEMESTER EXAMINATIONS, APR / MAY 2024

BIOMEDICAL ENGINEERING
Semester III
BM23303 - SENSORS AND MEASUREMENTS
(Regulation2023)

Time:3hrs

Max.Marks: 100

CO1	Recognize the purpose, characteristics, and methods of measurement.
CO2	Understand the principles and Characteristics of different sensors, signal conditioning circuits and display devices.
CO3	Understand the principles and Characteristics of biosensors.

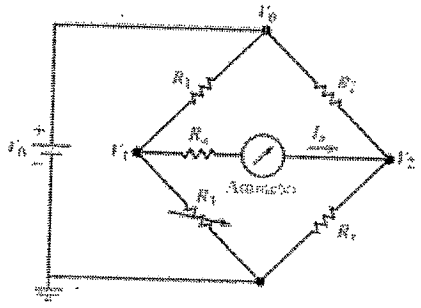
BL – Bloom's Taxonomy Levels
(L1-Remembering, L2-Understanding, L3-Applying, L4-Analysing, L5-Evaluating, L6-Creating)

PART- A(10x2=20Marks)
(Answer all Questions)

Q.No.	Questions	Marks	CO	BL
1	List two types of errors in measurement systems with examples.	2	CO1	L1
2	What are the primary differences between accuracy and precision?	2	CO1	L2
3	What is the gauge factor in a strain gauge, and how is it calculated?	2	CO2	L1
4	What is the principle behind the working of a capacitive transducer?	2	CO2	L1
5	What is the principle of operation of a phototube?	2	CO2	L1
6	What is the key difference between photoconductive cells and photovoltaic cells?	2	CO2	L1
7	What is the function of a Maxwell bridge, and how is it used in resistance measurement?	2	CO2	L1
8	What is a band-pass filter, and where would it be used in signal processing?	2	CO2	L1
9	Mention one example of a biomedical application of enzyme sensors.	2	CO3	L1
10	What is the role of a biological element in a biosensor?	2	CO3	L1

PART- B(5x 13=65Marks)
(Answer all Questions)

Q.No.	Questions	Marks	CO	BL
11 (a)	Explain the concept of static characteristics in measurement systems and their significance in ensuring accurate and reliable measurements. Discuss in detail the key static characteristics. Illustrate their impact on the performance of transducers and instrumentation systems. How do these characteristics influence the selection of a measurement system for specific applications?	13	CO1	L4
	OR			
11 (b)	Discuss the importance of calibration in measurement systems and its role in ensuring accuracy and reliability in instrumentation. Explain the different levels of standards used in calibration, such as primary and secondary standards, and their significance in maintaining traceability. Elaborate on the calibration process, including the methods and tools used.	13	CO1	L4
12 (a)	Compare the characteristics and applications of RTDs, thermistors, and thermocouples as temperature sensors. Highlight their advantages, limitations, and typical use cases in industrial and biomedical fields.	13	CO2	L2
	OR			
12 (b)	Explain in detail the working principle, characteristics, and applications of Linear Variable Differential Transformers (LVDTs). Discuss the key advantages of LVDTs over other displacement measurement systems, highlighting their non-contact operation, high sensitivity, and temperature stability.	13	CO2	L2
13 (a)	Explain the working principles and applications of photomultiplier tubes (PMTs). Compare their features, advantages, and limitations in light detection applications.	13	CO2	L4
	OR			
13 (b)	Elaborate on the working principle of piezoelectric active transducers and their application in pressure and ultrasound measurements in biomedical fields. Provide examples of how piezoelectric transducers are used in medical devices.	13	CO2	L4
14 (a)	For the Wheatstone bridge circuit shown, solve the following problems: (a) Express Ia,, the reading on the ammeter, as a function of all the circuit elements $R1$, $R2$, $R3$, Rx, Ra and $V0$. (b) If $R1 = 1\Omega$, $R2 = 2\Omega$, and $Rx = 3\Omega$, to what value should $R3$ be adjusted so as to achieve a balanced condition, that is, $Ia = 0$? (c) Further, if $V0 = 6V$, $Ra = 0.1\Omega$, and Rx were then to deviate by a	13	CO2	L4

	small amount to $Rx = 3.01\Omega$, what would be the reading on the ammeter? 			
	OR			
14 (b)	Discuss the concepts of low-pass, high-pass, band-pass, and band-stop filters. Explain their working principles, frequency responses, and applications in signal processing and instrumentation.	13	CO2	L4
15 (a)	Explain the working principle, components, and applications of enzyme sensors. Discuss their role in biosensors for detecting specific biochemical substances, with examples from healthcare and environmental monitoring.	13	CO3	L3
	OR			
15 (b)	Elaborate on the concept and functioning of immunosensors. Discuss how they are used for the detection of biological molecules such as antigens or antibodies.	13	CO3	L3

PART- C(1x 15=15Marks)
(Q.No.16 is compulsory)

Q.No.	Questions	Marks	CO	BL
16.	Discuss the working principle of strain gauges and analyze the various types used in practical applications. Elaborate on the relationship between strain and resistance in a strain gauge, emphasizing the concept of gauge factor. Critically evaluate the factors affecting the accuracy of strain measurements. Explain the integration of a strain gauge in a Wheatstone bridge circuit for precise strain measurement, highlighting its advantages and limitations	15	CO2	L5