E.G.S. PILLAY ENGINEERING COLLEGE

(Autonomous)

Approved by AICTE, New Delhi| Affiliated to Anna University, Chennai Accredited by NAAC with „A++"Grade| Accredited by NBA (CSE, EEE, MECH, ECE, CIVIL, IT)

NAGAPATTINAM–611002

B.E. Biomedical Engineering

Full Time Curriculum and Syllabus

Second Year – Fourth Semester

COURSE CODE	COURSE NAME	CATEGORY	L	T	P	C	MAX. MARKS		
							CA	ES	TOTAL
THEORY COURSES									
2302BM401	Bio Sensors and Measurements	PCC	3	0	0	4	40	60	100
2302BM402	Communication Engineering for Biomedical Engineers	PCC	3	0	0	3	40	60	100
2302BM403	Biomedical Signals & Systems	PCC	3	1	0	4	40	60	100
2302BM404	Diagnostic and Therapeutic Equipment I	PCC	2	0	4	4	40	60	100
2302BM405	Biomedical Instrumentation	PCC	3	0	2	4	40	60	100
2301HSX01	Universal Human values and Ethics	BSC	2	0	0	2	40	60	100
	Mandatory Course -1	MC	3	0	0	0	100	0	100
PRACTICAL COURSES									
2302BM451	Biosensors and Measurements Laboratory	PCC	0	0	3	2	40	60	100
2302BM452	Diagnostic and Therapeutic Equipment Laboratory	PCC	0	0	3	2	40	60	100
2302BM453	Biomedical Instrumentation Laboratory	PCC	0	0	3	2	40	60	100
	Professional Development Course 1	EEC	0	0	2	1	100	--	100
TOTAL						**28**	**430**	**470**	**900**

L–Lecture| T–Tutorial| P–Practical| C–Credit| CA –Continuous Assessment| ES–End Semester

2302BM401	BIOSENSORS AND MEASUREMENTS	L	T	P	C
		3	0	0	3

PREREQUISITE:

1. Nil

COURSE OBJECTIVES:

1. To Understand the Units and Standards of measurements for various physical quantities and how to use the measurement for calibration and error analysis.
2. To analyse the Characteristics of the Transducer using their models and Responses.
3. To make an experiment on various Resistance type transducer using their principle of operation and Applications.
4. To gain knowledge about Bio Sensors and their Applications.
5. To acquire the knowledge of another special Transducer.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO1:	Explain the Science of Measurement and Error Analysis
CO2:	Identify the characteristics of transducers and its Responses
CO3:	Experiment with Variable Resistance Transducers and their Applications.
CO4:	Describe the working function of Different types of Bio Sensors and their applications
CO5:	Explain the working principles of special Transducers.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	2	-	-	-	-	-	-	-	2	2
CO2	3	-	2	-	2	-	-	-	-	-	2	2
CO3	3	2	2	-	2	-	-	-	-	-	2	2
CO4	3	2	2	-	2	-	-	-	-	-	2	2
CO5	3	2	2	-	2	-	-	-	-	-	2	2

COs Vs PSOs MAPPING:

COs	PSO1	PSO2	PSO3
CO1	1	-	-
CO2	1	-	-
CO3	1	-	-
CO4	1	-	-
CO5	1	-	-

COURSE CONTENTS:

MODULE I	SCIENCE OF MEASUREMENT	9 Hours

Measurement system – Instrumentation - Units and Standards - calibration methods, statics calibration. Classification of errors- error analysis, statistical methods - odds and uncertainty.

MODULE II	CHARACTERISTICS OF TRANSDUCERS	9 Hours

Static characteristics - accuracy, precision, sensitivity, linearity. Mathematical model of transducers – zero, first order and second - order transducers - response to impulse step, ramp and sinusoidal inputs.

MODULE III	VARIABLE RESISTANCE TRANSDUCERS	9 Hours

Resistance Potentiometer - Principle of operation, construction details, characteristics and applications - strain gauges- resistance thermometers- thermistors- hot-wire anemometer and humidity sensors.

MODULE IV	**BIOSENSORS - PHYSIOLOGICAL RECEPTORS**	**9 Hours**
Type of Bio Sensor - Chemoreceptors, Baroreceptors, sensors for smell, sound, vision and taste. Biosensors - Working Principle and Applications.		
MODULE V	**SPECIAL TRANSDUCERS**	**9 Hours**
Piezoelectric transducers, magnetostrictive transducers, IC sensor digital transducers - smart sensor - fibre optic transducers-Introduction to MEMS and Nano Sensors.		
		TOTAL: 45 HOURS

REFERENCES:

1. *S.M. Sze, "Semiconductor Sensors," New York, 1994, John Wiley & Sons.*

2. *L. Ristic, "Sensor Technology and Devices," 1994, Artech House, Inc.*

3. *John G. Webster, HalitEren "Measurement, Instrumentation, and Sensors Handbook: Electromagnetic, Optical, Radiation, Chemical, and Biomedical Measurement", 2017*

4. *Jacob Fraden, "Handbook of Modern Sensors: Physics, Designs, and Applications", Fourth Edition, Springer.*

2302BM402	COMMUNICATION ENGINEERING FOR BIOMEDICAL ENGINEERS	L	T	P	C
		3	0	0	3

PREREQUISITE:

1. Semiconductor physics.
2. Basic electrical and electronics.

COURSE OBJECTIVES:

1. Explain the concepts of generation and detection of amplitude modulation schemes.
2. Describe the concepts of generation and detection of angle modulationschemes.
3. Explain the concepts of multiplexing and secured communication schemes.
4. Explain the concepts of generation and detection of amplitude modulation schemes.
5. Illustrate the usage of communication modalities to communicatephysiological Signals.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO1:	1. Describe the mathematical techniques of generation, transmission and reception of amplitude modulation (AM).
CO2:	2. Explain the concepts of frequency modulation and its bandwidth.
CO3:	3. Illustrate the transmission and reception of signals using digital modulation schemes.
CO4:	4. Interpret the technique of information theory and coding techniques.
CO5:	5. Classify the usage of PN Sequence for efficient transmission of signal communication.
	6. Discuss about the multiple access technique used in signal communication.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	1	-	-	-	-	-	1	1
CO2	3	2	1	1	1	-	-	-	-	-	1	1
CO3	3	2	1	1	1	-	-	-	-	-	1	1
CO4	3	2	1	1	1	-	-	-	-	-	1	1
CO5	3	2	1	1	1	-	-	-	-	-	1	1

COs Vs PSOs MAPPING:

COs	PSO1	PSO2	PSO3
CO1	2	2	1
CO2	2	2	1
CO3	2	2	1
CO4	2	2	1
CO5	2	2	1

COURSE CONTENTS:

MODULE I	**AMPLITUDE MODULATION**	**9+3 Hours**

Introduction to communication system-Need for modulation - Amplitude modulation -Signals and Spectral Analysis of AM, DSB-SC, SSB & VSB-signal-to- noise ratio (SNR)-Receivers for continuous wave modulation - Super heterodyne Receivers.

MODULE II	**ANGLE MODULATION**	**9+3 Hours**

Basic concepts of frequency modulation .single tone frequency modulation, spectrum Analysis of sinusoidal FM wave -Narrow band FM -Wide band FM, Constant Average power Transmission band width of FM wave-Noise.		
MODULE III	**DIGITAL MODULATION**	**9+3hours**
Amplitude Shift Keying (ASK) – Frequency Shift Keying (FSK) Minimum Shift Keying (MSK) –Phase Shift Keying (PSK) – BPSK – QPSK - Quadrature Amplitude Modulation (QAM).		
MODULE IV	**INFORMATION THEORY AND CODING**	**9+3Hours**
Measure of information – Entropy – Source coding theorem - Shannon-Fano coding, Huffman Coding, LZ Coding– Channel capacity – Shannon-Hartley law – Shannon's limit-Error control Codes.		
MODULE V	**SPREAD SPECTRUM AND MULTIPLE ACCESS**	**9+3 Hours**
PN sequences – properties – m-sequence –DSSS –Processing gain, Jamming – FHSS – Synchronization and tracking - Multiple Access – FDMA, TDMA, CDMA		
		TOTAL: 45+15=60 HOURS

REFERENCES:

1. Bernard Sklar, "Digital Communication, Fundamental and Application" Pearson Education Asia, 2nd Edition, 2001

2. Wayne Tomasi, "Advanced Electronic Communication Systems", Pearson Education, 6th edition,

3. Simon Haykin, "Communication Systems", John Wiley & Sons, 4th edition, 2004.

4. H.Taub, D L Schilling and G Saha, "Principles of Communication", Pearson Education, 3rd edition, 2007.

5. B. P.Lathi, "Modern Analog and Digital Communication Systems", Oxford University Press, 3rd edition, 2007.

6. R.S.Khandpur, 'Handbook of Bio-Medical instrumentation', Tata McGraw Hill Publishing Co Ltd.,3rd edition, 2014.

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2302BM403	BIOMEDICAL SIGNALS AND SYSTEMS	L	T	P	C
		3	1	0	4

PREREQUISITE:

1. Nil

COURSE OBJECTIVES:

1. To study and analyze the continuous and discrete-time signals and systems, their properties and representations.
2. To have Knowledge of time-domain representation and analysis concepts as they relate to difference equations, impulse response and convolution, etc.
3. To familiarize the concepts of frequency-domain representation and analysis using fourier analysis tools, Z-transform.
4. To understand the concepts of the sampling process and to identify and solve engineering problems
5. To analyze the systems by examining their input and output signals.

COURSE OUTCOMES:

After completion of the course, Student will be able to

CO1:	1. Analyze the properties of signals & systems.
CO2:	2. Apply Laplace transform, Fourier transform in signal analysis.
CO3:	3. Analyze continuous time LTI systems using Fourier and Laplace Transforms.
CO4:	4. Apply Z transform and DTFT in signal analysis for Discrete time signals.
CO5:	5. Analyze discrete time LTI systems using Z transform.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	2	1	1	-	-	-	-	-	-	-	-
CO3	3	2	1	-	1	-	-	-	-	-	-	-
CO4	3	2	1	-	-	-	-	-	-	-	-	-
CO5	2	1	-	-	-	-	-	-	-	-	-	-

COs Vs PSOs MAPPING:

COs	PSO1	PSO2	PSO3
CO1	2	1	-
CO2	2	1	-
CO3	3	1	-
CO4	3	2	-
CO5	3	3	-

COURSE CONTENTS:

MODULE I **CLASSIFICATION OF SIGNALS AND SYSTEMS** **9+3Hours**

Classification of Signals - Continuous time signals - Discrete time signals - Periodic and Aperiodic signals - Even and odd signals - Energy and power signals -Deterministic and random signals - Complex exponential and Sinusoidal signals. Classification of Systems: Continuous time systems - Discrete time systems - Linear system - Time Invariant system – causal system - BIBO system - Systems with and without memory - LTI system Classification of Systems.

MODULE II	**ANALYSIS OF CONTINUOUS TIME SIGNALS**	**9+3 Hours**
Fourier series analysis -Trigonometric Fourier series, Cosine Fourier series, Exponential Fourier series, Fourier Spectrum of continuous time signals, Fourier transform analysis, Laplace transform, Analysis of electrical network using Laplace transform.		
MODULE III	**LTI CT SYSTEM**	**9+3Hours**
Analysis of differential equation -Transfer function-Impulse response - Frequency response - Convolution integral - Fourier Methods - Laplace transforms analysis - Block diagram representation - State variable equation and Matrix.		
MODULE IV	**ANALYSIS OF DISCRETE TIME SIGNALS**	**9+3 Hours**
Spectrum of DT signals - Discrete Time Fourier Transform (DTFT) - Properties of discrete time Fourier transform - Discrete Fourier Transform (DFT) - Properties of DFT - Z-transform in signal analysis - Properties of Z - transform - Inverse Z - transform.		
MODULE V	**LTI DISCRETE TIME SYSTEMS**	**9+3 Hours**
Analysis of differential equation - Transfer function - Impulse response - Convolution sum - Analysis and characterization of DT system using Z transform Difference Equations-Block diagram.		
		TOTAL: 45+5 HOURS

REFERENCES:

1. *Allan V.Oppenheim, S.Wilsky and S.H.Nawab, "Signals and Systems", Pearson, 2007.*
2. *B. P. Lathi, "Principles of Linear Systems and Signals", Second Edition, Oxford, 2009.*
3. *R.E.Zeimer, W.H.Tranter and R.D.Fannin, "Signals & Systems - Continuous and Discrete", Pearson, 2007.*
4. *Hwei. P.Hsu, Schaum's Outlines: Signals and Systems, Pearson Education, 2002.*
5. *Bimal K. Bose, "Modern Power Electronics and AC Drives", 1st Edition, Pearson Education, 2015.*
6. *Anand Kumar A, "Signals and Systems" , PHI learning Pvt. Ltd., Second edition, 2012.*
7. *Simon Haykin and Barry Van Veen, "Signals and Systems" , John Willey & Sons, Inc., Second edition, 2004.*

2302BM404	DIAGNOSTIC AND THERAPEUTIC EQUIPMENT - I	L	T	P	C
		2	0	4	4

PREREQUISITE:

1. Biosciences in Medical Engineering.
2. Human Anatomy and Physiology.

COURSE OBJECTIVES:

1. Understand the medical equipment used in the measurement of parameters related to cardiology.
2. Discuss the equipment used in neurology.
3. Demonstrate EMG recording unit and its uses.
4. Explain diagnostic and therapeutic devices related to respiratory parameters.
5. Understand the various sensory measurements that hold clinical importance.

COURSE OUTCOMES:

After completion of the course, Student will be able to

CO1:	1. Describe the working and recording setup of all essential cardiac equipment.
CO2:	2. Understand the working and recording of all essential neurological equipment.
CO3:	3. Discuss about muscular and biomechanical measurements.
CO4:	4. Explain about respiratory measurement system.
CO5:	5. Describe the measurement techniques of sensory responses.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	-	-	-	-	-	-	-	-	-
CO2	3	2	1	-	-	-	-	-	-	-	-	-
CO3	3	2	1	-	-	-	-	-	-	-	-	-
CO4	3	2	1	-	-	-	-	-	-	-	-	-
CO5	3	2	1	-	-	-	-	-	-	-	-	-

COs Vs PSOs MAPPING:

COs	PSO1	PSO2	PSO3
CO1	-	1	-
CO2	-	1	-
CO3	-	1	-
CO4	-	1	-
CO5	-	1	-

COURSE CONTENTS:

MODULE I **CARDIAC EQUIPMENT** **9 Hours**

Electrocardiograph, Normal and Abnormal Waves, Heart rate monitor, Holter Monitor, Phonocardiography, ECG machine maintenance and troubleshooting, Cardiac Pacemaker Internal and External Pacemaker– Batteries, AC and DC Defibrillator.

MODULE II **NEUROLOGICAL EQUIPMENT** **9 Hours**

Clinical significance of EEG, Multi-channel EEG recording system, Epilepsy, Evoked Potential– Visual, Auditory and Somatosensory, MEG (Magneto Encephalo Graph). EEG Bio Feedback Instrumentation. EEG system maintenance and troubleshooting.

MODULE III	**MUSCULAR AND BIOMECHANICAL MEASUREMENTS**	**9 Hours**
Recording and analysis of EMG waveforms, fatigue characteristics, Muscle stimulators, nerve stimulators, Nerve conduction velocity measurement, EMG Bio Feedback Instrumentation. Static Measurement – Load Cell, Pedobarograph.		
MODULE IV	**RESPIRATORY MEASUREMENT SYSTEM**	**9 Hours**
Instrumentation for measuring the mechanics of breathing – Spirometer -Lung Volume and vital capacity, measurements of residual volume, Pneumotachometer – Airway resistance measurement, Apnoea Monitor. Types of Ventilators – Pressure, Volume, and Time controlled. Flow, Patient Cycle Ventilators, Humidifiers, Nebulizers, Inhalators.		
MODULE V	**SENSORY MEASUREMENT**	**9+3 Hours**
Psychophysiological Measurements – polygraph, basal skin resistance (BSR), galvanic skin resistance (GSR), Sensory responses - Audiometer-Pure tone, Speech, Eye Tonometer, Applanation Tonometer, slit lamp, auto refract meter.		
		TOTAL: 45+3 HOURS

REFERENCES:

1. *Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi, 2003.*
2. *Leslie Cromwell, "Biomedical Instrumentation and Measurement", Prentice Hall of India, New Delhi, 2007.*
3. *John G. Webster, "Medical Instrumentation Application and Design", John Willey and Sons, 2006.*
4. *Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson Education, 2004.*
5. *Richard Aston "Principles of Biomedical Instrumentation and Measurement", Merril Publishing Company, 1990.*
6. *L.A Geddas and L.E.Baker "Principles of Applied Biomedical Instrumentation" 2004.*
7. *John G. Webster, "Bioinstrumentation", John Willey and sons, New York, 2004.*

2302BM405	BIOMEDICAL INSTRUMENTATION	L	T	P	C
		2	0	4	4

PREREQUISITE:

1. Human Anatomy and Physiology.

COURSE OBJECTIVES:

1. To illustrate origin of bio potentials and its propagations to understand the different types of electrodes and its placement for various recordings.
2. To design bio amplifier for various physiological recordings and analyze different measurement techniques for non-physiological parameters.
3. To Summarize different biochemical measurements.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO1:	1. Categorize different bio potential electrodes based on its origin, propagations and characteristics.
CO2:	2. Apply different bio-potential measurements techniques and analyze the characteristics of bio signals.
CO3:	3. Apply various Biosignal conditioning techniques as a pre-processing method in Bio signal processing.
CO4:	4. Apply various techniques for non-electrical physiological measurements.
CO5:	5. Analyze the performance of biochemical sensors and biochemical measurement techniques.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	3	-	1	1	-	-	-	-	-	-
CO2	2	2	3	-	2	1	-	-	-	-	-	-
CO3	3	2	2	-	3	1	-	-	-	-	-	-
CO4	4	2	2	-	2	1	-	-	-	-	-	-
CO5	5	2	3	-	2	1	-	-	-	-	-	-

COs Vs PSOs MAPPING:

COs	PSO1	PSO2	PSO3
CO1	1	-	-
CO2	1	-	-
CO3	1	-	2
CO4	1	-	2
CO5	1	-	2

COURSE CONTENTS:

MODULE I **BIOPOTENTIAL ELECTRODES** **9 Hours**

Origin of bio potential and its propagation, Electrode-electrolyte interface, electrode-skin interface, half- cell potential, Contact impedance, polarization effects of electrode-non polarizable electrodes. Types of electrodes surface, needle, and microelectrodes and their equivalent circuits. Recording problems- motion artifacts, measurement with two electrodes.

MODULE II **BIOPOTENTIAL MEASUREMENTS** **9 Hours**

Bio signals characteristics-frequency and amplitude ranges. ECG-Einthoven's triangle, standard 12 lead system, Principles of vector cardiography. EEG-10-20 electrode system, unipolar, bipolar and average mode. EMG-unipolar and bipolar mode. Recording of ERG, EOG and ECG.		
MODULE III	**BIOSIGNAL CONDITIONING**	**9 Hours**
Need for bio-amplifier-single ended bio-amplifier, differential bio-amplifier, impedance matching circuit, isolation amplifiers- transformer and optical isolation- isolated DC amplifier and AC carrier amplifier, power line interference, Right leg driven ECG amplifier, Band pass filtering.		
MODULE IV	**MEASUREMENT OF NON- ELECTRICAL PARAMETERS**	**9 Hours**
Temperature, respiratory rate and pulse rate measurements. Blood Pressure: indirect methods- Auscultatory method, oscillometric method, directs methods: electric manometer, pressure amplifiers, systolic, diastolic, mean detector circuit. Blood flow and cardiac output measurement: Indicator dilution, thermal dilution and dye dilution method, Electromagnetic and ultrasound blood flow measurement.		
MODULE V	**BIOCHEMICAL MEASUREMENT AND BIOSENSORS**	**9 Hours**
Biochemical sensors- pH, pO2 and pCO2, Ion selective Field Effect Transistor (ISFET), Immunologically sensitive FET(IMFET), Blood glucose sensors, Blood gas analyzers- colorimeter, Sodium Potassium Analyser, spectrophotometer, blood cell counter, auto analyzer (simplified schematic description)-Biosensors-Principles-amperometric and voltometric techniques, Electrophoretic techniques.		
		TOTAL: 45 HOURS
REFERENCES:		

1. Joseph J. Carr and John M. Brown, ―Introduction to Biomedical Equipment Technology‖, Pearson education, 2012.

2. Leslie Cromwell, "Biomedical Instrumentation and Measurement", Prentice Hall of India, New Delhi, 2007

3. L.A Geddes and L.E.Baker, "Principles of Applied Biomedical Instrumentation", John Wiley and Sons, 3rd Edition, Reprint 2008.

4. Myer Kutz, "Standard Handbook of Biomedical Engineering & Design", McGraw-Hill Publisher, 2003.

2301HSX01	UNIVERSAL HUMAN VALUES AND ETHICS	L	T	P	C
		1	0	2	2

PREREQUISITE:

	1. Professional Ethics.

COURSE OBJECTIVES:

	1. Reinstate India's rich cultural legacy and human values of which we are the custodians.
	2. Focus on professional ethics, which help citizens to discern desirable and undesirable actions.
	3. Re-emphasize constitutional values, universal values, and holistic education to create integrated citizens.
	4. Lay down broader guidelines of human values and ethics for internal and external stakeholders.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO1:	1. Create such an environment, it is essential to ensure the inclusion of the learning process for holistic development..
CO2:	2. Create such an environment, it is essential to ensure the inclusion of impeccable governance.
CO3:	3. Create such an environment, it is essential to ensure the inclusion of effective institutional management.
CO4:	4. Create such an environment, it is essential to ensure the inclusion of well-laid system of rewards and reprimand.
CO5:	5. Create such an environment, it is essential to ensure the inclusion of institutional climate where "rights" are encouraged and "wrongs" are discouraged.
CO6:	6. Create such an environment, it is essential to ensure the inclusion of inward-looking groups and communities that have the potential to develop the capacity of individuals, source their potential and universal values, and ensure that their actions enable justice and equity to all.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	-	-	1	1	3	1	-	-	1
CO2	2	1	2	-	-	1	2	2	1	-	-	1
CO3	2	1	2	-	-	1	1	2	1	-	-	1
CO4	2	1	2	-	-	1	1	2	1	-	-	1
CO5	2	1	2	-	-	1	2	3	1	-	-	1
CO6	2	1	2			1	2	2	2	-	-	1

COs Vs PSOs MAPPING:

COs	PSO1	PSO2	PSO3
CO1	-	-	-
CO2	-	-	-
CO3	-	-	-
CO4	-	-	-
CO5	-	-	-

COURSE CONTENTS:

MODULE I	Introduction to Indian Ethos	8 Hours

Meaning of ethos and cultural essence of India – Scriptures as the base of the Indian Knowledge System (IKS) – Integrating the two methodologies: interiorization process for self-exploration, and exterior scientific pursuit for the prosperity of world – The Law of Karma and Nishkama Karma (The Law of action and selfless action).

Practical: Five hours of Yoga practice per week, Ethics through Music and Indian Poetry, Community Engagement.

MODULE II	**Human Values and Ethics**	**9 Hours**

the Self and the universal values that we stand for - This is self-enquiry & self-discovery – Background conversations and deep listening - recognizing the assumptions that we make - the biases we have - and the implications for ethical action – Self-identity: distinguishing and embracing oneself (and others) four profiles (inner-potential, social, professional, personality) – Distinguish ideology, perspectives beliefs from embodying values.

Practical: Self-discovery, self-enquiry and Mindfulness, Yama & Niyama of Ashthang Yoga.

MODULE III	**Constitutional Values and Global Citizenship**	**9 Hours**

Values embedded in the Preamble of the Indian Constitution Integration of Human Rights and duties – Directive principles and responsibilities as citizens of India – Sensibility and responsibilities towards global environment, Loksangraha and Vasudhaiva Kutumbakam.

Practical: Debates and Theatre on diversity and plurality, research on similarities and differences in the ethos of different countries.

MODULE IV	**Values and Skills for Youth**	**9 Hours**

Designing to make a difference through strategies using the Conscious Full Spectrum Response model – Listening for commitment behind complaints to transform contentious arguments and create a space for listening and change – Distinguishing judgement from discernment – Being assertive and confident (assertiveness incorporates self-confidence).

Practical: Development of concentration among students through music, fine arts, mathematics, sports, yoga and mindfulness.

MODULE V	**Integrated Personality and Well-being**	**10 Hours**

The three gunas (qualities of sattva—purity and harmony, rajas —activity and passion, tamas —darkness and chaos), the four antah-karanas (inner instruments), and panchkosha (five sheaths) – Stress management: meditated personality and agitated personality – Oneness, non-duality, and equanimity – Physical, mental, social, and spiritual well-being.

Practical : Talks on importance of the Ayurvedic concept of well being and nutrition,sports activities

TOTAL: 45 HOURS

REFERENCES:

1. 1. Blanchard, Kenneth and Peale, Norman Vincent. 1988. *The Power of Ethical Management*. New York: William Morrow and Company, Inc.

2. Gandhi, Mohandas Karamchand. 1971. *Pathway to God* compiled by MS Deshpande. Ahmedabad: Navajivan Mudranalaya, Navjivan Trust.

3. https://fdp-si.aicte-india.org/UHV-II%20Class%20Note.php.

2302BM451	BIOSENSORS AND MEASUREMENTS LABORATORY	L	T	P	C
		0	0	3	2

PREREQUISITE:

1. Biosensors and transducer lab.
2. Biomedical instrumentation lab.

COURSE OBJECTIVES:

1. To study the characteristics and working principles of temperature transducers like thermistors, thermocouples, and RTDs.
2. To analyze the performance of displacement sensors such as LVDT and capacitive transducers.
3. To understand the working principles and applications of strain gauges for stress and strain measurement.
4. To demonstrate the operation and functionality of measuring instruments like CRO and DSO.
5. To evaluate the characteristics of pressure sensors for industrial and environmental applications.
6. To develop practical skills in handling and analyzing various transducers used in measurement systems.

COURSE OUTCOMES:

After completion of the course, Student will be able to

CO1:	1. Analyze the characteristics of temperature transducers like thermistors, thermocouples, and RTDs.
CO2:	2. Evaluate the performance of displacement and pressure sensors like LVDT and capacitive transducers.
CO3:	3. Understand the working and applications of strain gauges for stress measurement.
CO4:	4. Operate and interpret signals using CRO and DSO.
CO5:	5. Examine the characteristics of capacitive and resistive sensors for measurement applications.
CO6:	6. Develop practical skills in handling and analyzing various transducers.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	-	-	2	-	-	-	-	3
CO2	3	3	-	3	-	-	-	-	-	-	-	-
CO3	3	3	3	3	-	-	-	-	-	-	-	-
CO4	3	3	-	3	-	-	2	-	-	-	-	3
CO5	3	3	3	3	-	-	2	-	-	-	-	-
CO6	3	3	3	3	-	-	2	-	-	-	-	3

COs Vs PSOs MAPPING:

COs	PSO1	PSO2	PSO3
CO1	-	3	-
CO2	3	3	-
CO3	3	3	-

CO4	3	3	-
CO5	3	3	-
CO6	-	-	3

LIST OF EXPERIMENTS:

1. Characteristic analysis of thermistor in temperature transducers.
2. Characteristic analysis of thermocouple in temperature transducers.
3. Characteristics analysis of LVDT (Linear variable differential transformer)
4. Characteristic analysis of strain gauge.
5. Demonstration of CRO & DSO.
6. Characteristic analysis of Capacitive transducer (Linear and angular).
7. Characteristic analysis of Pressure sensor.
8. Characteristics analysis of RTD (Resistance temperature detector).

TOTAL: 30 HOURS

REFERENCES:

1. *Principles of applied Biomedical Instrumentation by La Geddes and L.E. Baker.*
2. *Biomedical Instrumentation and Measurement by Leslie Cromwell, Fred. J. Weibell and Pfeiffer.*
3. *Principles of Biomedical Instrumentation and Measurement, Richard Aston, Merril Publishing Co., Columbus, 1990.*

2302BM452	DIAGNOSTIC AND THERAPEUTIC EQUIPMENT LABORATORY	L	T	P	C
		0	0	4	2

PREREQUISITE:

1.NIL

COURSE OBJECTIVES:

1. To demonstrate recording and analysis of different Bio potentials.
2. To analysis of different Bio potentials.
3. To examine different therapeutic modalities.
4. To understand the continuous Signals.
5. To Measure various physiological signals

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO1:	Measure different bioelectrical signals using various methods.
CO2:	Assess different non-electrical parameters using various methodologies.
CO3:	Illustrate various diagnostic and therapeutic techniques.
CO4:	Examine the electrical safety measurements.
CO5:	Analyze the different bio signals using suitable tools.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	2	1	1	1	-	1
CO2	3	3	-	3	-	-	2	1	1	1	-	1
CO3	3	3	-	3	-	-	2	1	1	1	-	1
CO4	3	3	-	3	-	-	2	1	1	1	-	1
CO5	3	3	-	3	-	-	2	1	1	1	-	1
CO6	3	3	-	3	3	-	2	1	1	1	-	1

COs Vs PSOs MAPPING:

COs	PSO1	PSO2	PSO3
CO1	-	3	-
CO2	3	3	-
CO3	3	3	-
CO4	3	3	-
CO5	3	3	-
CO6	-	-	3

LIST OF EXPERIMENTS:

1. Measurement of visually evoked potential.
2. Galvanic skin resistance (GSR) measurement.
3. Study of shortwave and ultrasonic diathermy.
4. Measurement of various physiological signals using biotelemetry.
5. Study of hemodialysis model.
6. Electrical safety measurements.
7. Measurement of Respiratory parameters using spirometry.

8. Study of medical stimulator.
TOTAL: 30 HOURS
REFERENCES:
1. John G. Webster, ―Medical Instrumentation Application and Design‖, 4th edition, Wiley India PvtLtd,New Delhi, 2015
2. Joseph J. Carr and John M. Brown, ―Introduction to Biomedical Equipment Technology‖, Pearson education, 2012.
3. Leslie Cromwell, ―Biomedical Instrumentation and measurement‖, 2nd edition, Prentice hall of India, New Delhi, 2015.

2302BM453	BIOMEDICAL INSTRUMENTATION LABORATORY	L	T	P	C
		0	0	4	2

PREREQUISITE:

1.NIL

COURSE OBJECTIVES:

1. To provide hands on training on Measurement of physiological parameters.
2. To study about blood flow and blood measurement.
3. To understand about Baby Ventilator.

COURSE OUTCOMES:

On the successful completion of the course, students will be able to

CO1:	1. Design the amplifier for Bio signal measurements.
CO2:	2. Measure heart rate and heart sounds.
CO3:	3. Record and analyze pulse rate and respiration rate.
CO4:	4. Measure blood pressure and blood flow.
CO5:	5. Analyse the functions of various components of the Baby Ventilator.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	1	1	-	-	-	-	-	1	1
CO2	3	2	1	1	1	-	-	-	-	-	1	1
CO3	3	2	1	1	1	-	-	-	-	-	1	1
CO4	3	2	1	1	1	-	-	-	-	-	1	1
CO5	3	2	1	1	1	-	-	-	-	-	1	1

COs Vs PSOs MAPPING:

COs	PSO1	PSO2	PSO3
CO1	-	3	-
CO2	3	3	-
CO3	3	3	-
CO4	3	3	-
CO5	3	3	-

LIST OF EXPERIMENTS:

1. ECG signal analysis using simulation.
2. Simulation and analysis of EMG.
3. Simulation and analysis of EEG.
4. Measurement of respiration rate.
5. Measurement of blood flow velocity using ultrasound transducer.
6. Measurement of blood pressure using sphygmomanometer.
7. Study the characteristics of Baby Ventilator.
8. Measurement of Hydrogen Ion using pH Meter.

TOTAL: 30 HOURS

REFERENCES:
1. Medical Instrumentation – Application and Design" by John G Webster.
2. "Transducers for Biomedical Measurements: Principles and Applications" by Richard S C Cobbold.
3.Measurement Systems, Application and Design" by Ernest O Doeblin
4. https://bmi-iitr.vlabs.ac.in/List%20of%20experiments.html.