SARVAJANIK UNIVERSITY
Sarvajanik College of Engineering and Technology

Bachelor of Technology (B. Tech.)

Instrumentation and Control

B. Tech.Year- III Semester – VI

Subject Name:Biomedical Instrumentation **Subject Code: BTIC14604**

Type of course: Professional Elective Course

Prerequisite (if any): Knowledge of sensor/ transducers, basic electronics, signal processing

List of Courses where this course will be prerequisite : Not applicable

Rationale:

The field of biomedical engineering is fast developing and biomedical instruments are getting introduced with new features in short span. So with the widespread use and requirement of biomedical instruments, it is essential to have fundamental knowledge of various medical instruments. This course describes the principle of operation, basic building blocks and working of the medical instruments used for physiological measurement.

Teaching and Examination Scheme:

TEACHING SCHEME				Theory Marks			Practical Marks		Total
L	T	P	C	TEE	CA1	CA2	TEP	CA3	
3	0	2	4	60	25	15	30	20	150

CA1: Continuous Assessment (assignments/projects/open book tests/closed book tests CA2: Sincerity in attending classes/class tests/ timely submissions of assignments/self-learning attitude/solving advanced problems TEE: Term End Examination TEP: Term End Practical Exam (Performance and viva on practical skills learned in course) CA3: Regular submission of Lab work/Quality of work submitted/Active participation in lab sessions/viva on practical skills learned in course

BSC: basic science course /ESC: Engineering Science Course /HSM: Humanities and management /PCC: Professional Core course /PEC: professional Elective course /OEC: Open Elective course/ MD: mandatory non-credit course

Content:

S. N.	Content	Total Hrs	Module Weightage
1	**The Human Body: An Overview** Introduction, The cell, Body fluids, Musculoskeletal system, Respiratory system, Gastrointestinal system, Nervous system, Endocrine system, The circulatory system, The body as a control system	4	10 %
2	**Basic Concept of Medical Instrumentation** Terminology of Medicine and Medical Devices, Generalized medical instrumentation systems, Alternative operational modes, Medical measurement constraints, Classification of Biomedical instruments, Interfering and modifying inputs, Compensation techniques, Bio statistics, Design criteria, Commercial medical instrumentation development process, Regulation of Medical devices	6	13 %
3	**Measurement errors, Signals and Noise** Categories of measurement, factors in making measurement, measurement errors, categories of error, dealing with measurement errors, error contribution analysis, operational definitions in measurement, Types of signal, Fourier series, Waveform symmetry, Transient signals, Sampled signals, Noise, Signal – to – Noise ratio, Noise factor, Noise figure, Noise temperature, Noise in cascade amplifier, Noise reduction strategies	6	13 %
4	**Basic Sensors and Principles** Resistive sensors, Inductive sensors, Capacitive sensors, Piezoelectric sensors, Thermocoples, Thermistors, Radiation thermometry, Fiber optic temperature sensors, Optical measurement, Radiation sources, Geometrical and fiber optics,	6	13%

	Radiation sensors		
5	**Biopotential Electrodes** The electrode-electrolyte interface, Polarization, Polarizable and Nonpolarizable electrodes, electrode behaviour and circuit model, The electrode-skin interface and motion artifact. Body surface recording electrodes, Internal electrodes, Electrode arrays, Microelectrode. Electrode for electric stimulation of tissue	**6**	**13%**
5	**Bioelectric Amplifier** Bioelectric amplifiers, Operational amplifiers, Basic amplifier configurations, Multiple input circuits, Differential amplifier, Signal processing circuits, practical consideration for operational amplifiers, practical consideration for bioelectric amplifiers, isolation amplifiers, chopper stabilized amplifiers, Input guarding	**6**	**13 %**
6	**Blood Pressure, Sound and Flow measurement** Physiological pressures, defining pressure, blood pressure measurement, Oscillometric and Ultrasonic Noninvasive pressure measurement, Direct method: H_2O measurement, Pressure transducers, Pressure amplifiers, Calibration methods, Cardiac output measurement, Dilution methods, Right-side heart pressure, Plethysmography, Blood flow measurement, Phonocardiograpy, Vectorcardiography, Catheterization laboratories, Defibrilators, Pacemakers, Hear-Lung machine	**6**	**13 %**
7	**Introduction to Medical Imaging System** Radiography, Magnetic resonance imaging, Nuclear medicine, Positron emission tomography, Ultrasonography	**5**	**12 %**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20 %	**40 %**	**10 %**	**10 %**	**10 %**	**10 %**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

Sr no	Title of book /article	Author(s)	Publisher and details like ISBN	Year of publication	Publication Edition
1	Introduction to Biomedical Equipment Technology	Joseph J. Carr and John M. Brown	Pearson Publication ISBN:9788177588835	2013	12th
2	Medical Instrumentation-Application and Design	John. G. Webster	John Wiley & Sons ISBN:9780471676003	2010	4th
3	Handbook of Biomedical Instrumentation	R. S. Khandpur	McGraw Hill Education (India) ISBN:9789339205430	2014	3rd
4	Biomedical Instrumentation and Measurements	Leslie Cromwell, Fred J. Weibell, and Erich A. Pfeiffer	Prentice-Hall of India ISBN:9788120306530	1990	2nd

Course Outcomes:

After learning the course the students should be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	characterize anatomy and physiology of important physiological system of human body.	15
CO-2	evaluate various types of sensor, transducer, electrodes used for physiological measurement.	20
CO-3	evaluate signal processing component used in medical instruments.	20
CO-4	know the principle of operation and working of various medical instruments.	30
CO-5	analyze medical parameter measurement constraint.	15

Mapping with POs:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO-1	3	1			1	1		1	1	1	1	1	1	2
CO-2	2	3	3	2	1	1				1	1	3	3	1
CO-3	2	3	3	2							1	3	3	1
CO-4	2	2	2	2	1	1	1	1	1	1	1	3	2	2
CO-5	2	3	3	2	1	1		1	1		1	1	1	3

List of Open learning website:

http://nptel.ac.in/video.php?subjectId=108105064
http://coep.vlab.co.in/?sub=25&brch=78 – online biomedical and signal processing laboratory
http://www.physionet.org/physiobank/database/mitdb/ - for patient ECG data

List of Open Source Software:

TINA and other circuit simulation software

FOR LAB SESSIONS:

List of Experiments:

1. Study of typical medical and physiological parameters along with their measurement range, frequency and standard sensor or method.
2. Study of Physiological system of human body.
3. Implementation of various Bio-electric amplifiers.
4. Implementation of Filter for noise removal in medical parameter measurements using software or hardware.
5. Implementation of Multiplexer, ADC & DAC.
6. Implementation of semiconductor based sensor IC - Temperature sensor IC- TMP 102, LM 35
7. Implementation of semiconductor based sensor IC - Pressure Sensor IC- Smartec SPD015G
8 Implementation of semiconductor based sensor IC -Light sensor OPT 101
9. Study of physiological measurement system - Electrodes, patient cable and monitors
10. Measurement of Blood pressure using i) sphygmomanometer ii) Pressure gauge
11. Measurement of blood oxygen saturation (SpO_2) using pulse oximeter
12. Visit report of I.C.U of hospital / micro biology laboratories
13. Course Project - A product report of any bio-medical instrument/ device/ system.

Major Equipment Needed:
Computers, DSO, Bio-ICs, Signal processing ICs, Blood pressure measurement system, etc.