

GUJARAT TECHNOLOGICAL UNIVERSITY
Instrumentation and Control Engineering
B. E. SEMESTER: VII

Subject Name: **Instrumentation for Bio Medical Applications**
Subject Code: **171705**

| Teaching Scheme | | | | Evaluation Scheme | | | |
|-----------------|----------|-----------|-------|---------------------|-----------|---------------------------|----------------------|
| Theory | Tutorial | Practical | Total | University Exam (E) | | Mid Sem Exam (Theory) (M) | Practical (Internal) |
| | | | | Theory | Practical | | |
| 4 | 0 | 2 | 6 | 70 | 30 | 30 | 20 |

| Sr. No | Course Content | Total Hrs. |
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| 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 | 3 |
| 2. | The Heart and Circulatory System The circulatory system, the heart, bioelectricity, electro-conduction system of the heart, heart problems | 3 |
| 3. | Introduction to biomedical instrumentation and measurement Introduction, significant figures, scientific notation, units and physical constants, average, decibel notation, basic measurement theory | 3 |
| 4. | Basic Theories of Measurement Introduction, Categories of measurement, factors in making measurement, measurement errors, categories of error, dealing with measurement errors, error contribution analysis, operational definitions in measurement | 3 |
| 5. | Signals and Noise 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 | 3 |
| 6. | Electrodes, Sensors, and Transducers Signal acquisition, Transduction, Active versus Passive sensors, Sensor | 3 |

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| | error sources, Sensor terminology, Tactics and signal processing for improved sensing, Electrodes for biophysical sensing, Medical surface electrodes, Microelectrodes, strain gauges, inductive transducers, Quartz pressure sensors, Capacitive transducers, Temperature transducers, Matching sensors to circuit | |
| 7. | 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 | 3 |
| 8. | Electrocardiographs The heart as a potential source, The ECG waveform, The standard lead system, Other ECG signals, The ECG preamplifier, ECG readout devices, ECG machine, ECG machine maintenance, ECG faults and troubleshooting | 3 |
| 9. | Physiological Pressure and Other Cardiovascular Measurement and Devices Physiological pressures, defining pressure, pressure measurement, blood pressure measurement, Oscillometric and Ultrasonic Noninvasive pressure measurement, Direct method: H ₂ O measurement, Pressure transducers, Pressure amplifiers, Calibration methods, Pressure amplifier design, AC carrier amplifiers, Systolic – diastolic and mean detector circuit, Pressure differentiation circuits, Automatic zero circuits, Practical problems in pressure monitoring, Step – function frequency response test, transducer care, cardiac output measurement, Dilution methods, Right-side heart pressure, Plethysmography, Blood flow measurement, Phonocardiography, Vectorcardiography, Catheterization laboratories, Defibrillators, Defibrillator circuits, Cardioversion, Testing defibrillators, Pacemakers, Hear-Lung machine | 4 |
| 10. | The Human Respiratory System and Its Measurement The human respiratory system, Gas laws, Internal (Cellular) respiration, External (Lung) respiration, Organs of respiration, Mechanics of breathing, Parameters of respiration, Regulation of respiration, Unbalanced and diseased states, Environmental threats to the respiratory system, Major measurements of the pulmonary function, Respiratory system measurement, Respiratory transducers and instruments, Spirometer, Pulmonary measurement systems and instruments | 4 |
| 11. | Respiratory Therapy Equipments Disease stage requiring artificial respiratory therapy, overview and terms of ventilation, Medical gasses and safety systems, Oxygen therapy, | 3 |

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| | Intermittent positive pressure breathing therapy, Artificial mechanical ventilation, Accessory device used in respiratory therapy apparatus, Sterilization and isolation procedures in respiratory therapy units, typical fault and maintenance procedure for ventilation | |
| 12. | The Human Nervous System Organization of the nervous system, The neuron, Structure and function of the central nervous system, Peripheral nervous system, Automatic nervous system, Behavior and the nervous system | 3 |
| 13. | Instrumentation for Measuring Brain Function Instrumentation for measuring anatomical and physiological parameters of the brain, Cerebral angiography, Cranial X-ray, Brain scans, Ultrasonic equipments, Electroencephalograph, EEG electrodes and the 10-20 system, EEG amplitude and frequency bands, EEG diagnostic uses and sleep patterns, Multichannel EEG recording systems and typical external control, The EEG system – simplified block diagram, Preamplifier and EEG system specifications, Visual and auditory evoked potential recording, EEG telemetry system, Typical EEG system artifacts – faults – troubleshooting and maintenance | 2 |
| 14. | Intensive and Coronary Care Units Special care units, ICU/CCU equipment, Bedside monitors, Bedside monitor circuits, Central monitoring consoles, ECG/Physiological telemetry | 3 |
| 15. | Operating rooms Surgery, Types of surgery, OR personnel, Sterilization, OR equipments | 1 |
| 16. | Medical Laboratory Instrumentation Blood (purpose and components), Blood test (cells and chemistry), Medical laboratory department, Overview of clinical instrumentation, Colorimeter, Flame photometer, Spectrophotometer, Blood cell counter, pH/Blood gas analyzer, Chromatograph, Autoanalyzer, Basic renal physiology, Renal failure, Peritoneal dialysis, Hemodialysis, The hemodialysis machine, High – flux and high efficiency dialysis, Electrical safety precautions, Typical faults – troubleshooting and maintenance | 3 |
| 17. | Medical Ultrasonography Introduction, Physics of sound and ultrasound waves, Ultrasound transducers, Absorption and attenuation of ultrasound energy, Scan modes and scanning systems, Biological effects of ultrasound, Doppler effect, Transcutaneous Doppler flow detectors, Flow meters, Ultrasonic blood pressure measurement, Echoencephalography | 3 |

Reference Books:

1. Introduction to Biomedical Equipment Technology by Joseph J. Carr and John M. Brown, Pearson Publication
2. Handbook of Biomedical Instrumentation by R. S. Khandpur, Tata – McGraw Hill Publication
3. Introduction to Medical Electronics Applications by D. Jennings, A Flint, BCH Turton, LDM Nokes; Edward Arnold Group Publication