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| <b>Course V</b>                | Elective - PHYE222  |
| <b>Title of the Course:</b>    | <b>Biomedical Instrumentation</b>   |
| <b>Credits:</b>                | <b>2-1-0-3</b>  |
| <b>Pre-requisites, if any:</b> | M. Sc., Physics, Theoretical Physics, Biophysics, Material Science, Nanoscience and Life Sciences   |
| <b>Course Objectives</b>       | <ol style="list-style-type: none"> <li>1. To introduce basic concepts of biosignals and their characteristics.</li> <li>2. To understand the instrumentation details of the simple measuring biomedical instruments.</li> <li>3. To describe the fundamentals of medical imaging systems.</li> <li>4. To explain the principle of operation of therapeutic and prosthetic devices</li> <li>5. To create broad awareness of safety measures to be practiced while using the biomedical instruments.</li> </ol>   |
| <b>Course Outcomes</b>         | <p><b>After the successful completion of this course, the students will be able to</b></p> <ol style="list-style-type: none"> <li>1. To identify the characteristics of the biosignals and their importance in diagnosis</li> <li>2. To outline the simple measurement and monitoring techniques to analyze biosignals for obtaining specific diagnostic information.</li> <li>3. To select appropriate imaging techniques for acquiring physiological parameters.</li> <li>4. To differentiate the suitability of a specific device for simple therapeutic and prosthetic applications.</li> <li>5. To conceive an idea about the safety measures of biomedical instruments for their better utility.</li> </ol> |
| <b>Units</b>                   |   |
| <b>I</b>                       | <b>Biosignal:</b> Physiological system - Bioelectric potentials - Electrodes - Transducers - System approach to biological systems - Physiological signal amplifiers Medical preamplifier design - Analysis of periodic and aperiodic signals – Analysis of random signals.   |
| <b>II</b>                      | <b>Measurements and Monitoring Systems:</b> ECG, EMG, EEG recording units - Measurement of Blood Pressure & Blood flow – Plethysmography - Measurement of Heart Sounds - Patient Monitoring Instrumentation - Respiratory system measurements - Measurement from Nervous System - Psychophysiological measurements – Testing motor responses – Experimental analysis of behavior – Biofeedback Instrumentation - Test on Blood Cells – Chemical tests and Automation  |
| <b>III</b>                     | <b>Medical Imaging System:</b> Information content of an image - radiography - computed radiography - computed tomography - magnetic resonance imaging - nuclear medicine - single-photon emission computed tomography positron emission tomography - ultrasonography.  |
| <b>IV</b>                      | <b>Therapeutic and Prosthetic Devices:</b> cardiac pacemaker - defibrillators - hemodialysis - lithotripsy - ventilator incubators drug delivery device - artificial heart valve - heart-lung machine - application of laser.   |
| <b>V</b>                       | <b>Electrical Safety:</b> Physiological effect of electricity - important susceptibility parameters - distribution of electric power - macro shock hazards micro shock  |

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|   | hazards - electrical safety code and standards - basic approaches to protection against shock - equipment design - electrical safety analyzer- testing.  |
| <b>Reading List (Print and Online)</b>  | <ol style="list-style-type: none"> <li>1. John G. Webster, "Medical Instrumentation – Application and Design", John Wiley &amp; Sons, Inc, Third Edition, 1999</li> <li>2. Richard Aston, "Principles of Biomedical Instrumentation and Measurements", Merrill Publishing Company, London, 1990.</li> <li>3. Tatsuo Togawa, Toshiyo Tamura and P. Ake Oberg, " Biomedical Transducers and Instruments", CRC Press, 1997</li> <li>4. J. J. Carr and J. M. Brown, "Introduction to Biomedical Equipment Technology", John Wiley &amp; Sons, Inc., 1981.</li> <li>5. D. Jennings, A. Flint, B. C. H. Turton, and L. D. M. Nokes, "Introduction to Medical Electronics Applications", Edward Arnold, Hodder Headline PLC, London, 1995.</li> <li>6. Joseph D. Bronzino, The Biomedical Engineering Handbook, Second Edition, Boca Raton: CRC Press LLC, 2000.</li> </ol> |
| <b>Recommended Texts</b>  | <ol style="list-style-type: none"> <li>1. L. Cromwell, F. J. Weibell and E. A. Pfeiffer, "Biomedical Instrumentation and Measurements", Prentice-Hall of India, 1995.</li> <li>2. R. S. Khanpur, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi, 1990.</li> </ol>   |
| <b>Online resources</b>   | <ol style="list-style-type: none"> <li>1. <a href="http://www.aami-bit.org/">http://www.aami-bit.org/</a></li> <li>2. <a href="http://bio-medical.com/">http://bio-medical.com/</a></li> <li>3. <a href="http://www.biomedcentral.com/browse/journals/">http://www.biomedcentral.com/browse/journals/</a></li> <li>4. <a href="http://www.ncbi.nlm.nih.gov/pmc/articles/">http://www.ncbi.nlm.nih.gov/pmc/articles/</a></li> </ol>   |
| <b>Related Online Contents [MOOC, SWAYAM, NPTEL, Websites, etc.]</b>  |  |
| <a href="https://nptel.ac.in/courses/103/108/103108100/">https://nptel.ac.in/courses/103/108/103108100/</a>   |  |
| <a href="https://nptel.ac.in/courses/108/105/108105064/">https://nptel.ac.in/courses/108/105/108105064/</a>   |  |
| <a href="https://nptel.ac.in/courses/103/105/103105130/">https://nptel.ac.in/courses/103/105/103105130/</a>   |  |
| <a href="https://nptel.ac.in/courses/108/105/108105101/">https://nptel.ac.in/courses/108/105/108105101/</a>   |  |
| <a href="https://www.edx.org/course/fundamentals-of-biomedical-imaging-ultrasounds-x-r?index=product&amp;queryID=3343e1c9475d84541b9fd1c8a0734232&amp;position=2">https://www.edx.org/course/fundamentals-of-biomedical-imaging-ultrasounds-x-r?index=product&amp;queryID=3343e1c9475d84541b9fd1c8a0734232&amp;position=2</a> |  |
| <a href="https://nptel.ac.in/courses/108/105/108105091/">https://nptel.ac.in/courses/108/105/108105091/</a>   |  |

**Method of Evaluation:**

| Sessional I | Sessional II | End Semester Examination | Total | Grade |
|-------------|--------------|--------------------------|-------|-------|
| 20          | 20           | 60                       | 100   |       |

**Methods of assessment:**

**Recall (K1) - Simple definitions, MCQ, Recall steps, Concept definitions**

**Understand/ Comprehend (K2) - MCQ, True/False, Short essays, Concept explanations, Short summary or overview**

**Application (K3) - Suggest idea/concept with examples, Suggest formulae, Solve problems, Observe, Explain**

**Analyze (K4) - Problem-solving questions, Finish a procedure in many steps, Differentiate between various ideas, Map knowledge**

**Evaluate (K5) - Longer essay/ Evaluation essay, Critique or justify with pros and cons**

**Create (K6) - Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations**

**Mapping with Programme Outcomes:**

|             | <b>PO 1</b> | <b>PO 2</b> | <b>PO 3</b> | <b>PO 4</b> | <b>PO 5</b> | <b>PO 6</b> | <b>PO 7</b> | <b>PO 8</b> | <b>PO 9</b> | <b>PO 10</b> |
|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|--------------|
| <b>CO 1</b> | S           | M           | M           | M           | L           | M           | M           | L           | L           | L            |
| <b>CO 2</b> | S           | S           | S           | M           | M           | M           | M           | M           | M           | L            |
| <b>CO 3</b> | S           | S           | S           | M           | M           | M           | M           | M           | M           | L            |
| <b>CO 4</b> | S           | S           | S           | M           | M           | M           | M           | M           | M           | L            |
| <b>CO 5</b> | S           | M           | M           | M           | L           | M           | M           | M           | L           | L            |