

BIOMEDICAL ENGINEERING TECHNOLOGY (BE_T)

BE_T 101: Introduction to Medical Equipment Maintenance

1 Credits

Introduction to the field of clinical engineering and the management of medical equipment and systems. BE_T 101 Introduction to Medical Equipment Maintenance (1) BE_T 101 is an introductory course in medical equipment management. It is an entry level course intended to give students the big picture of the field of biomedical and clinical engineering. The course covers the background and history of the field, exploring how medical equipment technology has changed as well as the management of the service of the equipment. The focus of this class will be from the perspective of the biomedical equipment technician, what skills are necessary, education requirements, training opportunities, certification, job duties and descriptions, and career paths. The types of employers, their organization structures, required regulations, recommended standards and information about the work place will be presented. Business ethics of working with medical equipment, patients, clinical care givers and other health care providers will be discussed. Topics covered include: * Background and history of medical equipment management * Changes in medical equipment technology * Certification for biomedical equipment technicians * BET job duties, descriptions and requirements * BET continuing education needs * Ethical decisions in medical equipment management * Functions & Organization of clinical engineering departments * Employer types * Department organization charts * Reporting structures * Services provided by clinical engineering departments * Regulatory and standards requirements * Documentation systems

BE_T 197: Special Topics

1-9 Credits/Maximum of 9

Formal courses given infrequently to explore, in depth, a comparatively narrow subject which may be topical or of special interest.

BE_T 201: Medical Equipment & Systems I

5 Credits

Introduction to the field of biomedical engineering technology, electrical wiring devices, theories of measurement, cardiovascular systems and ECG monitor operation. BE_T 201 Medical Equipment & Systems I (5) This course introduces the student to electrical safety standards and related wiring devices, methods and systems. Grounding and leakage current is studied so the student understands the causes of leakage current, safety limits, measurement and safe control of medical devices. Electrical wiring devices, over current protective devices, power quality devices and simplified hospital electrical distribution systems are discussed in relation to the electrical power delivery and quality required for medical devices. The electro-physiological theories of measurement, sensors, electrodes and measurement errors are discussed to provide an understanding of how signals are detected on the human body. A variety of transducers will be studied that are used with medical devices, such as: pressure, temperature, audio, relays, solenoids, lighting, video displays, motors, printers and batteries. The blood, heart, and cardiovascular system is studied in detail, as well as the electro-physiological signals of the heart. The normal and many abnormal electrocardiograph signals are studied pursuant to a

thorough understanding of the function and operation of the heart. The electrocardiograph (ECG) machine is studied from an electrical/electronic design perspective so the student has an understanding of the electronic circuits required to measure and display the human ECG signal. The controls, operation, electrical safety testing, performance testing and general design of an ECG monitor is studied so the student has a full understanding of its operation, usage and preventative maintenance testing. Topics covered include: - electrical safety - grounding, leakage current and protective systems - electrical wiring devices, over current protective devices, and isolated power - power quality, disturbances and corrective methods - simplified hospital electrical distribution system - theory of measurement: terms, factors, and errors - electrodes, sensors, and transducers devices and circuits - cardiovascular anatomy and physiology - bio-potentials: electro-conduction system of the heart - common ECG waveforms: normal and abnormal - ECG monitor application and connections to patient

Enforced Prerequisite at Enrollment: EET 105

BE_T 203: Biomedical Equipment Laboratory (Internship)

4 Credits

Practical experience, within or related to the hospital environment, on a variety of biomedical instruments. BE_T 203 Biomedical Equipment Laboratory (4) The final semester internship is a curriculum requirement for the Biomedical Engineering Technology (BET) Program. It allows eligible students to develop entry level skills in the biomedical field while gaining valuable work experience before graduation. The program consists of 400 hours of hands-on experience in an actual work environment on patient care and life support equipment. The student is expected to understand and perform basic fundamentals of the operation, minor corrective repairs and perform basic preventative maintenance and electrical safety tests to a wide variety of medical devices. During the internship, the student will be expected to participate in a wide variety of clinical procedures to learn the environment, application, problems, and the routine and abnormal situations that may occur in regards to the medical devices. Students will also be exposed to the organization and management of a clinical engineering department by attending various committees, investigating education and training for biomedical equipment technicians, investigating the risk based preventative maintenance system, investigating the clinical engineering department performance indicators, and investigating the required policy and procedures of a clinical engineering department. Students will be expected to use good communication and customer skills when working with co-workers, clinical personnel, patients, visitors and all others while conducting the internship. Students will be expected to document their activities as required by the course requirements as well as the requirements of the internship location. Students will be assigned an internship supervisor that they will take direction from on a daily basis. The student will be expected to work and follow the requirements of the internship site and follow all required policies and procedures. A biomedical engineering technology student manual will be provided to the student detailing all of the requirements for the internship. This must be the last course taken for the degree.

Enforced Prerequisite at Enrollment: (BIOL 163 and BIOL 164 or BISC 4) BE_T 204W and BE_T 206

BE_T 204W: Medical Equipment and Systems II

5 Credits

Principles of medical equipment: operation, application; circuit and block diagrams; preventive maintenance inspections; and troubleshooting with report writing and presentations. BE T 204W Medical Equipment and Systems II (5) This course introduces various types of medical instrumentation in preparation for the biomedical internship (BET 203). Equipment operation and application, circuit and block diagrams, preventive maintenance, inspections, performance testing, and troubleshooting are explained or reviewed. In addition, the student is required to demonstrate communication skills for the biomedical field in the form of technical reports, equipment reviews, and in-service presentations. In studying the various medical devices, the human cardiopulmonary system, basic anatomy and physiology structures will be reviewed as they apply to that medical device or measurement. Topics covered include: - electrical safety -ECG monitoring -blood pressure monitoring (invasive/non-invasive) -cardiac output measurement - defibrillators -pacemakers -pulse oximeter -surgical equipment & systems -sterilization systems & process -surgical fiber-optic scopes -anesthesia gas machines -electrosurgical units -infusion devices - dialysis equipment -ventilators & respiratory therapy equipment - clinical laboratory equipment -general medical devices -FDA (510K) & SMDA requirements -regulation & standard organization review - imaging systems overview & X-ray equipment & system review - report writing -technical presentations. Lectures will be supported through laboratory exercises regarding medical devices (physiological ECG monitors, electrocardiographs, blood pressure monitors, noninvasive external pacemakers, defibrillators, pulse oximeters, infusion pumps, and electrosurgical units) and perform operational and preventative maintenance testing on those devices. Written laboratory reports outlining the laboratory activity are required. Reports are graded based upon technical quality, grammar and professionalism. Computers are used to simulate electrical circuits and systems and also produce high quality weekly medical device reports and laboratory reports.

Enforced Prerequisite at Enrollment: BE_T 201 and BE_T 205
Writing Across the Curriculum

BE_T 205: Medical Electronics

4 Credits

Solid state devices, diodes, power supplies, operational amplifiers, transistors, timing circuits, high power devices, circuits as applied to medical devices. BE T 205 Medical Electronics (4) BET 205 introduces solid state devices and circuits as they apply to medical devices. This course begins with the fundamentals of solid state devices, diode models and applications, then application of these fundamentals in linear power supply design. Students design a theoretical linear power supply as a term project, applying the fundamentals of diodes, transformers, filters and regulators. Operational amplifiers, transistor devices and circuits is presented along with the applications of amplifiers, switches, filters and other related circuits. Special solid state and high power devices will be discussed and their applications to medical device circuits. This course provides students with a broad exposure to a wide variety of solid state devices and their application to medical devices. Topics covered include: -Fundamentals of solid state principles -P-N junction, forward and reverse biasing -diode models: ideal, practical and complete -specialty diodes: zener and LED -diode specifications and testing - transformers: step up, step down & isolation -rectifier circuits: half and full wave -linear power supply: rectification, filters & regulation designs -

Switching Mode Power Supply (SMPS) fundamentals -linear power supply design project -operational amplifiers: amplifiers, comparators, filters and others -transistors: BJT, JFET, MOSFET -special power devices: photo detectors, optoisolators, TRIAC, DIAC and others -timing circuits -tuned amplifiers & band width Topics are supported by laboratory exercises where students learn about solid state devices and power supplies. Students are required to complete a theoretical design of a linear power supply with given specifications. Students are also required to prepare written laboratory reports outlining the laboratory activity and power supply design project. Reports are graded on technical quality, grammar, and professionalism. Students in BET 205 are required to use computers in to simulate electrical circuits and systems and also produce high quality laboratory reports.

Enforced Prerequisite at Enrollment: EET 105

BE_T 206: Medical Computers and Networks

4 Credits

Introduction to computer hardware, software and networks for medical equipment; PC and medical equipment hardware; networking fundamentals. BE T 206 Medical Computers and Networks (4) This course provides an introduction to computer hardware, software and networks used by medical equipment with an in-depth background of PC and medical equipment hardware and networking fundamentals. The topics covered include: Microsoft Office review and advanced applications; personal computer (PC) hardware fundamentals; formatting and sectoring hard drives; installing various Windows operating systems and other required software/drivers; networking hardware component fundamentals; administrator networking software settings and configurations; fundamentals of health level 7 (HL7) standards; fundamentals of digital imaging and communication in medicine (DICOM) standards; operation of DICOM viewer software for medical images; fundamentals of picture archive and communications systems (PACS) configurations for medical applications; fundamentals of The Health Insurance Portability and Accountability Act of 1996 (HIPAA) Privacy and Security Rules in regards to medical equipment maintenance; creation of a simple PC network with several PCs and basic networking hardware components; creation of a simple physiological computer based network with several physiological devices and basic networking components; creation and testing of network cables using applicable tools and test equipment; troubleshoot and correct technical problems of a basic PC and medical equipment networks using appropriate software, tools and equipment; and analyzing and generating a written reports. Lectures will be supported by laboratory exercises in which the student learns about PC hardware, PC software, network hardware, network configuration and troubleshooting these systems. Students will be required to prepare written laboratory reports outlining the laboratory activity. Reports will be graded based both on their technical quality and their grammatical and professionalism. Students in BET 206 will be required to use computers in both class and laboratory exercises to use software, create and configure networks for PCs and physiological monitors.

Enforced Prerequisite at Enrollment: BE_T 201 Enforced Concurrent at Enrollment: IST 220

BE_T 210: Troubleshooting Medical Equipment

3 Credits

Methods and strategies for troubleshooting medical equipment, systems and electronics components. BE T 210 Troubleshooting Medical Equipment (3) BE T 210 will provide students with methods and

strategies for servicing medical equipment, systems and electronics components. Many different methods can be used to identify and solve problems that include using many different skill sets. This course introduced logical methods for troubleshooting medical devices including: equipment operation, application, normal and abnormal outcomes, tools, test equipment, simulators and analyzers. In addition to the technical skills of troubleshooting, the "soft" skills or "people" skills are investigated. How to communicate with others and the customer skills will be introduced. While working with medical equipment, individuals need to have an awareness of infection control and the steps that must be followed to protect them, the patients and co-workers. Cleaning, handling and general safety methods will be discussed. Topics covered include:- Safety procedures• Skill set requirements -Test equipment, simulators, analyzers and tools -Troubleshooting methods - Troubleshooting components -Troubleshooting systems -Troubleshooting medical equipment -Hands on troubleshooting skills -Customer skills - Infection Control

Enforced Prerequisite at Enrollment: BE_T 201

BE_T 296: Independent Studies

1-18 Credits/Maximum of 18

Creative projects, including research and design, that are supervised on an individual basis and that fall outside the scope of formal courses.

BE_T 297: Special Topics

1-9 Credits/Maximum of 9

Formal courses given infrequently to explore, in depth, a comparatively narrow subject which may be topical or of special interest.