Course Number and Title: ELC 260 Biomedical Instrumentation

Campus Location:
Dover

Effective Date:
2018-51

Prerequisite:
ELC 127 and ELC 226 or concurrent

Co-Requisites:
none

Course Credits and Hours:
4.00 credits
3.00 lecture hours/week
3.00 lab hours/week

Course Description:
This course introduces and applies the operation and maintenance of biomedical equipment through classroom and laboratory environment. Students learn to evaluate, test, troubleshoot, and repair various types of equipment commonly used in the medical field.

Required Text(s):
Obtain current textbook information by viewing the campus bookstore - https://www.dtcc.edu/bookstores online or visit a campus bookstore. Check your course schedule for the course number and section.

Additional Materials:
None

Schedule Type:
Classroom Course

Disclaimer:
None

Core Course Performance Objectives (CCPOs):

1. Explain the principles and practices related to medical electronics safety. (CCC 2, 3, 6; PGC 1, 2)
2. Describe the types of electrodes and transducers used to evaluate various physiological systems, and list the major body systems. (CCC 1, 2, 6; PGC 1, 2)
3. Describe the types and functions of bioelectric amplifiers. (CCC 1, 2, 6; PGC 2, 3, 4)
4. Explain the computing and network infrastructure used to support medical operations and biomedical instruments. (CCC 5, 6; PGC 1, 2, 4, 5)
5. Differentiate among various test equipment, tools, and troubleshooting techniques used in a medical environment. (CCC 1, 6; PGC 1, 4)
6. Describe and list the electrical and communication equipment used to support medical operations. (CCC 2, 6; PGC 1, 2, 3, 4, 5)
7. Describe, troubleshoot, and repair the instrumentation used to support a medical laboratory. (CCC 1, 2, 6; PGC 2, 3, 4, 5)
8. Describe and list instrumentation used to support the major medical specialties of cardiology, medical imaging, and respiratory treatment. (CCC 1, 2, 6; PGC 1,2,4,7)
9. Evaluate medical equipment to determine whether or not equipment is operating within service manual specifications. (CCC 1, 2, 6; PGC 2, 3, 4, 5)

See Core Curriculum Competencies and Program Graduate Competencies at the end of the syllabus. CCPOs are linked to every competency they develop.

Measurable Performance Objectives (MPOs):
Upon completion of this course, the student will:

1. Explain the principles and practices related to medical electronics safety.
    1. Discuss electrical safety.
    2. List the names of major organizations that publish electrical safety codes and standards.
    3. List responsibilities of hospital staff regarding safety.
    4. Relate how preventive maintenance reduces electrical hazards.
    5. Explain the physiological effects of poor safety measures on the human body.
    6. Define *leakage current*.
    7. Explain the usefulness of alternating current (AC) line isolation systems.
    8. List the dangers associated with poor grounding.

9. Describe required grounding of electronics equipment.
10. Explain how hazards through ground faults can be reduced.
11. Describe the following safety code standards:
    1. National Fire Protection Association (NFPA) 99
    2. NFPA 70
    3. NFPA 102
    4. Code of Federal Regulations (CFR) 21
12. Describe microshock (also called cardiac shock).
13. Describe macroshock.
14. State the ground resistance limit for existing portable medical equipment in patient care areas.
15. State the ground resistance limit for new portable medical equipment in patient care.
16. State the chassis leakage current limit for portable medical equipment in patient care areas.
17. State the lead leakage current limit for portable medical equipment in patient care areas.
18. Describe the current radiation safety rules required in medical equipment use and maintenance.
19. Describe the current rules for safety in the maintenance and use of medical laser equipment.
20. Describe fire safety rules commonly required for medical equipment maintenance personnel.
21. Describe chemical rules commonly required for medical equipment maintenance personnel.

2. Describe the types of electrodes and transducers used to evaluate various physiological systems, and list the major body systems.
    1. Define *electrode*.
    2. Define *biopotentials*.
    3. Explain how impedance mismatches between electrodes and skin surfaces can affect accuracy in measurements.
    4. Give an approximate impedance of wet human skin.
    5. Give an approximate impedance of dry skin.
    6. Define *half-cell potential*.
    7. Name different types of electrodes and the body organs to which they are applied.
    8. Describe the shapes of electrodes as they relate to their applications.
    9. Describe the chemical/paste applied between electrode and skin.
    10. Define the types of artifacts and their causes.
    11. List some measures which can be adopted to minimize or avoid artifacts.
    12. Describe a transducer.
    13. Sketch the configuration of a Wheatstone bridge.
    14. Explain how a Wheatstone bridge can be compared in configuration with most biomedical transducers.
    15. Describe the types of transducers used in biomedical instrumentation.
    16. Sketch the electrical configuration of different transducers.
    17. Name the units of transducer sensitivity.
    18. Explain terms associated with transducers such as piezoresistance, thermocouple, and impedance.
3. Describe the types and functions of bioelectric amplifiers.
    1. List the basic properties of the operational amplifier (op amp).
    2. Sketch the circuit diagram of an op amp.
    3. Calculate voltage gain, input and output impedance, and other characteristics of op amps.
    4. Discuss terms used in bioelectric amps (e.g., inverter, offset null, zero suppression, summing junction, common mode rejection, and virtual ground).
    5. Describe the functions of the bioelectric amplifier.
    6. State the requirements for bioelectric amplifiers.
    7. Describe the basic principles of operation of a bioelectric amplifier.
    8. Describe the different configurations used in the design of bioelectric amplifiers.
    9. State the principles of operation of isolation amplifiers.
4. Explain the computing and network infrastructure used to support medical operations and biomedical instruments.
    1. Describe the interrelationship between computers and communications technology.
    2. Describe worldwide numbering systems.
    3. Discuss how network control points are used to support medical operations.
    4. Discuss how databases are used to support medical operations.
    5. Explain computer telephone integration (CTI).
    6. Describe the problems that are commonly encountered when interconnecting electronics products.
    7. Explain electrical surge potentials.
    8. List ways to combat damage from electrical surges.
    9. State the expected voltage, current, or signals expected at interconnection or equipment interface points.
    10. Describe the Personal Communication Industry Association (PCIA) and wireless computer communications interfacing procedures used with medical equipment.
    11. Describe the Internet and its usefulness in medical data communications.
    12. Explain transmission control protocol/Internet protocol (TCP/IP) duties and protocols.
    13. Explain security problems with Internet service.
5. Differentiate among various test equipment, tools, and troubleshooting techniques used in a medical environment.
    1. Demonstrate proper use of common biomedical and electronic test equipment.
    2. Describe the use of time domain reflectometers (TDRs) and optical time domain reflectometers (OTDRs).
    3. List services which provide test equipment calibration for commonly used biomedical instruments.
    4. List the main differences between a medical, and a laboratory or service oscilloscope.

5. List the characteristics of a medical oscilloscope (sweep speed, display format, and persistence).
6. Demonstrate proper usage of test equipment as well as common digital voltmeter (DVM), signal tracers and sources, oscilloscopes, and loop and network testing equipment.
7. Describe the divide and conquer troubleshooting technique.
8. List types of electro-magnetic interference (EMI) that may affect the validity of test equipment results.
9. Diagnosis and repair defective electronic medical equipment.
10. Identify and list types of noise that effect medical equipment.

6. Describe and list the electrical and communication equipment used to support medical operations.
    1. Describe the uses and installation requirements for unshielded twisted pair (UTP).
    2. Recognize RJ45/48 connectors and fittings.
    3. Explain the difference between single twisted pair and category 5 (CAT 5) cabling.
    4. Describe the uses, frequency characteristics, and installation requirements for Ethernet 10Base-T.
    5. Describe the T568A and T568B wiring standards for RJ-45 jacks, and explain their purpose.
    6. Explain how cable TV coaxial cable wiring is used for data and voice services.
    7. Explain the differences among coax types RG 58, RG 59, and RG 6.
    8. List the standards used in the electrical wiring of buildings.
    9. Explain methods of pre-wiring and ways to wire existing buildings, including entry, attic, and crawl space precautions as well as methods of fishing walls and routing wiring through false ceilings.
    10. Explain National Electrical Code (NEC®) or other safety rules pertaining to building wiring and grounding.
    11. Describe the types of optical cable, and explain the different parameters associated with optical cables and reasons for choosing each.
    12. Describe the conversion process from copper to fiber signals and from fiber to copper.
    13. Discuss synchronous optical networking (SONET).
7. Describe, troubleshoot, and repair the instrumentation used to support a medical laboratory.
    1. State the main functions and composition of blood.
    2. List the instruments used in the medical laboratory, including calorimeters, photometers, spectrophotometers, pH analyzers, autoanalyzers, chromatographs, and dialyzers.
    3. State the maintenance procedures for blood gas analyzers, co- oximeters, centrifuges, microscopes, cell counters, and chemistry analyzers.
8. Describe and list instrumentation used to support the major medical specialties of cardiology, medical imaging, and respiratory treatment.
    1. List three types of cardiac arrhythmias.
    2. Describe the events taking place in each part of the electrocardiogram (ECG) waveform.
    3. Describe the principles of defibrillation.
    4. Describe the principles and operation of the pacemaker.
    5. Describe the principles and operation of a defibrillator.
    6. Discuss the minimum energy required from an implantable pacemaker.
    7. Discuss the minimum energy required from an external pacemaker.
    8. Describe the general steps for proper testing of a defibrillator.
    9. Explain the terms used in the study of radiology.
    10. Name the units used for measuring radioactivity, including Curie, Roentgen, and dose rate.
    11. List the main functions of an X-ray machine.
    12. Describe the therapeutic applications of X-ray machines.
    13. State the diagnostic (measurement) function of an X-ray machine.
    14. State the different categories of X-ray machines such as still picture, continuous, and motion picture.
    15. List the dangers associated with X-rays.
    16. Explain the purpose of ultrasound in medical applications.
    17. Define the terms associated with ultrasound.
    18. Explain the biological effects of ultrasound.
    19. Describe the operation of the instruments used in delivering ultrasound such as the Doppler flow meter, blood pressure monitor, fetal monitor, echocardiography, and echoencephalography.
    20. Describe the operation of ultrasound instruments.
    21. List safety precautions regarding the maintenance and use of ultrasound instruments.
    22. List the principle pulmonary capacity parameters measured, and describe the various respiratory transducers.
    23. List the instruments used with the respiratory system.
    24. Describe the function of the instruments used in the respiratory system.
    25. Describe the various volumes measured, including tidal, inspiratory reserve, expiratory, reserve, and residual minute.
    26. Describe the operation of adult and pediatric ventilators.
9. Evaluate medical equipment to determine if equipment is operating within service manual specifications.
    1. Evaluate medical equipment using general test equipment to determine if the equipment is operating within normal parameters.
    2. Evaluate medical equipment using specialized test equipment to determine if the equipment is operating within normal parameters.

Evaluation Criteria/Policies:
Students must demonstrate proficiency on all CCPOs at a minimal 75 percent level to successfully complete the course. The grade will be determined using the Delaware Tech grading system:

92	–	100	=	A
83	–	91	=	B
75	–	82	=	C
0	–	74	=	F

Students should refer to the Student Handbook - https://www.dtcc.edu/handbook for information on the Academic Standing Policy, the Academic Integrity Policy, Student Rights and Responsibilities, and other policies relevant to their academic progress.

Core Curriculum Competencies (CCCs are the competencies every graduate will develop):

1. Apply clear and effective communication skills.
2. Use critical thinking to solve problems.
3. Collaborate to achieve a common goal.
4. Demonstrate professional and ethical conduct.
5. Use information literacy for effective vocational and/or academic research.
6. Apply quantitative reasoning and/or scientific inquiry to solve practical problems.

Program Graduate Competencies (PGCs are the competencies every graduate will develop specific to his or her major):

1. Perform the duties of an entry-level technician using the skills, modern tools, theory, and techniques of the electronics engineering technology.
2. Apply a knowledge of mathematics, science, engineering, and technology to electronics engineering technology problems that require limited application of principles but extensive practical knowledge.
3. Conduct, analyze, and interpret experiments using analysis tools and troubleshooting methods.
4. Apply critical thinking skills necessary to analyze, install and maintain biomedical electronic systems and equipment
5. Troubleshoot and repair malfunctioning electronic circuits, systems and networks found in a healthcare environment or associated industries
6. Explain the importance of engaging in self-directed continuing professional development.
7. Demonstrate basic management, organizational, and leadership skills which commit to quality, timeliness and continuous improvement.

Disabilities Support Statement:
The College is committed to providing reasonable accommodations for students with disabilities. Students are encouraged to schedule an appointment with the campus Disabilities Support Counselor to request an accommodation needed due to a disability. A listing of campus Disabilities Support Counselors and contact information can be found at the disabilities services - https://www.dtcc.edu/disabilitysupport web page or visit the campus Advising Center.