Core Competencies for The Biomedical Equipment Technician (BMET)

A Guide for Curriculum Development in Academic Institutions

About AAMI

AAMI, the Association for the Advancement of Medical Instrumentation, is a diverse community of more than 7,000 healthcare technology professionals united by one important mission—supporting the healthcare community in the development, management, and use of safe and effective medical technology. Founded in 1967, AAMI fulfills its mission through education, certification, publications, and standards development.

- Membership: www.aami.org/membership
- Career Center: www.aami.org/career
- Student Website: www.aami.org/student
- Promotion of the Field: www.lamHTM.com

AAMI’s Vision for the Healthcare Technology Management Professional
Biomedical Equipment Technician/Technologist
(AAMI’s 2011 Future Forum)

HTM professionals will be fully integrated members of the healthcare delivery team and will have significant influence in the management of all healthcare technology. In addition, the career path will be better defined, with a supportive educational infrastructure.


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Core Competencies for The Biomedical Equipment Technician (BMET)

A Guide for Curriculum Development in Academic Institutions

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Introduction
Introduction

Preface

The intent of Core Competencies for the Biomedical Equipment Technician (BMET): A Guide for Curriculum Development in Academic Institutions is to provide academic institutions/schools\(^2\) that offer Biomedical Equipment Technician (BMET) programs with the following:

1. a standard set of competencies that graduates of Biomedical Equipment Technician (BMET) programs (certificate, diploma, or degree) are expected to possess upon program completion; and

2. recommended topics that a program curriculum should include in order for BMET students to learn and possess the core competencies identified in this Guide.

The competencies and topics in this Guide are relevant to BMETs entering the workforce, and the topics reflect the knowledge and skills that BMETs are expected to perform successfully in entry level positions regardless of the employment organizations, e.g., hospitals, clinics, independent service organizations, military, and manufacturers. This Guide may also assist schools in preparing their graduates for professional certification, e.g., AAMI/International Certification Commission’s (ICC) certification exams.\(^3\)

Competencies and topics were developed and agreed upon by an AAMI committee of experts from academia, hospitals, independent service organizations, device manufacturers, employer institutions, the U.S. Department of Defense, and the U.S. Veterans Administration. This Guide will also serve these and other organizations by assessing the preparedness of entry level BMET professionals to perform the responsibilities expected of them in a complex medical technology environment.

It is important to note that biomedical equipment technology is continuously changing, and the body of knowledge that BMETs acquire starts in the academic setting and continues throughout a BMET professional’s career. The core competencies described in this Guide were developed and written to illustrate the skills and knowledge that BMETs will apply in the healthcare field for many years to come. However, it is essential for all academic institutions to stress the importance of continuing and lifelong learning to their BMET students.

\(^2\) To find a list of BMET academic institutions/schools, go to www.aami.org/student/education.html.

\(^3\) Certified Biomedical Equipment Technician (CBET); Certified Laboratory Equipment Specialist (CLES); Certified Radiology Equipment Specialist (CRES). A “Handbook for Applicants” is available from AAMI at www.aami.org/certification/.
This Guide does not describe a required curriculum by an accrediting organization, agency, or institution. It also does not describe a recommended teaching method. Specific courses, curricula, educational material, for example, that already or will incorporate and adopt the recommended topics in this Guide are left up to the school. In fact, some material at one school may be integrated into a comprehensive course, while it may be taught in separate courses at another school. For example, math, physics, and chemistry could be taught as separate subjects or taught in a combined course. In addition, this report does not recommend or describe testing or assessment methods. That, too, is left up to the school.

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4 Accrediting agencies are private educational associations and conduct peer evaluation of educational institutions and programs. Accrediting agencies can, in turn, be accredited by the U.S. Department of Education (USDE), the Council for Higher Education Accreditation (CHEA), or both.
Introduction

Development Progression of Core Competencies for the Biomedical Equipment Technician (BMET): A Guide for Curriculum Development in Academic Institutions

In 2007, the Medical Engineers & Technicians Association (META) Education Committee recommended a comprehensive list of outcomes for BMET education programs (see Figure 1).

In 2009, AAMI created the Educators Roundtable at the request of academicians and healthcare organizations concerned about the state and future of BMET education.

In 2010, the AAMI Educators Roundtable agreed that a set of core competencies and recommended curricular topics should be created so that BMET schools and/or programs had guidance for preparing their graduates to enter the workforce. A Core Curriculum Committee (CCC) was formed to oversee the development of expected BMET core competencies and recommended topics. It was intended that BMET schools that adopt or incorporate the CCC’s recommended topics into their curricula could be assured their graduates would have an appropriate education to fulfill the responsibilities required of most entry-level BMET positions. Likewise, employers who are recruiting for entry-level BMET positions could be assured that graduates of such schools have an appropriate educational preparation.

From 2010–2012, the CCC and a Development Committee, led by an independent expert project manager, completed the first draft of core competencies and topics based on a comprehensive analysis of program descriptions, syllabi, curricula, course descriptions, job descriptions, and the AAMI/ICC certification program outline.5

In 2011, AAMI held its first Future Forum meeting and recommended “Healthcare Technology Management” as the official name of the field responsible for managing the selection, maintenance, and safe and effective use of medical equipment and systems.6

In 2012, a Role Delineation Task Force was created and the Professional Testing Company, Inc. (PTI), an independent provider of assessment, evaluation, and certification services, conducted a role delineation study.

In 2013, the results of the role delineation study validated the findings and analyses of the project manager, the CCC, and the Development Committee.

In 2013, the first edition, Core Competencies for the Biomedical Equipment Technician (BMET): A Guide for Curriculum Development in Academic Institutions, was published.

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5 See “Accreditation/Certification” tab in this guide for the 2012 AAMI/ICC exam outline.

**META Outcomes**

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
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<tbody>
<tr>
<td>1.</td>
<td>Demonstrate knowledge and skills in the function of the electrical and computer components of medical equipment. Demonstrate knowledge of biological signals.</td>
</tr>
<tr>
<td>2.</td>
<td>Demonstrate knowledge of hospital organization and structure and the role of a BMET in a healthcare organization.</td>
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<tr>
<td>3.</td>
<td>Demonstrate a working medical vocabulary and ability to communicate as part of the healthcare team. Demonstrate knowledge of basic human anatomy and physiology.</td>
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<td>4.</td>
<td>Demonstrate knowledge of clinical safety requirements, regulations, and standards as related to medical equipment technology and patient privacy. Identify the organizations responsible for these codes and standards.</td>
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<tr>
<td>5.</td>
<td>Demonstrate competence in the clinical environment through internship or practical experience including performing preventive maintenance and repairs.</td>
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<tr>
<td>6.</td>
<td>Identify key components of effective clinical customer service.</td>
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<tr>
<td>7.</td>
<td>Use mathematics, science and emerging BMET tools to solve problems and demonstrate solutions.</td>
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<tr>
<td>8.</td>
<td>Function as a member of a team to complete a task in a timely manner. Demonstrate ability to organize work done by team members.</td>
</tr>
<tr>
<td>9.</td>
<td>Identify, analyze and integrate the technical equipment requirements with the needs of medical staff and patients.</td>
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<tr>
<td>10.</td>
<td>Demonstrate professional oral and written business communication skills appropriate in a clinical environment.</td>
</tr>
<tr>
<td>11.</td>
<td>Demonstrate skills for life-long learning by locating, evaluating, and applying relevant information using external resources such as the Internet, data books, trade publications, and library resources.</td>
</tr>
<tr>
<td>12.</td>
<td>Demonstrate knowledge of professional ethical behavior and the requirements of the clinical setting.</td>
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<tr>
<td>13.</td>
<td>Demonstrate a respect for diversity. Recognize contemporary professional, societal, and global issues.</td>
</tr>
<tr>
<td>14.</td>
<td>Demonstrate quality, timeliness, and ability to complete increasingly complex assignments.</td>
</tr>
</tbody>
</table>

**Figure 1. Medical Engineers & Technicians Association’s (META) recommendations for Outcomes for BMET Programs**

(Reprinted with permission from META)

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7 META www.mymeta.org.
The Profession
The Profession

BMETs and the Healthcare Technology Management Profession

Healthcare technology management (HTM) is the official name of the professional field responsible for managing the selection, maintenance, and safe and effective use of medical equipment and systems. The field includes biomedical equipment technicians, clinical engineers, imaging equipment specialists, laboratory equipment specialists, and others who protect patient safety and reduce healthcare costs related to technology.

BMET Definition

A Biomedical Equipment Technician, also referred to as a Biomedical Engineering Technician/Technologist (BMET) or Biomedical Equipment/Engineering Specialist (BES or BMES), is typically an electro-mechanical technician who ensures that medical equipment is well-maintained, properly configured, and safely functional. In hospital or clinical environments BMETs often work with Clinical Engineers, although as in most technical fields there is a professional and legal distinction between engineers and engineering technicians.

BMET Career Ladder

At the time of the release of the first edition of this Guide, AAMI is in the process of developing a practical career roadmap for healthcare technology management (HTM) professionals that will serve as a resource for HTM professionals to use from the beginning of their careers to the end to sharpen their skills, plan for the future, and achieve leadership positions. Moreover, the roadmap would establish a clear definition of what an HTM leader is, giving professionals a tangible professional goal on which to focus. The project will also include a plan to help healthcare organizations identify and cultivate future HTM leaders.

Professional Certifications

Many BMETs pursue professional certification, such as satisfying certain education requirements and passing an examination from the International Certification Commission (ICC) and the AAMI to become a certified biomedical equipment technician (CBET). There are three other certifications BMETs can obtain: AAMI/ICC Certified Radiology Equipment Specialist (CRES) that specializes more specifically in diagnostic imaging, radiological, and nuclear medicine equipment;

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9 A Clinical Engineer is a professional who supports and advances patient care by applying engineering and managerial skills to healthcare technology, American College of Clinical Engineering, (ACCE) 1992. See www.accenet.org/downloads/reference/Whats_a_Clinical_Engineer.pdf for additional information.
THE PROFESSION

BMETs and the Healthcare Technology Management Profession

AAMI/ICC Certified Laboratory Equipment Specialist (CLES) that covers the abundance of equipment found in the many different kinds of laboratory environments; and the Biomedical Electronics Technician certification (BMD) from the Electronics Technician Association (ETA) after first obtaining the Associate Electronics Technician certification (CET). In most cases, carrying the title of “CBET” is highly encouraged but not mandatory and is respected within the technical community.

See “AAMI/ICC Certification” for more information.
The Profession

BMET Employment

Employment Market
According to the U.S. Department of Labor, the job growth outlook for BMETs for the current decade is 31%, making it one of the fastest growing jobs in the country.10

Places of Employment
BMETs work in a hospital’s Biomedical or Clinical Engineering or HTM Department but can also find employment with a third-party independent service organization (ISO), an original equipment manufacturer (OEM), durable medical equipment provider, or many other healthcare organizations. BMETs working for an OEM or ISO are often called Field Service Engineers (FSE).

General Responsibilities
BMETs install, inspect, maintain, repair, calibrate, modify, and design biomedical equipment and support systems to adhere to medical standards and guidelines. BMETs are involved in the total management of healthcare technology—from repairs and scheduled maintenance to capital asset planning, project management, budgeting and personnel management, designing interfaces and integrating medical systems, training end-users to utilize medical technology, and evaluating new devices for acquisition. BMETs educate and advise staff and other agencies on theory of operation, physiological principles, safe clinical application of biomedical equipment, and maintaining the facility’s patient care and medical staff equipment.

BMETs cover a vast array of different fields and devices. However, in many cases there is a separation of responsibilities, whereby other (more specific) specialists focus on certain kinds of medical instruments—e.g., an Imaging Repair Specialist works on medical imaging equipment.

Regulatory Responsibilities
BMETs must comply with safety regulations, and most biomedical systems must have documentation to show that they were managed, tested, delivered, and used according to a planned, approved process that increases the quality and safety of diagnostics and therapeutic equipment and reduces the risk of harm to patients and staff.

In the United States, the work performed by BMETs must comply with various regulations and standards. Clinical devices and technologies are generally governed by the U.S. Food and Drug Administration (FDA); National Fire Protection Agency (NFPA), particularly NFPA 99 and chapter 7, NFPA 70, Life Safety Code 101; or the Code of Federal Regulations (CFR) 21. There are also accrediting bodies, such as The Joint Commission (TJC) or Accreditation Association for Ambulatory Health Care standards. Other countries typically have their own mechanisms for regulation.

**Job Tasks and Qualifications**

In the development of this Guide, job descriptions were obtained from BMET employers, including hospitals, independent service organizations (ISO), and medical equipment manufacturers—the major categories of employers of entry-level BMETs. The following job task activities and qualifications were most common throughout the descriptions.

**Most Common Job Task Activities**

- Troubleshoot and repair general/low-risk clinical equipment
- Calibrate equipment
- Order parts per policies and procedures
- Perform scheduled maintenance and safety testing
- Assure inspections performed in accordance with requirements and standards
- Use specialized test equipment and tools
- Document actions and results
- Know/comply with departmental policies and procedures
- Participate in performance and quality improvement activities
- Perform in a manner consistent with mission
- Perform incoming inspections and setup
- Assist with projects such as installation, relocation of equipment

**Most Common Job Qualifications**

- Education
- Experience
- Knowledge of electronics
- Competent and professional with oral and written communications
- Safety
- Teamwork
- Customer service
The Profession

BMET Education in the Military

All members of the military entering the BMET career field receive comprehensive technical training. Prior to 1998, Army and Navy BMETs received training at the United States Army Equipment and Optical School (USAMEOS) at Fitzsimons Army Medical Center (FAMC) in Aurora, Colorado. Only after a July 1995 Base Realignment Closure Commission decided to close FAMC did the Army and Navy merge with the Air Force, conducting training at the DoD Biomedical Equipment Technician Training School.

This school has a partnership with Aims Community College where students receive 81 quarter credits (from the Community College of the Air Force) toward an Associate of Applied Science (A.A.S.) Degree with an emphasis in Biomedical Electronics Technology. In addition to the credits acquired from DoD BMET Training School, a minimum of 24 credits must be completed through Aims Community College to receive a degree.

As of August 4, 2010, the U.S. Military moved the BMET training to San Antonio, Texas as a part of their new base realignment plan. Members of all three forces remain in rigorous, tri-service training for 10 months prior to returning to their individual services. The training is held at Fort Sam Houston and is a part of the Military Education and Training Campus.
Core Competencies
Core Competencies

Functional and Personal Core Competencies

BMET core competencies have two primary objectives and should be first among program outcomes to be adopted by a school.

1. Graduates should be fully prepared for employment in the field of biomedical equipment technology.
2. Graduates should be prepared to pass the AAMI/ICC CBET Certification Exam.

These two objectives lead to two categories of ten (10) core competencies:

1. **Functional competencies**—the technical competencies associated with the performance of BMETs; and
2. **Personal competencies**—the individual attributes required of successful BMETs.

The knowledge and skills in the functional competency category provide the foundation essential to the BMET profession.

The knowledge and skills in the personal competency category prepare a BMET to offer value-added performance for a successful and productive career and support the concept of continuous professional education and experience.

**Organization of this Guide**

This Guide is organized according to seven (7) main categories of **Functional Competencies** and three (3) main categories of **Personal Competencies**:

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<th>Functional Competencies</th>
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<td>II. Electronics</td>
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<td>IV. Anatomy and physiology</td>
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<td>V. Mathematics</td>
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<td>VI. Physics</td>
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<td>VII. Chemistry</td>
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</table>
Stated Objectives follow the descriptions. The Objectives specifically encompass the abilities and/or “competencies” that a BMET graduate must possess within the main Functional and Personal Competency categories prior to entering the job market.

Recommended Educational topics for a BMET program curriculum are divided between the ten main Functional and Personal Competency categories. Within a few of these main categories, sub-categories are included for convenience of organization.

Educational topics are considered key to the fulfillment of program outcomes and therefore fundamental to a BMET core curriculum. These topics are specific items of instruction that should be covered within the context of the main Personal and Functional Competency categories. These topics contribute to the entire body of knowledge and are included in the separate courses of the curriculum. (See figure 2.)

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Core Competency I: Biomedical Equipment Technology (BMET)

An interdisciplinary field encompassing healthcare technology management, including the maintenance and support, planning and acquisition, installation and training, modification and design of medical equipment and systems according to standards and guidelines.

Objectives

1. The ability to understand the design, purpose, and performance of medical equipment.
2. The ability to apply this understanding to the needs of healthcare technology management, such as maintenance, repair, and user assistance for medical equipment.

Educational Topics

A. Basic Concepts
   - Biomedical equipment technology definition, scope
   - BMET employers
   - Medical and electronics terminology
   - Hospital organization

   [More continues]

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Figure 2. Example of Educational main and sub-topics for each Competency category
Progression of BMET Education

The core curriculum is the minimum necessary body of knowledge required of all BMET students and is based upon desired learning or program outcomes or goals. The Curriculum and the Outcomes are considered the foundation of the BMET Education Program.

Program outcomes are fulfilled by desired core competencies, and individual topics within an educational program are the building blocks for core competencies. (See Figure 3.)

Note that this approach to organizing educational concepts and/or material does not dictate specific “courses” that should be offered in an educational BMET program. That is still up to the school, allowing for flexibility in teaching methods and learning styles.

Figure 3. The progression of a BMET education program

- **Core Curriculum**
  - Program Outcomes
    - Components of the educational program
      - Core Competencies
        - Education Topics
          - Components of a BMET program described in this Guide

The minimum necessary education required is the **core curriculum**

The goals of the core curriculum are its **program outcomes**

The objectives of the program outcomes are the knowledge and skills imparted by the **core competencies**

The basic concepts of education in the core competencies are **education topics**
Core Competencies

I. Biomedical Equipment Technology

Biomedical Equipment Technology is an interdisciplinary field encompassing healthcare technology management, including the maintenance and support, planning and acquisition, installation and training, modification and design of medical equipment and systems according to standards and guidelines.

Objectives

1. To understand the design, purpose, and performance of medical equipment.

2. To apply this understanding to the needs of healthcare technology management, such as maintenance, repair, and user assistance for medical equipment.

Educational Topics

A. Basic Concepts

- Biomedical equipment technology definition, scope
- BMET employers
- Medical and electronics terminology
- Hospital organization
- Hospital departments and divisions
- Hospital care areas
- Clinical engineering (CE) department organization
- Facilities
- Environment of care
- BMET functions and responsibilities
- BMET professionalism and ethics
- Customer relations
- Professional organizations
- Field service representatives
- BMET specialists
- Medical equipment/healthcare technology management
- Administrative functions
- Management and supervision
- Equipment control

- Healthcare technology life cycle
- Equipment acquisition
- Computerized maintenance management system (CMMS)
- Safety Codes and Regulations
- The Joint Commission accreditation standards
- Center for Devices and Radiological Health
- Occupational Safety & Health Administration (OSHA)
- National Fire Protection Association (NFPA)
- National Electrical Code (NEC/NFPA 70)
- American National Standards Institute (ANSI)
- U.S. Food and Drug Administration (FDA)
- ECRI Institute
- Local, regional, and national professional organizations
- Patient safety
- Electrical safety
- Fire safety
- Radiation safety
- Power cords
- Electrical wiring
- Grounding
CORE COMPETENCIES

I. Biomedical Equipment Technology

Electrical receptacles
Electrical shock
Leakage current
Ground fault circuit interrupter
Isolated power
Line isolation monitor
Inspections on and preventive maintenance:
Inspection and preventive maintenance software
Risk factors, assessment
Troubleshooting
Repair
Biological hazards
Infection control
Universal Protections
Material safety data sheet (MSDS)
Mercury spill containment
Medical Gasses and hazards of compressed gasses
Hazard and recall communications
Professional registration
BMET-related PowerPoint presentations

B. Medical Specialties

Anesthesia
Gynecology
Obstetrics
Ophthalmologist
Respiratory therapy
Intensive/coronary care units
Operating rooms
Endoscopy
Cardiac catheterization laboratory
Radiology
Clinical laboratory
Cytology

C. Medical Equipment

Measurement
Signal
Noise
Signal processing and analysis
Fourier analysis
Physiologic parameters
Sensor
Transducer
Battery-operated equipment
Electromagnetic interference
Temperature measurement
Pressure and force transducer
Motion transducer
Flow transducer
Optical transducer
Electrochemical transducer
Biopotential transducer
Biopotential amplifier
Signal isolation
Electrical noise filtering
Defibrillation protection circuit
Display
Sphygmomanometer
Stethoscope
Electrocardiograph
ECG leads and electrodes
Exercise electrocardiography
Electroencephalograph
Electromyograph
Defibrillator
External pacemaker
Infusion pump
Patient controlled analgesic pump
Feeding pump
Syringe pump
Electrocardiograph monitor
Physiologic monitor
Central station monitor
Invasive (direct) blood pressure monitor
Non-invasive blood pressure (NIBP) monitor
Doppler ultrasound unit
Pulse oximeter
Respiration monitor
Apnea monitor
Volume monitor
End tidal CO₂ monitor
Oxygen analyzer
Cardiac output monitor
Alarms
Physiologic monitor network
Telemetry
Ambulatory (Holter) recording
Bispectral index (BIS) monitor
Life support equipment
Intra-aortic balloon pump
Heart-lung machine
Cell saver
Ventricular assist device
Extracorporeal membrane oxygenator
Respiratory therapy equipment
Bag-valve-mask resuscitator
Suction devices
Pressure regulator
Suction/pressure pump
Dental compressor unit
Dental operating system
Dental ultrasonic prophylaxis unit
Ventilator
Spirometer
Pulmonary function analyzer
Fetal monitor
Neonatal monitor
Sequential compression device (SCD)
Blood/fluid warmer
Hypo-hyperthermia unit
Physical therapy equipment
Continuous passive motion (CPM) unit
Traction unit
Muscle stimulator
Therapeutic ultrasound machine
Transcutaneous electrical nerve stimulator (TENS) unit
Intensive care bed
Infant incubator
Infant transport incubator
Infant radiant warmer
Phototherapy device
Dialysis machine
Anesthesia machine
Anesthetic gas monitor
Electrosurgical unit
Smoke evacuator
Laser
Minimally invasive surgery
Surgical robot
Optics
Ophthalmoscope
Otoscope
Slit lamp
Electro-optics
Microscope
Surgical microscope
Endoscope
Cystoscope
Video
Sterilizer
Clinical Laboratory
Analysis equipment
Organization of the lab

Regulatory agencies
Laboratory safety
pH/blood gas analyzer
Clinical chemistry analyzer
Cell counter
Centrifuge
Hematology analyzer
Colorimeter
Spectrophotometer
Flame photometer
Utility equipment
Ion selective electrode
Co-oximeter
Dosimetry
Electromagnetic radiation
Ionizing radiation
Atom and electron shells
Photons
Inverse square law
Electromagnetic spectrum
X-ray
X-ray regulations
X-ray unit high voltage generator
X-ray unit controls
X-ray tube: anode, cathode, induction motor, cathode and filament currents
Film processor
Mobile x-ray
Fluoroscopy
Dental panoramic x-ray
Digital x-ray
Plate reader
Diagnostic ultrasound machine
Acoustic waves
Electromagnetic waves
Properties of sound in human tissue
Manufacturers of diagnostic ultrasound machines
Clinical uses of diagnostic ultrasound
Propagation of ultrasound waves
Acoustic impedance, reflection, refraction, intensity, attenuation
Diagnostic ultrasound machine modes of operation
Controls of diagnostic ultrasound machine
Transducers used with diagnostic ultrasound
Doppler theory
Axial and lateral resolution of ultrasound
Ultrasound scanner
Scan converter
**CORE COMPETENCIES**

I. Biomedical Equipment Technology

- Quality assurance procedure for ultrasound
- Problems with and troubleshooting ultrasound
- Nuclear medicine/gamma camera
- Computed tomography (CT)
- Positron emission tomography
- Magnetic resonance imaging (MRI)
- Radiation therapy
- Computer applications in imaging
- Medical network standards, DICOM, HL7
- Picture archiving and communication system (PACS)
- Power distribution system
- Environmental control unit
- Oxygen storage and generation system

### D. Test Equipment and Procedures

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<td>Electrosurgical unit analyzer</td>
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<td>Electrosurgical unit inspection</td>
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<td>Medical ultrasound analyzer</td>
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<tr>
<td>Physiologic monitor inspection</td>
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<td>Non-invasive blood pressure (NIBP) monitor analyzer</td>
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<td>NIBP inspection</td>
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<td>Invasive blood pressure inspection</td>
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<td>Cardiac output monitor inspection</td>
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<td>Pulse oximeter testing</td>
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<td>Electrocardiograph simulator/analyzer</td>
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<td>Electrocardiogram (ECG) testing</td>
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<td>Telemetry inspection</td>
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<td>Fetal monitor inspection</td>
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<td>Infusion pump analyzer</td>
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<td>Infusion pump inspection</td>
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<td>Infant incubator inspection</td>
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<td>Infant radiant warmer inspection</td>
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<td>Defibrillator analyzer</td>
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<td>Defibrillator testing</td>
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<td>Anesthesia machine maintenance</td>
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<td>Gas analyzer</td>
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<td>Pressure meter</td>
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</table>

- Flowmeter
- X-ray unit testing
- Centrifuge preventive maintenance
- Microscope maintenance
- Water bath inspection
- Slide stainer inspection
- Water bath operation and maintenance
- Laboratory incubator operation and maintenance
- Slide stainer operation and maintenance
- Diluter operation and maintenance
- Cell counter inspection
- Colorimeter operation and maintenance
- Spectrophotometer operation and maintenance

### E. Troubleshooting and Repair

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<td>Schematic, wiring diagram</td>
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<td>Circuit extraction</td>
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<td>Relay troubleshooting</td>
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<td>Ventilator operation and troubleshooting</td>
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<td>Compressor operation and repair</td>
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<td>Alternating pressure pump operation and troubleshooting</td>
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<td>Heating pad pump operation and troubleshooting</td>
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<td>Oxygen concentrator operation and troubleshooting</td>
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<td>Low-volume suction machine operation and troubleshooting</td>
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<td>Electrocardiograph operation and troubleshooting</td>
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<td>Defibrillator troubleshooting</td>
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<td>Physiologic monitor troubleshooting</td>
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<td>NIBP troubleshooting</td>
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<td>Invasive blood pressure troubleshooting</td>
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<td>Pulse oximeter operation and troubleshooting</td>
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<td>Fetal monitor operation and troubleshooting</td>
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<td>Electrosurgical unit operation and troubleshooting</td>
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<td>Sterilizer operation and troubleshooting</td>
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<td>Diagnostic ultrasound troubleshooting</td>
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<td>Dental x-ray operation and troubleshooting</td>
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<td>X-ray unit operation and troubleshooting</td>
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<td>Blood gas analyzer operation and troubleshooting</td>
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<td>Centrifuge operation and troubleshooting</td>
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<td>Centrifuge repair</td>
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</table>
Core Competencies

II. Electronics

The field of electronics deals with active and passive electrical components, and with analog and digital electrical circuits that involve such components. Electronics is used in information processing, telecommunications, and signal processing. Today, most electronic devices use semiconductor components to perform electron control.

Objectives

1. To understand the principles of electronic components, circuits, and instruments.
2. To apply this understanding to troubleshooting and repairing of electronic equipment.

Educational Topics

<table>
<thead>
<tr>
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<th>Power</th>
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<td>Electrical mathematics</td>
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<td>Units of measurement</td>
<td>Energy, efficiency</td>
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<td>Atomic structure of matter</td>
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<tr>
<td>Charge, current, energy, voltage</td>
<td>Series, parallel, series-parallel circuits</td>
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<tr>
<td>Magnetism</td>
<td>Network theorems</td>
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<tr>
<td>Conductor, insulator</td>
<td>Kirchhoff’s voltage law</td>
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<td>Resistance</td>
<td>Variable resistor</td>
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<td>Wire jackets</td>
<td>Voltage divider</td>
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<td>Wire gauge table</td>
<td>Rheostat</td>
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<td>Motor</td>
<td>Kirchhoff’s current law</td>
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<td>Current divider</td>
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<td>DC circuit analysis</td>
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<td>Open and short circuit</td>
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<td>Branch and loop current</td>
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<td>Node voltage</td>
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<td>Source conversion</td>
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<td>Branch, nodal, mesh conversion</td>
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<td>Thevenin</td>
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<td>Superposition, Thevenin's theorem,</td>
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<td>Norton's theorem</td>
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<td>Maximum power transfer theorem</td>
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<td>DC power supply</td>
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<table>
<thead>
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<th>B. Direct Current</th>
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<td>Resistor color code</td>
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<td>Ohm’s Law</td>
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<td>Watt’s Law</td>
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<tr>
<td>Resistive DC circuits</td>
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<tr>
<td>Resistive DC parallel circuit</td>
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<td>Resistive DC series-parallel circuit</td>
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<tr>
<td>Capacitor</td>
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<tr>
<td>Inductor</td>
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</tbody>
</table>
C. Alternating Current

- Magnetism and electromagnetism
- Sinusoidal AC voltage and current
- AC waveform, amplitude, frequency
- Signal generator
- AC circuit
- Reference ground in an AC circuit
- Test points in an AC circuit
- Phasors
- Average and RMS calculations
- Impedance
- Capacitor
- Inductor
- Reactance
- Transformer
- Transformer in a power supply
- RC circuit
- RL circuit
- RLC circuit and resonance
- Series, parallel, series-parallel circuits
- Series resonance
- Parallel resonance
- Filter
- Circuit theorems
- Pulse response of reactive circuits
- Series-parallel resonant conditions
- Power and power factor
- Power: apparent, reactive, real
- Three-phase power system
- Bode plot
- Poly-phase system

D. Solid State

- Semiconductors
- Atomic structure of semiconductors
- Electrons in each shell for Cu, Si, and Ge
- Majority and minority current flow in Si and Ge
- Semiconductor theory
- Atomic theory
- Energy levels
- Crystals
- Hole and electron current
- N-type and p-type semiconductors
- PN junction
- Forward and reverse characteristics for PN junction
- Model for ideal and practical diode
- Diode
- Diode V-I curve
- Diode circuits
- Series and parallel diode configurations
- Half- and full-wave rectification
- Bridge rectifier
- Rectifier filter
- DC power supply circuit
- Power supply filtering
- Split power supply
- Semiconductor analog circuit
- Clipping and clamping circuits
- Special purpose diodes
- Light emitting diode (LED)
- Zener diode
- Zener voltage regulator
- Zener diode application circuit
- Photodiode
- Transistor theory
- Transistor parameters and ratings
- Bipolar junction transistor (BJT)
- Current flow in BJTs
- Symbols for NPN and PNP BJTs
- Active, off, and saturation for BJTs
- Bias
- Base bias
- Voltage divider bias
- Collector feedback bias
- Emitter feedback bias
- Input/output impedance
- DC load lines
- PNP circuits
- Transistor switch
- Gain in a transistor
- Bandwidth
- Transistor amplifier
- Single stage BJT amplifier
- Voltage amplifier
- Troubleshooting a BJT amplifier
- Transistor AC equivalent circuits
- Common-emitter amplifier
- Common-collector amplifier
- Common-base amplifier
- Multi-stage amplifier
- Noise
- Fixed and voltage divider bias of BJTs
- Emitter and collector feedback bias of BJTs
- Design and characteristics of BJT circuit configurations
- Maximum ratings for BJTs
- Four primary types of biasing networks
Transistor regulated power supply
Series and pass transistor operation
Field effect transistor (FET)
Junction gate field-effect transistor (JFET)
Metal–oxide–semiconductor field-effect transistor (MOSFET)
JFET and MOSFET bias circuits
FET amplifiers
FET amplifier AC equivalent circuit
Common-source FET amplifier
Common-drain FET amplifier
Power amplifier
Class B amplifier
Class C amplifier
Push–pull amplifier
Amplifier frequency response
Decibel
Curves for BJTs, FETs, SCRs, and diodes
Compound configurations
Operational amplifier
Negative feedback
Linear operational amplifier circuits
Inverting and non-inverting amplifiers
Inverting adder
Differential amplifier
Bridge amplifier
Instrumentation amplifier
Comparator
Integrator
Differentiator
Level detector
Open loop system
Positive feedback
Active filter
High-pass, low-pass, band-pass, and notch active filters
Oscillator
Frequency response
Fourier series
Unijunction transistor (UJT)
Programmable unijunction transistor (PUT)
Build and operate UJT and PUT relaxation oscillators
Thyristor
Diac
Triac
Silicon controlled rectifier (SCR)
Switch mode power supply
Control circuit
Temperature sensor

Photodevice
Phase control with SCR and Triac
Phase-locked loop
Voltage regulator
Integrated circuit
Fixed and adjustable IC regulator
555 timer

E. Digital
Number systems
Binary number system
Digital mathematics
Transistor–transistor logic (TTL) devices
Complementary metal–oxide–semiconductor (CMOS) devices
Logic gates
Logic level
Pulse waveform
Truth tables
Timing diagrams
System clock
Circuit reduction techniques
Logic families
Digital circuits
MSI/LSI logic circuits
Boolean algebra
DeMorgan's Theorem
Karnaugh maps
Delay times
Switching times
Power dissipation
Digital circuit
Digital arithmetic circuits
Adder
Comparator
Encoder
Decoder
Multiplexers/demultiplexers
Parity circuit
Seven segment display
Edge-triggered circuitry
J-K flip-flop
Negative gate
Build and operate basic gate circuits
Combinational logic circuit
Design a combinational logic circuit
Sequential logic circuit
Latch circuit

Core Competencies for the Biomedical Equipment Technician (BMET)
II. Electronics

Synchronous and asynchronous counters
Shift register
Frequency divider circuit
Switching circuit
Counter
Serial data transmission
Clock circuit
Build and operate two common clock signal source circuits
Monostable theory
Oscillator circuit
Binary input and output
Multiplexing data
Analog to digital conversion
digital to analog conversion
Optical isolator
Semiconductor memory
Read-only memory (ROM)
Erasable programmable read-only memory (EPROM)
Programmable logic array
Bus systems

F. Telecommunications

Terminology
Signals
Spectra
Noise
Amplitude
Single side band
Transmitter, receiver
Frequency
Modulation
Angle and pulse modulation
Transmission and reception
Communications techniques
Digital and data communication
Multiplexing
digital-to-analog and analog-to-digital conversions
Radio telemetry
Cabling
Transmission line
Antenna
Laser techniques
Fiberoptics
Television theory

G. Test Equipment

Digital meter
Oscilloscope
Power supply
High voltage probe
Function generator
Frequency counter

H. Skills

Safety
Screwdrivers
Pliers
Wrenches
Power tools
Sockets
Hand measurement tools
Hammers
Punches
Taps and dies
Component identification
Anti-static grounding
Soldering
Wire tinning
Wire joining
Desoldering
Audio/video connectors
Fasteners
Use of digital ohmmeter
Use of digital multimeter
Use of prototype board
Troubleshooting electrical faults
Use of oscilloscope
Build temperature simulator
Build DC power supply
Build connectors
Ordering parts and components from catalogs using Internet
Procedures and equipment for electrostatic discharge (ESD)
Build and operate a complex logic circuit
Digital circuit troubleshooting
Core Competencies

III. Information Technology

Information technology is the field involving the design, application, and support of computer-based information systems. Information technology (IT) uses computers and telecommunications equipment to store, retrieve, transmit, and manipulate data.

Objectives

1. The ability to understand the principles of computers, peripherals, networks, and software.
2. The ability to apply this understanding to applications with medical equipment and systems of medical equipment.

Educational Topics

A. Basic Concepts

Number systems
Microcomputer hardware
Microprocessor
Microprocessor types
Central processing unit
Power supply
Motherboard
Slots
Bus slot card
Input/output card
Drives
Hard drive types
Hard drive interfaces
Optical drive
Address
Microprocessor memory
DRAM subsystem
Microprocessor register
Clocks and timers
Machine code
Assembly code
Machine code instructions
Keyboard and mouse

Data input
Microcomputer architecture
Input/output ports
Disc subsystem
Serial and parallel ports
Input and output devices
Video
Video display hardware
Sound
Printers
Laptop
Storage devices
Disk input/output
Measuring and improving drive performance
Interface applications
Programming
Software architecture
68HC12 instruction set
Addressing modes
Subroutines
Serial data transmission
Bus structure
Read/write timing cycle
Interrupt, interrupt request (IRQ)
III. Information Technology

Memory
Direct memory access (DMA)
Virtual memory
Paging
Basic programming
Stack operations
Intermediate programming
BCD operations
Conversion subroutines
Multiplexed displays and routines
Multiplexed keyboard and routines
Virus, spyware
Computer certifications
A+ certification

B. Microprocessor Applications

Computer applications
Basic input/output system (BIOS)
Operating system
Installing, configuring, upgrading, troubleshooting operating system
DOS commands
MS-DOS
Windows XP
Windows XP installation and setup
Internet
Windows
Files and folders
File management
Word processing
Spreadsheet
Database
Electronic mail
Word
Documents
Tables
Technical reports
Importing data
HTML
Web pages
Excel
Excel: worksheets
Excel: charts
Excel: functions
Excel: solving electronic engineering problems
Excel: parts inventory
Excel: scheduling
Presentation software
PowerPoint
Project
LabView
Programming languages
Visual Basic
AutoCAD
Programmable controller
Embedded system
Program editing
Formatting
“If” statements
Loops
Text boxes, buttons, pop-ups, picture boxes
Arrays
Subroutines, functions
Accessing hardware

C. Microcomputer Maintenance

Safety procedures
Disassemble personal computer
How to build a computer
Personal computer repair tools
Hard drive organization
Hardware and software diagnostic tools
Performance analysis
System optimization
Sound card
System configuration
Backup device
Universal serial bus (USB)
Compact disc–read only memory (CD-ROM)
Hard drive maintenance
Memory layout
Mouse operation
Serial communication
Keyboard operation
Install operating system
Major components
Remove/replace hardware
Error code
Preventive maintenance
Power supply problems
Media types
Partition hard drive
Microcomputer troubleshooting
Power-on-self-test
Format hard drive
Customer relations
Security
Password
D. Networks

Network
Network terminology
Network topology
Network standards
Network cable types
Network cabling
Network connectors
Network operating system
Network address
Cisco network
Open systems interconnection (OSI) model
802 networking model
Baseband and broadband
Signal transmission
Cables and connectors
Network cabling
Network adapter
Local area network (LAN)
Wide area network (WAN)
Remote connectivity
Ethernet network
Ethernet switching
Token ring network
Connecting device to network
Fiber distributed data interface (FDDI)
Asynchronous transfer mode (ATM)
Digital subscriber line (DSL)
Internet connection sharing (ICS)
Remote access
Frequency and wavelength
Serial data transmission
Synchronous/asynchronous transmission
Network components
Hub
Switch
Cisco switch
Repeater
Bridge
Router
Backbone, segment
Centralized computing environment
Client/server environment
Network protocol
Static route
Routing information protocol (RIP) route
Network traffic, load, utilization
Network gateway

Spanning tree protocol
Root switch and root port
Routing protocol
Access control list (ACL)
Packet filtering ACL
Network address translation/port address translation (NAT/PAT)
Open system interconnection protocol theory
Virtual local area network (VLAN)
Domain name system (DNS)
Dynamic host configuration protocol (DHCP)
Network support tools
Network troubleshooting
Synchronous optical network (SONET)
Client and server relationships
Crosstalk
Data frame
Network software
File sharing
File transfer protocol (FTP)
Transmission control protocol/internet protocol (TCP/IP)
Peer to peer network
Active, passive, hybrid hubs
Wireless network
Network interface controller (NIC)
Network interface controller (NIC)
Packet structure and function
Managing network accounts
Managing network performance
Avoiding data loss
Modem
Point to point protocol (PPP)
Institute of Electrical and Electronics Engineers (IEEE) standards
Media access control (MAC) address
International standard for wide-area packet-switched communications (X.25)
Virtual private network (VPN)
Router and server security
Encapsulation
Internet history
Internet protocol (IP) addressing
Internet functions
Layered model
Subnet
Number conversion
Routing
Packet forwarding
Static routing
### III. Information Technology

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<th>Troubleshooting wireless network</th>
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<td>Shared wireless access protocol (SWAP)</td>
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<td>Carrier sense multiple access (CSMA), collision detection and avoidance</td>
<td>Documentation</td>
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<td>Routing information protocol (RIP)</td>
<td>Simple network management protocol (SNMP)</td>
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<td>Variable length subnet masking (VLSM)</td>
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<td>Classless inter-domain routing (CIDR)</td>
<td>Network security and management</td>
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<td>Routing information protocol version 2 (RIPv2)</td>
<td>Fault tolerance</td>
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<td>Enhanced interior gateway routing protocol (EIGRP)</td>
<td>Analog and digital signals</td>
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<td>Link-state routing protocol</td>
<td>Access point</td>
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<td>Open shortest path first (OSPF) routing</td>
<td>Data collision</td>
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<td>Radio wave propagation</td>
<td>Free space optics (FSO)</td>
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<td>Radio frequency spectrum</td>
<td>Satellite fixed broadband wireless</td>
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<td>Wireless advantages and disadvantages</td>
<td>Communications channel bandwidth and data rate</td>
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<td>Wireless protocol</td>
<td>Satellite voice and data communications</td>
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<td>Wireless local area network (WLAN)</td>
<td>Data communications techniques and theories</td>
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<td>Wireless signal noise</td>
<td>Low- and high-level modulation</td>
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<td>Wireless infrastructure</td>
<td>Active and passive filters</td>
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<td>Wireless router</td>
<td>Cellular telephone</td>
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<td>Wireless gateway</td>
<td>Infrared wireless technology</td>
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<tr>
<td>Troubleshooting transmitters and receivers</td>
<td>Telecommunications standards</td>
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<tr>
<td>Fixed and non-fixed wireless networks</td>
<td>FCC rules and regulations</td>
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<td>Wireless system security</td>
<td>Wireless communication standard IEEE 802</td>
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<td>Firewall</td>
<td>Bluetooth wireless standard</td>
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Core Competencies

IV. Anatomy and Physiology

Anatomy and physiology are fields of biology that study the structure and the function of living systems respectively. This includes organisms, organ systems, organs, cells, and bio-molecules in a living system.

Objectives

1. To understand the structures and functions of the human body.

2. To apply this understanding to the interaction of medical equipment with the human body.

Educational Topics

Word roots, prefixes, and suffixes
Definitions, terminology
Human body
Body cavities
Symptoms
Diagnoses
Treatments
Atoms, molecules, compounds, polymers
Chemistry of the human body
Role of water in the body
Ingestion, digestion, absorption, excretion
Metabolism
Adenosine triphosphate (ATP)
DNA
RNA
Cell
Nucleus, cilia, lysome
Tissue
Connective tissue
Biological membranes
Epithelial membrane
Tumor
Organ
System
Organism
Abnormal conditions

Infection, infectious disease
Metabolic disorder
Immune disorder
Meningitis, hydrocephalus, encephalitis, cerebrovascular accident
Centers for Disease Control and Prevention (CDC)
Bacteria, virus, fungus
Anaerobic, aerobic, streptococci, staphylococci
Pasteurization, sterilization, disinfection, antisepsis, antibiotic, media
Immunity
Blood
Circulation, respiration
Oxygen and carbon dioxide transport
Blood testing
Hepatitis
Diffusion, semi-permeable, osmosis, filtration, isotonic, hemolysis
Biomedical measurements
Action potential
Biopotentials
Physiologic parameters
Homeostasis
Vital signs
Hypothermia, hyperthermia
## CORE COMPETENCIES

### IV. Anatomy and Physiology

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<th>Respiration</th>
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<td>Musculoskeletal system</td>
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<td>Cardiovascular system</td>
<td>Nervous system</td>
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<tr>
<td>Auscultation</td>
<td>Neuron, afferent and efferent</td>
</tr>
<tr>
<td>Blood pressure</td>
<td>Nerve impulse, neurotransmitter</td>
</tr>
<tr>
<td>Hypertension</td>
<td>Electroencephalogram</td>
</tr>
<tr>
<td>Heart</td>
<td>Autonomic nervous system</td>
</tr>
<tr>
<td>Heart chambers and valves</td>
<td>Eye</td>
</tr>
<tr>
<td>Cardiac cycle</td>
<td>Ear</td>
</tr>
<tr>
<td>Cardiac conduction system</td>
<td>Renal/urinary system</td>
</tr>
<tr>
<td>Coronary circulation system</td>
<td>Urinalysis</td>
</tr>
<tr>
<td>Heart rate and arrhythmia</td>
<td>Renal testing</td>
</tr>
<tr>
<td>Cardiovascular measurements</td>
<td>Endocrine system</td>
</tr>
<tr>
<td>Electrocardiogram</td>
<td>Exocrine system</td>
</tr>
<tr>
<td>Cardiac output</td>
<td>Reproductive system</td>
</tr>
<tr>
<td>Blood vessels</td>
<td>Lymphatic system</td>
</tr>
<tr>
<td>Gastrointestinal system</td>
<td>Skin</td>
</tr>
<tr>
<td>Bone</td>
<td>Balance</td>
</tr>
<tr>
<td>Skeletal system</td>
<td>Growth and development</td>
</tr>
</tbody>
</table>
Core Competencies

V. Mathematics

Mathematics is the study of numbers and their relationships. Mathematics is an essential tool in the study and application of many other fields, including science, engineering, and economics.

Objectives

1. To understand mathematical concepts up to the level of calculus.
2. To apply this understanding to applications in biomedical equipment technology, electronics, information technology, physics, and chemistry.

Educational Topics

Whole numbers
Prime number
Fractions
Decimal numbers
Percent
Metric system
Metric measures
Metric prefixes
Binary number system
Octal number system
Hexadecimal number system
Other units systems
Exponential notation
Engineering notation
Scientific notation
Scientific calculation
Unit conversion
Converting between number systems
Sets
Set operations
Algebra
Factoring
Equation
Ratio
Proportion
Isolating the variable
Powers
Roots
Exponent
Radical
Logarithm
Linear equation
Formula evaluation and rearrangement
Simplifying algebraic expressions
Inequality
Absolute value equation
Function
Linear function
Equations of a line
Non-linear function
Composite function
Inverse function
Polynomial function
Rational function
Exponential function
Logarithmic function
Systems of equations
Linear systems of equations in two variables
Nonlinear systems of equations in two variables
Matrices
Determinants
Geometry
### Core Competencies

V. Mathematics

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Trigonometric identity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graphing</td>
<td>Vectors in two-dimensional plane</td>
</tr>
<tr>
<td>Circle, bar, and line graphs</td>
<td>Trigonometric form of complex number</td>
</tr>
<tr>
<td>Rectangular coordinate system</td>
<td>Product and quotient of complex numbers</td>
</tr>
<tr>
<td>Graphing linear equations with two variables</td>
<td>Powers and roots of complex numbers</td>
</tr>
<tr>
<td>Vector addition</td>
<td>Equations with complex solutions</td>
</tr>
<tr>
<td>Quadratic equation</td>
<td>Polar coordinates</td>
</tr>
<tr>
<td>Simultaneous equation</td>
<td>Variation</td>
</tr>
<tr>
<td>Exponential equation</td>
<td>Graphing trigonometric functions</td>
</tr>
<tr>
<td>Logarithmic equation</td>
<td>Analytic geometry</td>
</tr>
<tr>
<td>Complex number</td>
<td>Lines and conic sections</td>
</tr>
<tr>
<td>Angles</td>
<td>Estimation</td>
</tr>
<tr>
<td>Radians and degrees</td>
<td>Probability</td>
</tr>
<tr>
<td>Right triangle trigonometry</td>
<td>Statistics</td>
</tr>
<tr>
<td>Oblique triangle trigonometry</td>
<td>Rate of change</td>
</tr>
<tr>
<td>Trigonometric functions</td>
<td>Integration</td>
</tr>
<tr>
<td>Graphs of trigonometric functions</td>
<td>Area</td>
</tr>
<tr>
<td>Inverse trigonometric functions</td>
<td>Volume</td>
</tr>
<tr>
<td>Analytic trigonometry</td>
<td>Financial management</td>
</tr>
<tr>
<td>Trigonometric equation</td>
<td></td>
</tr>
</tbody>
</table>
Core Competencies

VI. Physics

Physics is a field of science involving the study of matter and energy and their interactions.

Objectives

1. To understand the principles of physics.
2. To apply this understanding to applications in biomedical equipment technology, electronics, and information technology.

Educational Topics

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Thermal energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metric abbreviations</td>
<td>Specific heat capacity</td>
</tr>
<tr>
<td>Vector quantities</td>
<td>Latent heat</td>
</tr>
<tr>
<td>Matter</td>
<td>Heat transfer methods</td>
</tr>
<tr>
<td>Motion</td>
<td>Ideal gas laws</td>
</tr>
<tr>
<td>Force</td>
<td>Electric force</td>
</tr>
<tr>
<td>Motion on incline</td>
<td>Electric field</td>
</tr>
<tr>
<td>Trajectory motion</td>
<td>Electric potential and capacitance</td>
</tr>
<tr>
<td>Acceleration</td>
<td>Current and resistance</td>
</tr>
<tr>
<td>Gravity</td>
<td>Series and parallel circuits</td>
</tr>
<tr>
<td>Newton’s Laws of motion</td>
<td>Magnetism</td>
</tr>
<tr>
<td>Friction</td>
<td>Electromagnetic induction</td>
</tr>
<tr>
<td>Field forces</td>
<td>Electromagnetic radiation</td>
</tr>
<tr>
<td>Work</td>
<td>Waves</td>
</tr>
<tr>
<td>Energy</td>
<td>Light</td>
</tr>
<tr>
<td>Power</td>
<td>Optics</td>
</tr>
<tr>
<td>Circular motion</td>
<td>Reflection</td>
</tr>
<tr>
<td>Force addition by scaling and complement methods</td>
<td>Refraction</td>
</tr>
<tr>
<td>Concurrent and non-concurrent equilibrium</td>
<td>Interference</td>
</tr>
<tr>
<td>Impulse</td>
<td>Diffraction</td>
</tr>
<tr>
<td>Momentum</td>
<td>Geometrical optics</td>
</tr>
<tr>
<td>Collision</td>
<td>Physical optics</td>
</tr>
<tr>
<td>Mechanical energy</td>
<td>Spectra</td>
</tr>
<tr>
<td>Heat</td>
<td>Color</td>
</tr>
<tr>
<td>Thermodynamics</td>
<td>Photometry</td>
</tr>
<tr>
<td></td>
<td>Basic forces in physics</td>
</tr>
<tr>
<td></td>
<td>Special theory of relativity</td>
</tr>
<tr>
<td></td>
<td>Photoelectric effect</td>
</tr>
<tr>
<td></td>
<td>Compton effect</td>
</tr>
<tr>
<td></td>
<td>Quantum mechanics</td>
</tr>
<tr>
<td></td>
<td>Cosmology</td>
</tr>
<tr>
<td></td>
<td>Atomic and nuclear physics</td>
</tr>
<tr>
<td></td>
<td>Mechanics</td>
</tr>
<tr>
<td></td>
<td>Hydraulics</td>
</tr>
<tr>
<td></td>
<td>Pneumatics</td>
</tr>
<tr>
<td></td>
<td>Motor applications</td>
</tr>
</tbody>
</table>
Core Competencies

VII. Chemistry

Chemistry is a field of science that involves the composition, structure, properties, and reactions of matter. Chemistry is concerned with atoms and their interactions with other atoms and various forms of energy.

**Objectives**

1. To understand the principles of chemistry.
2. To apply this understanding to applications in biomedical equipment technology, and anatomy and physiology.

**Educational Topics**

Measurements
- Mass
- Temperature measurement
- Temperature conversion
- Atoms
- Elements
- Periodic table
- Chemical formula, equation
- Compounds
- Energy
- Structure and properties of matter
- States of matter
- Gases, Liquids, and Solids
- Combined gas law
- Ideal gas law

Law of partial pressures
- Mixtures, solutions, solvents, solutes, and suspensions
- Specific gravity
- Density
- Chemical bonding
- Ionic bond
- Covalent bond
- Chemical reactions
- Chemical equilibrium
- Acids, bases, pH
- Electrolyte
- Ion, cation, anion
- Isotope
- Titration
Core Competencies

VIII. English

The field of English involves the study and use of the English language, including grammar, vocabulary, composition, and literature.

Objectives

1. To understand vocabulary and grammar, and to be able to read, write, and present.

2. To apply this understanding and ability to communicate with people involved with healthcare technology management (e.g., clinicians, administrators, manufacturers, and vendors).

Educational Topics

<table>
<thead>
<tr>
<th>Grammar</th>
<th>Coordination and subordination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planning and drafting</td>
<td>Reflective essay</td>
</tr>
<tr>
<td>Thesis statement</td>
<td>Technical writing</td>
</tr>
<tr>
<td>Writing essays</td>
<td>Research techniques</td>
</tr>
<tr>
<td>Theme</td>
<td>Citation</td>
</tr>
<tr>
<td>Writing skills</td>
<td>Critical reading</td>
</tr>
<tr>
<td>Outline, notes</td>
<td>Logical reasoning</td>
</tr>
<tr>
<td>Organization, transition, integrating sources</td>
<td>Textual analysis</td>
</tr>
<tr>
<td>Reviewing</td>
<td>Narration</td>
</tr>
<tr>
<td>Revision</td>
<td>Description</td>
</tr>
<tr>
<td>Metacommentary</td>
<td>Critique</td>
</tr>
<tr>
<td>Diction</td>
<td>Argument</td>
</tr>
<tr>
<td>Tone</td>
<td>Journal</td>
</tr>
<tr>
<td>Style</td>
<td>Research paper</td>
</tr>
<tr>
<td>Paragraphs</td>
<td>Audience analysis</td>
</tr>
<tr>
<td>Sentences</td>
<td>Documents for reference or instruction</td>
</tr>
<tr>
<td>Subject and verb agreement</td>
<td>Integrating visuals with text</td>
</tr>
</tbody>
</table>
Core Competencies

IX. Professional Skills

Professional skills include the practical abilities that help employees succeed as practitioners in their careers. This material supplements the theoretical aspects of the curriculum and teaches skills applicable to the professional world. Professional skills are necessary for effective participation in a profession.

Objectives

1. To understand interpersonal relationships (e.g., communications, customer service, professional organizations) necessary for success in the workplace.
2. To apply this understanding to jobs in healthcare technology management.

Educational Topics

A. Philosophy
Logical fallacies
Deductive and inductive reasoning
Argument evaluation and construction
Thinking critically about the media
Science and pseudoscience

B. Psychology
Research methods
Biology of behavior
Learning
Cognition (memory, thought, and language)
Job analysis and evaluation
Employee selection
Evaluating employee performance
Group behavior
Employee motivation
Employee satisfaction and commitment
Organizational communication
Stress management

C. Technology Careers
Goals
Time management
Budget
Personal attributes
Safety
Critical thinking
Academic integrity
Working with data
Data-driven decision making
Documentation
Communication
Engineering communication
Electronic communication
Presentation skills
Public speaking
Career exploration
Engineering careers
Job search
Resume
CORE COMPETENCIES
IX. Professional Skills

Job application
Interviewing techniques
Job application follow-up
Job performance skills
Working relations
Professionalism
Professional ethics
Ethical and social responsibilities in the workplace
Whistleblowing
Diversity
Diversity in the workplace
Bias in the workplace
Workplace problem solving
Teams, teamwork, and self-monitoring
Design and teamwork
Quality, quality improvement

D. Practicum/Internship to Include

Hospital and department organization
Employee orientation
BMET department experience
Clinical engineering department meeting
Chemical safety
Biological safety
Codes and standards

The Joint Commission
American Association of Blood Banks
National Fire Protection Association/
NFPA-99 Health Facilities Code
U.S. Food and Drug Administration
Safe Medication Devices Act (SMDA)
Occupational Safety & Health Administration (OSHA)
X-ray tester/scope meter
Infusion pump tester
Multi-parameter patient simulator
Anesthetic gas analyzer
CO₂/O₂ analyzer
Medical equipment function
Inspection and preventive maintenance
Servicing medical equipment
Equipment maintenance documentation
Medical equipment use
Medical equipment cycle—acquisition to disposal
Infection control/Sterile procedures
Operating cost/budgeting
Problem solving
Interpersonal skill development
Professional development
Write paper on experience
Research project
Core Competencies

X. Practical Experience—Internship/Laboratory

Laboratory and/or internship education involving use of biomedical equipment; applied healthcare technology management education, as opposed to theoretical; the BMET program advisory committee reviews and advises on content at least annually.

Objectives
1. To understand how to operate and maintain biomedical equipment.
2. To apply this understanding and ability to actual biomedical equipment, either in a laboratory or in a hospital.
3. To apply education with real-life, hands-on experience in an actual work environment.
4. To practice a variety of healthcare technology management responsibilities including the following:
   a. equipment safety;
   b. inspection and maintenance procedures;
   c. troubleshooting and repair;
   d. acceptance testing/incoming inspection;
   e. documentation; and
   f. equipment evaluation.

Educational Topics
Student responsibilities in a working environment written and explained
Employee orientation to department and organization
Policies and procedures of department and organization
Organizational chart of department and organization
Evaluation of student by supervisor
Recording and reporting experience working as a BMET
Hands-on experience in the department
Hands-on experience in representative areas served by department
Hands-on experience in different organizations—hospital, ISO, manufacturer
Attention to detail
CORE COMPETENCIES
X. Practical Experience Internships and Laboratory

Reliability
Verbal communication
Ability to accept criticism
Demeanor
Professional behavior in the workplace
Personal grooming
Collaboration
Initiative
Self-improvement
Adaptability
Attention to patient and personal safety
Safe and proper use of biomedical equipment
Safe and proper use of biomedical test equipment
Inspection of and maintenance of biomedical equipment
Troubleshoot problems with biomedical equipment
Equipment inventory and control
Computerized maintenance management system (CMMS)
Attendance at department meetings

Note regarding laboratory courses:
Obtaining representative samples of modern medical equipment for laboratory courses has always been a challenge for BMET schools. Modern medical equipment is an expensive, moving target, and budgets are limited and donations are usually limited to out-of-date, retired equipment. Nevertheless, schools, with assistance from their advisory committees, must determine the types of equipment that are most critical to their students' laboratory experience, and strive to obtain it by negotiating for donations or discounts with manufacturers and vendors.

Note regarding internships:
Placing students in internship positions can be challenging due to the scarce number of potential internship sites in the vicinity. BMET schools have taken various approaches to establishing internships. One approach is to have only limited (or no) internships and instead develop very strong laboratory courses to provide practical experience. Another approach is cast a wider net to internship sites regionally or nationally, beyond the immediate locale of the BMET school. Although somewhat inconvenient, a paid internship could provide the BMET intern with resources for temporary housing and living expenses.
Resources for BMET Educational Programs
Resources for BMET Educational Programs

The following textbooks, workbooks, and tools/supplies are suggested resources only and not inclusive of all resources that may be used by BMET schools.

**Textbooks**

**Biomedical Equipment Technology**

*Basic Laboratory Methods for Biotechnology*
Seidman, Lisa A.; Moore, Cynthia J.

*Biomedical Device Technology—Principles and Design*
Chan, Anthony

*Biomedical Instrumentation, Technology and Applications*
Khandpur, R.S.

*BMET Study Guide: Preparing for Certification and Sharpening Your Skills*
AAMI, 2012

*Clinical Engineering Handbook*
Dyro, Joseph

*Clinical Engineering Principles and Practices*
Webster and Cook
Prentice Hall, 1979

*Electrocardiography for Health Care Personnel, 3rd ed.*
Booth, Kathryn; O’Brien, Thomas
MacGraw Hill, 2012

*Introduction to Biomedical Equipment Technology*
Carr & Brown

*Introduction to Biomedical Instrumentation: The Technology of Patient Care*
Christe, Barbara
Cambridge University Press, 2009

*Medical Equipment Management Manual*
Stiefel, Robert H.

*NFPA 99 Health Care Facilities*
National Fire Protection Association, 2012

*NFPA 99 Health Care Facilities Code Handbook*
National Fire Protection Association, 2012

*Principles of Biomedical Instrumentation and Measurement*
Aston, R.
Merrill Publishing Co., Columbus, OH, 1990

*Radiographic Science for Technologists: Physics, Biology, and Protection, 10th ed.*
Bushong, Stewart C.
Resources for BMET Educational Programs

Recommended practice for a medical equipment management program, ANSI/AAMI EQ56:2013

Safety in Healthcare Facilities
Cram, Nicolas; Holder, Selby
TSTC, 2007

Tech Careers: Biomedical Equipment Technicians
Bowles, Roger
ISBN 978-1-934302-29-3

Ultrasound Physics and Technology: How, Why, and When
Gibbs, Vivien; Cole, David; Sassano, Antonio

Electronics

Circuit Analysis—Theory and Practice
Robbins, Allan; Miller, Wilhelm C.

Digital Fundamentals
Floyd, Thomas L.
Prentice Hall, ISBN 9780132359238

Digital Systems, 10th ed.
Tocci, Ronald J.
Prentice Hall

Digital Systems Principles and Applications
Tocci, Ronald J.; Widmer, Neal S.

Drafting for Electronics, 3rd ed.
Lamit and Lloyd
Prentice Hall

Electrical Machines, Drives, and Power systems, 6th ed.
Wildi, T.
Prentice Hall

Electronic Devices and Circuit Theory, 10th ed.
Boylestad, Robert; Naqshelsky, Louis
Prentice-Hall, 2009

Electronic Devices—Conventional Flow Version
Floyd, Thomas L.
Prentice Hall, ISBN 0131140809

Electronic Devices—Electron Flow Version
Floyd, Thomas L.
Prentice Hall, ISBN 0132549859

Electronic Principles, 7th ed.
Malvino, Albert

Electronics—A First Course
Bishop, Owen
ISBN 0-7506-6960-8

Electronic Devices
Floyd, Thomas L.

Electronics Fundamentals, Circuits, Devices, and Applications, 8th ed.
Floyd, Russell L.; Buchia, David M.

Essentials of Electronics, 2nd ed.
Petruzella, Frank D.

Meade, Russell L.; Diffenderfer, Robert
Thomson Delmar Learning, 2007

Grob Basic Electronics
Grob, Bernhard

Introductory Circuit Analysis, 12th ed.
Boylestad, Robert L.

Introductory Electronic Devices and Circuits, 7th ed.
Paynter, R. T.
Prentice Hall, 2003

Operational Amplifiers and Linear Integrated Circuits
Coughlin, Driscoll
Prentice Hall, ISBN 9780130149916

Principles of Electric Circuits
Floyd, Thomas L.

Sensors and Signal Conditioning
Pallas-Areny, Ramon; Webster, John G.
Wiley & Sons, 2006

TTL Data Book
Texas Instruments
**Information Technology**

*Application of risk management for IT Networks incorporating medical devices—Part 1: Roles, responsibilities and activities, ANSI/AAMI/IEC 80001-1:2010*


*Application of quality management system concepts to Medical Device Data Systems (MDDS), ANSI/AAMI SW87:2012*


*Beginning Programming for Dummies*

Burd, Barry

*Digital Fundamentals*

Floyd, Thomas L.
Pearson Education, 2005

*MC68HC12 An Introduction: Software and Hardware*

Huang, Han-Way
Thomson/Delmar Learning, ISBN 076683484

*Microsoft Office 2003*

Beskeen, David W.; Cram, Carol M.; Duffy, Jennifer; Friedrichsen, Lisa; Reding, Elizabeth E.

*Network + Guide to Networks*

Dean, Tamara
Course Technology, 2009, ISBN 1423902459

*Networking for Home and Small Businesses*

Reid, Allen; Lorenz, Jim
Cisco Press, 2007

*Peter Norton’s Introduction to Computers*

Peter Norton

*Programming in Visual Basic 6.0*

Bradley, Julia Case; Millsapgh, Anita C.

*Practical Computing, 2nd ed.*

Hogan, Lynn
Pearson Education Inc., 2009

*The 8051 Microcontroller & Embedded Systems*

Mazidi, Muhammed Ali

*Upgrading and Repairing PCs, 19th ed.*

Mueller, Scott
Que Publishing, 2009

**Anatomy and Physiology**

*Anatomy and Physiology from Science to Life, 2nd ed.*

Jenkins, Gail; Kemnitz, Christopher; Tortora, Gerard
John Wiley & Sons, 2010

*Barron’s Essential Atlas of Physiology*

Barron’s Educational, 2005, ISBN 0764130935,
9780764130939

*Essentials of Human Anatomy and Physiology with Essentials of Interactive Physiology*

Marieb, Elaine N.

*Memmler’s The Human Body in Health and Disease, 11th ed.*

Cohen, Barbara Janson

*Anatomy and Physiology Complete Collection DVD*

CTI Productions, 2010
RESOURCES
Resources for BMET Educational Programs

Mathematics

Algebra and Trigonometry, An Early Functions Approach, 2nd ed.
Blitzer, Robert
Prentice Hall, 2006

Basic Technical Mathematics with Calculus, 9th ed.
Washington, Allyn J.
Addison-Wesley, 2009

Calculus Early Transcendentals
Varberg, Purcell, and Rigdon
Pearson Prentice Hall

Larson, Ron
ISBN 9780495970651

College Algebra, Graphs and Models, 4th ed.
Bittinger, Beecher, Ellenbogen & Penna
Pearson/Addison-Wesley, 2009

Mathematics with Applications, 9th ed.
Lial, Margaret L.; Hungerford, Thomas, W.

The Nature of Mathematics
Smith, Karl J.

Trigonometry Alternate, 8th ed.
Larson, Ron
ISBN 9780495970668

Other

The Bedford Reader, 11th ed.
Kennedy, X.J.; Kennedy, Dorothy M.; Aaron, Jane E.

College Physics, 9th ed.
Serway, Raymond A.; Vullie, Chris

Bassham, G.; Irwin, W.; Nardone, H.; Wallace, J.

General, Organic, and Biological Chemistry, Structures of Life, 3rd ed.
Timberlake, Karen
Pearson, Prentice Hall

General, Organic, and Biological Chemistry, 5th ed.
Stoker, H. Stephen
Houghton Mifflin, 2007

Aamodt, Michael G.
Wadsworth, 2010

Introductory Chemistry
Corwin, C.
Prentice Hall

Introduction to Engineering Technology
Pond, R.; Rankinen, J.
Pearson Publishing

Physical Science, 9th ed.
Tillery, Bill W.
McGraw Hill, 2011

The Physical Universe, 13th ed.
Krauskopf, K.; Beiser, A.
McGraw Hill, 2010

Physics, 8th ed., Volume 2
Cutnell and Johnson

Reid, Stephen
Prentice Hall, Upper Saddle River, 2006

Public Speaking
Beebe, Steven A.; Beebe, Susan J.
Allyn and Bacon, 2006


Studying Engineering: A Roadmap to a Rewarding Career, 3rd ed.
Landis, Raymond B.
Workbooks

Dell

Anatomy & Physiology Laboratory Manual
Math-Science Department
Cengage Publishers, 2010

The Composition of Everyday Life, Brief, 3rd ed.
Mauk, John; Metz, John
Wadsworth, 2010

DC Lab Manual
Morris

Experiments in Electronics Fundamentals and Electric Circuits
Fundamentals, 8th ed.
Buchia, David M.
Pearson Prentice Hall, 2010

Inorganic and Organic Chemistry CHM 115
Laboratory Manual
Beaupry, Lesa; Hartzell, Bruce; Smith, Bruce
Pearson Custom Publishing, 2005

Laboratory Exercises for Electronic Devices
Buchla, David
ISBN 9780132429719

Laboratory Projects to Accompany Foundations of Electronics,
5th ed.
Meade, Russell L.
Thomson Delmar CENGAGE Learning, 2007

The Little, Brown Compact Handbook, 7th ed.
Aaron, Jane
Pearson Longman, 2010

A Sequence for Academic Writing, 4th ed.
Behrens, Laurence; Rosen, Leonard J.
Pearson, 2010

Study Guide for Memmler’s The Human Body in Health
and Disease, 11th ed.
Cohen, Barbara Janson

They Say, I Say, 2nd ed.
Graff, Gerald; Birkenstein, Cathy
Norton and Co., 2010

A Troubleshooting Approach to Accompany Digital Principles
and Applications
Deloach, Jim C.; Ambrosio, Frank
ISBN 0-13-188136-1

Tools/Supplies

Arduino Experimentation Kit, ARDX, v1.0
Digital/analog trainer, RSR Electronics pn P01PAD234A
Digital multimeter
Electronics component kit
Electronics tool kit
Graphing calculator
Logic probe kit, Elenco Electronics model LP-525K
LabVolt MindSight System
MS Excel
MS Word
Removable storage device
Scientific calculator
Accreditation
Accreditation

Accreditation of institutions of higher learning is intended to ensure the quality of the education provided. There are a variety of types of accreditation, including national or regional, and institutional or programmatic. There are over 7,000 colleges and universities and more than 20,000 programs accredited by 19 institutional accrediting agencies and 61 programmatic accreditors (Eaton, JS.).

Accrediting agencies are private educational associations that conduct peer evaluations of educational institutions and programs. Accreditation agencies do not specify curricula or competencies. Accrediting agencies can, in turn, be accredited by the U.S. Department of Education (USDE), the Council for Higher Education Accreditation (CHEA), or both. Institutions of higher learning that are accredited by an agency that is recognized by the U.S. Secretary of Education can participate in federal financial assistance programs administered by the U.S. Department of Education.

ABET and The Association of Technology, Management, and Applied Engineering (ATMAE) are national accreditation agencies that accredit programs in applied science, computing, engineering, and engineering technology. Most of the agencies that accredit institutions that provide BMET education programs are regional and accredit the entire institution—not individual programs.

Regional accreditation agencies include:

- Middle States Association of Colleges and Schools
- New England Association of Schools and Colleges
- New York State Board of Regents
- North Central Association of Colleges and Schools
- Northwest Commission on Colleges and Universities
- Oklahoma Board of Career and Technology Education
- Oklahoma State Regents for Higher Education
- Pennsylvania State Board of Vocational Education
- Puerto Rico State Agency for the Approval of Public Postsecondary Vocational, Technical Institutions and Programs
- Southern Association of Colleges and Schools
- Western Association—Community and Junior Colleges
- Western Association—Senior Colleges and Universities
It is beyond the scope of this Guide to discuss the accreditation criteria for BMET educational programs or their schools. However, the ABET criteria may serve as an example. The ABET program criteria for bioengineering technology (and similarly named programs) are more general than the specific topics included in our BMET topics list. Their criteria are available on ABET’s website at www.abet.org/accreditation-criteria-policies-documents (see Figure 4).

### ABET Accreditation Criteria for Bioengineering Technology and Similarly Named Programs

**Lead Society:** Biomedical Engineering Society

**Cooperating Societies:** American Ceramic Society, American Institute of Chemical Engineers, American Society of Agricultural and Biological Engineers, American Society of Mechanical Engineers, Institute of Electrical and Electronics Engineers

**Applicability:** These program criteria apply to engineering technology programs that include bioengineering, biomedical engineering, medical electronics, biomedical equipment and similar modifiers in their titles.

**Objective:** An accreditable program in Bioengineering Technology will prepare graduates with the technical skills necessary to enter careers in the design, application, installation, operation and/or maintenance of biomedical equipment. Graduates of associate degree programs typically have strengths in the building, testing, operation, and maintenance of existing biomedical equipment or systems, whereas baccalaureate degree graduates are well prepared for development and implementation of biomedical equipment or systems.

**Outcomes:**

Graduates of associate degree programs must demonstrate knowledge and hands-on competence appropriate to the goals of the program in the following:

a. the application of circuit analysis and design, analog and digital electronics, microcomputers, bioengineering systems, and safety in the building, testing, operation, and maintenance of biomedical equipment; and

b. the applications of physics, chemistry, and biological sciences to building, testing, operation, and maintenance of biomedical equipment in a rigorous mathematical environment at or above the level of algebra and trigonometry;

In addition to the above, graduates of baccalaureate degree programs must demonstrate the following:

a. the ability to analyze, design, and implement bioengineering systems;

b. the ability to utilize statistics/probability, transform methods, discrete mathematics, or applied differential equations in support of bioengineering systems; and

c. an understanding of the clinical application of biomedical equipment.

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**Figure 4. ABET Accreditation Criteria**
Accreditation

AAMI/ICC Certification

The International Certification Commission for Clinical Engineering and Biomedical Technology (ICC), through AAMI, certifies biomedical equipment technicians (CBET), radiology equipment specialists (CRES), and laboratory equipment specialists (CLES).

The AAMI/ICC Certification for the Biomedical Equipment Technician (BMET) is a formal recognition by the International Certification Commission for Clinical Engineering and Biomedical Technology for individuals that have demonstrated excellence in theoretical as well as practical knowledge of the principles of biomedical equipment technology.

Certification gives formal recognition of an individual’s theoretical and practical knowledge of biomedical equipment technology. Information about certification and the current “Handbook for Applicants” is available from AAMI (see www.aami.org/certification). The handbook explains the application for testing and the exam itself. See Figure 5 for a list of the topics included in the 2012 edition of the handbook.

Applicants must have an appropriate combination of education and experience. One such combination is an associate’s degree in biomedical equipment technology and two years of full-time BMET experience. However, applicants can also be eligible for candidate status by completing their educational requirement. Then, upon completion of the experience requirement, they can receive full certification.
I. Anatomy and Physiology (Approximately 12%)
   A. Systems
      1. Respiratory
      2. Gastrointestinal
      3. Nervous
      4. Circulatory
      5. Musculoskeletal
      6. Endocrine
   B. Organs
      1. Heart
      2. Lungs
      3. Liver
      4. Kidneys
      5. Brain
      6. Gallbladder
      7. Pancreas
      8. Other
   C. Blood
      1. Components
      2. Metabolism
   D. Terminology

II. Public (employee, patient, visitor) Safety in The Healthcare Facility (Approximately 15%)
   A. Electrical
      1. Microshock/Electrical Safety Testing
      2. Other
   B. Chemical
      1. Material Safety Data Sheet
      2. Other
   C. Radiation Hazards
      1. Light Spectrum
      2. Types of Rays
   D. Biological
      1. Standard Precautions
      2. Other
   E. Fire
      1. Class
      2. Fire Extinguishers
   F. Codes and Standards
      1. Credentialing and Certification
         a. Joint Commission Comprehensive Accreditation Manual
         b. AABB
         c. American College of Radiology

Figure 5. List of topics in 2013 CBET Examination

Please refer to the most recent version of the handbook, available at www.aami.org/certification.
2. NFPA 99
   a. Gas and Vacuum Systems
   b. Electrical Systems
3. FDA
   a. SMDA
   b. Other
4. OSHA
5. Other (NEC, ANSI, FCC, etc.)

III. Fundamentals of Electricity and Electronics *(Approximately 13%)*

A. Transducers
B. Calculations and Conversions
   1. Hex/Decimal/Binary
   2. Other
C. Circuits and Components
   1. Active Devices
      a. Solid-State Devices
         1. Analog
         2. Digital
      b. Other (CRTs, X-Ray tubes, Photomultipliers, etc.)
   2. Power Supplies
   3. Passive Devices
D. Power Distribution and Storage Systems
   1. Transformers
   2. Distribution
   3. Batteries
   4. UPS/Line Conditioning
E. Terminology

IV. Healthcare Technology Function and Operation *(Approximately 25%)*

A. Monitoring Systems (ECG, EEG, Blood Pressure, Pulse Oximetry, Fetal Monitor)
B. Portable Equipment (Infusion Devices, Syringe Pumps, PCA Pumps, Hypo Hyperthermia)
C. Life Support Equipment (Defibrillators, Anesthesia Machines, Critical Care Ventilators, Balloon Pumps)
D. Therapeutic Equipment (Infant Warmers, Ultrasound Therapy)
E. Laboratory Equipment (Centrifuges, Water Baths, Analyzers)
F. Diagnostic Imaging (Ultrasound, Radiographic/Fluoroscopy)
G. Operating Room (Electro Surgical Generators, Video Carts, Lasers, Tournquets, Sterilizers, Warmers)
H. Test Equipment (Electrical Safety, Defibrillator, Electro Surgical, Physiologic Simulators, Oscilloscopes, Meters)
I. Diagnostic Equipment
J. Terminology

Figure 5. List of topics in 2013 CBET Examination (continued)
## V. Healthcare Technology Problem Solving *(Approximately 25%)*

- A. Electronic Component Level, Block Level
- B. Monitoring Systems (ECG, EEG, Blood Pressure, Pulse Oximetry, Fetal Monitor)
- C. Portable Equipment (Infusion Devices, Syringe Pumps, PCA Pumps, Hypo Hyperthermia)
- D. Life Support Equipment (Defibrillators, Hemodialysis, Anesthesia Machines, Critical Care Ventilators, Balloon Pumps)
- E. Therapeutic Equipment (Infant Warmers, Ultrasound Therapy)
- F. Laboratory Equipment (Centrifuges, Water Baths, Analyzers)
- G. Diagnostic Imaging (Ultrasound, Radiographic/Fluoroscopy)
- H. Operating Room (Electro Surgical Generators, Video Carts, Lasers, Tourniquets, Sterilizers, Warmers)
- I. Diagnostic Equipment
- J. Situational (User Error, User Training, Applications)

## VI. Healthcare Information Technology *(Approximately 10%)*

- A. Regulatory and Safety
  - 1. Medical Device Data Systems (MDDS)
  - 2. IEC 80001 – Application of Risk Management for IT Networks
  - 3. Health Insurance Portability and Accountability Act (HIPAA)
  - 4. Digital Millennium Copyright Act (DMCA)
- B. Foundations
  - 1. Hardware
    - a. Topology
    - b. PCs/Laptops/Servers
    - c. Wiring/Structured Cabling/Connectors
    - d. Switches/Hubs/Routers
    - e. Wireless Communications
    - f. Other
  - 2. Software/Middleware/Applications
    - a. EMR/EHR
    - b. Healthcare Information Systems (PACs, LIS, RIS)
    - c. Network Protocols (IP, CCP, UDP)
    - d. Operating Systems
- C. Function and Operation
  - 1. Hardware
    - a. PCs, Switches, Patch Panels
    - b. Networks, Topology
    - c. Peripherals
    - d. Other

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*Figure 5. List of topics in 2013 CBET Examination (continued)*
2. Integration
   a. Bedside Medical Device Integration (BMDI)
   b. Medical Device Integration (MDI) (Labs, Printers, etc.)
   c. Mobile Devices (Handhelds, Smart Phones, Tablets, etc.)
3. Test Equipment
   a. Cable Test Devices (Copper, Fiber)
   b. Network Test Devices
4. Security
D. Problem Solving
   1. Computer Networks
   2. Integration
   3. PCs, Switches, Hubs
E. Terminology

Figure 5. List of topics in 2013 CBET Examination (continued)
Definitions and Acronyms
Definitions and Acronyms

**AAMI** Association for the Advancement of Medical Instrumentation

**Accredit/Accreditation** 1. To bring into credit or favor. 2. To authorize; give credentials to. 3. To believe in; take as true. 4. To certify as meeting certain set standards by regional associations. 5. To attribute. *Webster’s New World Dictionary.* A process in which certification of competency, authority, or credibility is presented by an authoritative body.

**ACCE** American College of Clinical Engineering

**ACL** Access control list

**ANSI** American National Standards Institute

**ATM** Asynchronous transfer mode

**ATMAE** Association of Technology, Management and Applied Engineering

**ATP** Adenosine triphosphate

**BIOS** Basic input/output system

**BIS** Bispectral index—as in “BIS monitor”

**BJT** Bipolar junction transistor

**BMET** Biomedical Equipment Technician/Technologist

**CBET (Certified Biomedical Equipment Technician)** A professional certification issued to eligible individuals upon passing the AAMI/International Certification Commission exam.

**CDC** Centers for Disease Control and Prevention

**CD-ROM** Compact disc–read only memory

**CDRH** Centers for Devices and Radiological Health (Division of the U.S. Food and Drug Administration)

**CE** Clinical Engineering

**CFR** Code of Federal Regulations

**CHEA** Council for Higher Education Accreditation

**CIDR** Classless inter-domain routing

**CLES (Certified Laboratory Equipment Specialist)** A professional certification issued to eligible individuals upon passing the AAMI/International Certification Commission exam.

**CMMS** Computerized maintenance management system

**CMOS** Complementary metal-oxide-semiconductor—as in “CMOS devices”
Competence/competent 1. Well qualified; capable; fit. 2. Sufficient; adequate. 3. Permissible or properly belonging; authorized, or fit. *Webster’s New World Dictionary.*

**Core competency** An area of specialized expertise that is the result of harmonizing complex streams of technology and work activity.” ~ C.K. Prahalad

**Core competency** An area of expertise that is fundamental to a particular job or function. *Encarta® World English Dictionary [North American Edition] © & (P) 2009 Microsoft Corporation*

**Competency** An observable and measurable behavior that has a definite beginning and end; can be performed within a limited amount of time; consists of two or more competency builders; and leads to a product, service, or decision.

**Competency builders** The skills, knowledge, and attitudes (written in measurable terms) needed to perform a given competency.

**CPM** Continuous passive motion—as in “CPM unit”

**CRES** (Certified Radiology Equipment Specialist) A professional certification issued to eligible individuals upon passing the AAMI/International Certification Commission exam.

**CSMA** Carrier sense multiple access

**CT** Computed tomography

**DHCP** Dynamic host configuration protocol

**DMA** Direct memory access

**DNS** Domain name system

**DSL** Digital subscriber line

**ECG** Electrocardiogram

**EIGRP** Enhanced interior gateway routing protocol

**Entry level** A position of employment that requires no previous experience, but may require some training and/or specific skills, knowledge, or attitudes.

**EPROM** Erasable programmable read-only memory

**ESD** Electrostatic discharge

**ETA** Electronics Technician Association

**FCC** Federal Communications Commission

**FDDI** Fiber distributed data interface

**FET** Field effect transistor

**FSE** Field service engineers

**FSO** Free space optics

**FTP** File transfer protocol

**Healthcare Technology Management (HTM)** The professional field responsible for managing the selection, maintenance, and safe and effective use of medical equipment and systems.

**ICC (International Certification Commission)** AAMI’s issuing body of professional certifications.

**ICS** Internet connection sharing

**Information technology** The field involving the design, application, and support of computer-based information systems. Information technology (IT) uses computers and telecommunications equipment to store, retrieve, transmit, and manipulate data.

**IP** Internet protocol

**IEEE** Institute of Electrical and Electronics Engineers

**IRQ** Interrupt request
ISO Independent service organization

JFET Junction gate field-effect transistor

LAN Local area network

LED Light emitting diode

MAC Media access control—as in “MAC address”

META Medical Engineers & Technicians Association

MRI Magnetic resonance imaging

MSDS Material safety data sheet

MOSFET Metal-oxide-semiconductor-field-effect-transistor

NAT/PAT Network address translation/port address translation

NEC National Electrical Code

NIBP Non-invasive blood pressure—as in “NIBP monitors”

NIC Network interface controller

NPFA National Fire Protection Agency

OEM Original equipment manufacturer

OSPF Open shortest path first

OSHA Occupational Safety and Health Administration

PACS Picture archiving and communication system

PPP Point to point protocol

PUT Programmable unijunction transistor

RIP Routing information protocol—as in “RIP route”

ROM Read only memory

SCR Silicon controlled rectifier

SCD Sequential compression device

SMDA Safe Medication Devices Act

SONET Synchronous optical network

SNMP Simple network management protocol

SWAP Shared wireless access protocol

TCP/IP Transmission control protocol/network protocol

TENS Transcutaneous electrical nerve stimulator—as in “TENS unit”

TJC The Joint Commission

TTL Transistor-transistor logic—as in “TTL devices”

UJT Unijunction transistor

USB Universal serial bus

USDE United States Department of Education

U.S. FDA United States Food and Drug Administration

VLAN Virtual local area network

VLSM Variable length subnet masking

VOIP Voice over internet protocol

VPN Virtual private network

WAN Wide area network

WLAN Wireless local area network
Bibliography and AAMI Online Resources
Bibliography


**AAMI Online Resources**

AAMI Career Tools for the HTM Community www.aami.org/careertools

AAMI Communities www.aami.org/communities

AAMI Membership www.aami.org/membership

AAMI Publications www.aami.org/publications

AAMI Student Website www.aami.org/student

BMET Schools www.aami.org/student/education.html

Promotion of the Field www.IamHTM.com
AAMI Programs Making a Difference

Standards—AAMI is a leading source of consensus standards and guidelines to expedite and enhance the development, management, and use of healthcare technology. More than 100 AAMI technical committees and working groups write medical device standards, recommended practices, and technical information reports on issues ranging from sterilization to dialysis and clinical alarms to electromedical equipment. E-mail: standards@aami.org.

Publications—AAMI offers several complimentary publications to keep members up to date on standards and regulations, new technologies, policy developments, and guidance. Visit www.aami.org/publications/books.

Books & CDs—AAMI’s comprehensive and practical books and manuals cover a wide variety of important topics including sterilization, information technology, accreditation, human factors, healthcare technology management, quality systems, and certification. Visit www.aami.org/books.

AAMI’s Annual Conference & Expo—It’s the premier conference for healthcare technology management—a three-day networking and learning experience that features the best and brightest speakers discussing key issues affecting patient safety and the healthcare technology management profession. To learn more, visit www.aami.org/ac.

International Standards Conference—The AAMI/FDA International Conference on Medical Device Standards and Regulation is a unique annual event bringing together industry and government leaders to explore the latest developments in international standards key to global market access and regulatory compliance. To learn more, visit www.aami.org/isc.

Training Programs—AAMI provides numerous face-to-face training programs, and online courses and webinars covering critical topics such as quality systems, sterilization, clinical engineering, design control, process and software validation, risk management, documents/records, statistics, purchasing controls, human factors, benchmarking, and IT issues. To learn more, visit www.aami.org/meetings.

Certification—AAMI provides leadership in public safety through the oversight of the International Certification Commission’s certification programs for biomedical equipment technicians (CBET), radiology equipment specialists (CRES), and laboratory equipment specialists (CLES). To learn more, visit www.aami.org/certification.

Benchmarking—AAMI offers two web-based benchmarking tools designed specifically to help healthcare technology management and sterile processing departments measure their practices, policies, and procedures against similar departments at other facilities. Visit www.aami.org/benchmarking.

Healthcare Technology Safety Institute (HTSI)—The AAMI Foundation’s HTSI is a new community of leaders focused on a common vision, “Healthcare technology will advance patient safety and will do no harm.” HTSI engages the healthcare community in multidisciplinary safety initiatives to strengthen the development, management, and use of healthcare technology for improved patient outcomes. To get involved, e-mail htsi@aami.org or visit www.aami.org/htsi.