Microcredentials for Healthcare Engineering Technology

A Competency Based Framework for Badging

Education

Industry
What is a Micro-credential?

If an A.S. degree is a large chunk of proven learning, a micro-credential can be thought of a small chunk of proven learning. Micro-credentials document, incentivize, and display proven competencies. Micro-credentials are often in a digital format that can be issued from an institution or an individual. Digital badges and certificates are an example of the most common forms of micro-credentials. To earn a badge or other micro-credential, certain criteria must be met through assessment. The process of developing badges is outlined further on page 4.

Who uses them?

Tons of companies and people. You have probably used them without even knowing it. Institutions that use badging in one form or another include: IBM, CISCO, U. S. Military, Bank of America, National Park Service, Reddit, almost every video game company, and of course higher education intuitions.

Why use them?

The healthcare technology management field is in need of of highly skilled biomedical equipment technicians. Technicians need proven, documented, update to date competencies in a variety of electromechanical tests, medical devices, and information technology. Microcredentials, specifically badges fulfill this in three ways:

Transparency

Badges provide clarity to what is learned by clearly stating what was proven. Badges can be tied to evidence which show what the learner is competent at in a much more granular level then a degree can.

Flexibility

Badges can be created and updated fluidly and quickly. Microcredentials do not have to go through traditional curriculum development processes and review.

Incentivization

Badges encourage competency mastery. A learner who only knows how to test a medical device in part, but not fully, is not what is needed. Incorrect testing or calibration is an unacceptable outcome when lives depend on the reliability of technology. Badges are earned only upon mastery of all required evidence. In addition, badges, unlike degrees can expire if competency evidence is not maintained regularly.
Biomedical Engineering Technology (BMET)

What is Biomedical Engineering Technology?
Also called BMET, biomed, medical equipment/device repair technicians, and aka biomedical equipment technicians. Yes there is a naming issue in this career path. But the bottom line is anyone who works with managing, repairing, maintaining, and documenting medical technology is a part of this field. The field name is healthcare technology management and the primary industry organization is the American Association for Medical Instrumentation (AAMI). The BMET program at St. Petersburg College aligns curriculum to the AAMI core competencies.

What do they do?
These professionals can specialize in a variety of areas in healthcare technology. They maintain equipment through preventative maintenance, repair equipment, document work, update medical device software, network medical devices, and maintain endpoint security.

Where do they work?
Students work for hospitals, medical device manufactures, and third party service providers – most will work with basic medical devices to start, but other avenues for careers include specialized lab equipment, medical imaging equipment, medical device training, medical device sales, management, and customer support.
Badge Process

IDENTIFY
First, local and national industry is surveyed for desired set of skills for entry level BMET’s. The most frequently requested competencies are used to build digital badges.

BUILD
Badges are built using identified competencies. Badges can include: image, name, description, criteria, and expiration date. For more detailed explanation of badging check out the latest badging standards [click here](#) for open badges standard.

ASSESS
Learners perform competency checklist for assessment by a qualified evaluator. Learners who meet qualifications are awarded badge.

PROVE
Evidence of competencies are documented using video, pictures, and written reports.

SHARE
Learners share their earned credentials with potential employers by displaying evidence linked badges in resumes, digital portfolios, and social platforms such as LinkedIn.
Example of Badge

An example of a badge for electrical safety testing is shown below. The image is what a learner or viewer (such as an employer) would see. Each area of the badge is explained.

**Badge Image** - Images are developed to visually communicate earned competencies. They also can reinforce broader brand awareness of an institution, organization, and or career field.

**Badge Name** - Title of the badge serves to reinforce and clarify badge image, also important for keyword searches and search engine optimization for badge issuers.

**Badge Description** - A brief description of what the badge, can be used to summarize badge criteria.

**Badge Criteria** - Checklist of required competencies, should include enough detail to be replicated consistently between different issuers reviewers.

**Badge Hashtags** - Important for social platform sharing and search optimization can help market learner and improve community awareness.
Mapping Badges to Curriculum

This template (or key) outlines each section in the layout for our developed badges and how they align to curriculum, content, and assessment.

1st Section: General Information
Includes badge image, badge name, and badge description

2nd Section: Alignments
Shows what alignment to Program outcomes, AAMI core competencies, and course learning objectives

3rd Section: Supporting Content
Content can be used to support the learner as they work towards the required competencies. Priority was given to free readily accessible content when possible.

4th Section: Criteria and Recommended Assessment

Criteria – is a descriptive list of competencies that must be completed by the learner to earn the badge, competencies should be verified by the qualified evaluator.

Recommended Assessments – These are assessments created to evaluate criteria. Ultimately as long as the criteria is met the badge can be awarded, but recommended assessment can be used provide uniformity between institutions and best practice sharing.
Badges

**Badge Name:** Electrical Safety Testing

**Description:** Learner is able to perform and analyze electrical safety tests for medical devices

---

**Program Learning Outcome:**
Student is able to perform performance checks and inspect and medical equipment

**AAMI Core Competency:**
I. Biomedical Equipment Technology
   1. D Test Equipment and procedures
   G. Safety regulations and standards

**Course and Learning Objective Alignment [COURSE ETI1412]**
1.a. researching and recognizing the regulations from Association for the Advancement of Medical Instrumentation
2.a. selecting the correct piece of equipment to test biomedical devices
2.b. performing electrical safety test to check for ground leakage, chassis leakage, patient leakage, and patient auxiliary leakage
7.a. analyzing and recognizing procedures needed for new equipment receiving, testing and installation
1.e. researching and recognizing the regulations from National Fire Protection Association

---

**Supporting Content Links (see online version to use links)**
- [Engineering Technology for Healthcare Playlist](#)
- [Electrical Safety: Standards and Basic Testing](#)
- [Rigel ISO 60601 Guide](#)
- [Electrical Safety Manual 2015](#)
- [The Practical Approach to Electrical Safety Testing Webinar - Rigel Medical](#)

---

**Criteria**
- Ground wire resistance (with ESA and multimeter)
- Earth leakage
- Enclosure leakage
- Patient leakage
- Patient auxiliary leakage
- Perform tests to IEC60601 standards
- Perform tests to NFPA 99 standards

**Recommend Assessment**
Electrical Safety Activity NFPA and ISO60601 located in content folder called activities, use this [link](#) for access
**Badge Name:** Electrical Troubleshooting

**Description:** Leaner is able to perform electrical troubleshooting including: test fuses operational amplifiers, resistors, diodes, and capacitors, soldering and de-soldering, build circuits, repair power supplies and plugs, test and replace batteries, create electrical schematics.

**Program Learning Outcome:**
Student will test and repair electrical equipment

**AAMI Core Competency:**
II. Electronics
A. Basic concepts of electricity
B. Direct current principles, circuits and analysis
C. Alternating current principles, circuits, and analysis
D. Solid state devices and analysis
E. Digital electronics
F. Telecommunications and signal transmission
G. Electrical test equipment including meters and oscilloscopes
H. Technical skills including component identification and schematic usage
I. Basic sensors and actuators including motors and actuators including motors

**Course and Learning Objective Alignment [COURSE ETS2424]**
1.b. recognizing and describing uses of biomedical sensors and transducers.
4.d. describing the operation of amplifier circuits.
3.g. measuring the circuit parameters related to diodes and transistors.
2.k. measuring the AC circuit parameters related to resistance, voltage and current.
1.h. measuring the DC circuit parameters related to resistance, voltage and current.
1.a. measuring voltage, current, and resistance using the digital multimeter
1.b. determining different frequencies and waveforms using a function generator.
2.a. choosing the correct piece of electronic equipment when presented to test parameters on electronic circuits.
4.d. applying basic measurement techniques to electronic circuits.

**Supporting Content Links (see online version to use links)**
Engineering Technology for Healthcare Playlist

**Criteria**
- Measure resistance
- Verify/test fuse (in circuit, out of circuit, visually)
- Test/verify op-amp
- Test/measure capacitor
- Test/measure diode
- Solder and de-solder
- Perform oscilloscope scope measurements of voltage versus time
- Repair power plug
- Replace battery
- Power supply troubleshooting
- Test line voltage
- Identify type of signal (analog versus digital)
- Build/create operational amplifier circuit
- Test/measure electronic board test points
- Create electrical schematic
- Identify alarm conditions for LIM

**Recommend Assessments**
Learner is given a circuit and testing equipment. The circuit includes an operational amplifier, resistor, capacitor, and diode. One or more components should not work. The student must identify which component is not working then the student must correctly fix the circuit. They must verify amplification of a signal using the oscilloscope. Then they must draw an electrical schematic of the built circuit.

Learner is given multiple power supplies with switches, batteries, and fuses. Student must troubleshoot problems correctly.

Electric Stethoscope Activity—located in content folder called activities, use this link for access
**Badges**

**Badge Name:** Computer Hardware and Software

**Description:** Learner is able to perform computer hardware and software work including installation, network connections, and operating system maintenance

---

**Program Learning Outcome:**
Student is able support software based medical devices

**AAMI Core Competency:**
III. Information Technology
   A. Basic concepts of computer architecture and systems
   B. Computer connectors and cabling

---

**Course and Learning Objective Alignment [COURSE CET1175]**
2.e. using MS Office applications to organize and produce documentation that includes word processing, spreadsheets and databases needed in a healthcare setting
2.a. using and configuring the Windows Operating System for use in a health care setting

---

**Supporting Content Links** (see online version to use links)
[Engineering Technology for Healthcare Playlist](#)

---

**Criteria**
- Install operating system
- Create network patch cable
- Install wireless router
- Install and format hard drive
- Install power supply
- Access Bios
- Determine CPU usage and disk space
- Run disk cleanup and defragment hard drive

**Recommend Assessment**
- Learner builds and tests patch cable
- Operating system tools activity
- Computer hardware activity
- Computer software activity
- Content located in content folder called activities, use this [link](#) for access
# Badges

**Badge Name:** Defibrillator Performance Testing  
**Description:** Learner is able to test defibrillator for energy output, pacer function, and create automatic test sequences surgical generator for power output, high frequency leakage

<table>
<thead>
<tr>
<th>Program Learning Outcome:</th>
<th>Course and Learning Objective Alignment [COURSE ETS2424]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student is able to perform performance checks and inspect and medical equipment</td>
<td>2.a. identifying functions and demonstrating the operation of selected biomedical instrumentation.</td>
</tr>
</tbody>
</table>

**AAMI Core Competency:**  
I. Biomedical Equipment Technology  
C. Medical equipment  
D. Test Equipment and procedures  
G. Safety regulations and standards

**Supporting Content Links (see online version to use links)**  
[Engineering Technology for Healthcare Playlist](#)

**Criteria**  
- Perform energy output test  
- Verify defibrillator diagnostics  
- Test pacer  
- Create automatic test sequence

**Recommend Assessment**  
Defibrillator Activity – located in content folder called activities, use this [link](#) for access
**Badges**

**Badge Name:** Electrosurgical Performance Testing

**Description:** Learner is able to test electrical surgical generator for power output, high frequency leakage, and RECM

---

**Program Learning Outcome:**
Student is able to perform performance checks and inspect and medical equipment

**AAMI Core Competency:**
I. Biomedical Equipment Technology
C. Medical equipment
D. Test Equipment and procedures
G. Safety regulations and standards

**Course and Learning Objective Alignment**
2.b. recognizing functions and demonstrating operation of electrosurgical generators and related biomedical technology for specialty units
5.a. diagnosing and testing electro-surgical generators
b. analyzing and calibrating electro-surgical generators
c. troubleshooting and repairing electro-surgical generators
d. analyzing and maintaining electro-surgical generators

---

**Supporting Content Links (see online version to use links)**
- Engineering Technology for Healthcare Playlist
- Preventive maintenance on electrosurgical units

---

**Criteria**
- Safely use generator
- Measure Power output
- Measure High frequency leakage
- Test RECM

**Recommend Assessment**
- Electrical Safety Generator Activity – located in content folder called activities, use this [link](#) for access
Badges

**Badge Name:** Infusion Pump Performance Testing

**Description:** Learner is able to test infusion pumps for: flow rate and occlusion pressure

**Program Learning Outcome:**
Student is able to perform performance checks and inspect and medical equipment

**AAMI Core Competency:**
I. Biomedical Equipment Technology
C. Medical equipment
D. Test Equipment and procedures
G. Safety regulations and standards

**Course and Learning Objective Alignment [COURSE BME1008]**
5.e. Testing and verifying infusion devices to check correct flow rates and total dispensed volume

**Supporting Content Links** (see online version to use links)
[Engineering Technology for Healthcare Playlist](#)

**Criteria**
- Verify alarms
- Test occlusion pressure sensor
- Flow rate verification using density
- Flow rate verification using flow sensor

**Recommend Assessment**
Infusion pump activity - located in content folder called activities, use this [link](#) for access
Badges

**Badge Name:** Mechanical Skills

**Description:** Learner is able to use mechanical tools including: hammer, screwdriver, heat gun, soldering gun, wire strippers, crimping tool, and hose clamps

---

**Program Learning Outcome:**
Able to use mechanical tools including:

**AAMI Core Competency:**
I. Biomedical Equipment Technology
D. Test Equipment and procedures
E. Troubleshooting and repair

**Course and Learning Objective Alignment [Course ETS2940]:**
3.a. Carrying out preventive maintenance of protocol for selected biomedical instrumentation.
3.d. Performing repairs on selected biomedical technology.

**Course and Learning Objective Alignment [Course ETS2424]:**
4.d. Examining and maintaining basic mechanical, fluidic, and pneumatic systems.

---

**Supporting Content Links (see online version to use links):**
Engineering Technology for Healthcare Playlist

---

**Criteria**
Learner is able to identify and use the following tools:
- Hammer
- Screwdriver
- Heat gun
- Soldering gun
- Desoldering tool
- Wire strippers
- Crimping tool
- Hose clamps and connectors

**Recommend Assessment**
Student must be able to identify, select, and properly use tools to install, repair, and test medical devices
Badges

**Badge Name:** Medical Device Networking

**Description:** Learner is able to monitor, test, and analyze networked medical equipment

**Program Learning Outcome:**
Student is able support software based medical devices

**AAMI Core Competency:**
III.E. Fundamentals of local area networks (LANs) including hardware, software, management, and security
III.F. Computer and device communications including protocols and address schemes

**Course and Learning Objective Alignment [COURSE ETS2450C]**
2.e. creating network connections with Ethernet and network interface cards

**Supporting Content Links (see online version to use links)**
Engineering Technology for Healthcare Playlist

**Criteria**

- Ping a medical device
- Connect telemetry
- Connect infusion pump using Wi-Fi or Bluetooth
- Find/check MAC address, IP address
- Configure common network settings
- Interpreting HL7

**Recommend Assessment**
Learner will build a small scale network that connects to a medical device. Learner will use listed criteria to create and configure network. The learner will then observe data using packet capture software and interpret data.
Badges

**Badge Name:** Medical Device Security

**Description:** Learner is able to test security of a medical devices

---

**Program Learning Outcome:**
Student is able support software based medical devices

**AAMI Core Competency:**
I. G safety regulations and standards
I. C Medical equipment
II. F Telecommunications of signal transmission
III.G. HIPAA HIPAA regulations, HL7 protocols, and device integration with the electronic medical record

**Course and Learning Objective Alignment [ETS2470]**
4.c. discussing and creating methods for hacking medical devices
4.d. designing and creating methods for securing medical devices
3.g. identifying and evaluating potential vulnerability that are in the healthcare technology environment
4.b. analyzing patient data that is transmitted between devices

---

**Supporting Content Links (see online version to use links)**
Engineering Technology for Healthcare Playlist

---

**Criteria**

- Monitor network traffic to device
- Utilize HL7 to communicate information to medical equipment
- Remove malware from computers and medical equipment
- Identify phishing emails
- Remove ransomware
- Transfer and store images in PACS/DICOM
- Identifies HIPPA violations

---

**Recommend Assessment**
Learner will perform a penetration test and create a written report for a medical device using an exploitation framework
**Badges**

**Badge Name:** Medical Device Software  
**Description:** Learner is able to use medical testing software and medical computerized maintenance software

---

**Program Learning Outcome:**  
Student is able support software based medical devices  

**AAMI Core Competency:**  
III.G. HIPAA regulations, HL7 protocols, and device integration with the electronic medical record  
III. Fundamental decision making in computer programs including loops

**Course and Learning Objective Alignment [ETS2450C]**  
1.c. analyzing and describing network traffic of a medical device  
1.d. analyzing network cables with a tester  
2.g. creating a segregated network  
2.f. creating a network connection using a terminal emulator  
3.c. identifying a describing HL7  
4.g. creating a method to store and transfer patient data from a medical device to a data storage location

---

**Supporting Content Links (see online version to use links)**  
Engineering Technology for Healthcare Playlist

---

**Criteria**  
Install and use medical device software  
Document medical repairs in CMMS  
Using medical software

**Recommend Assessment**  
Computerized Maintenance Management System Activity – located in content folder called activities, use this link for access
**Badges**

**Badge Name:** Medical Device Troubleshooting  
**Description:** Learner is able to troubleshoot medical equipment including: fluid and air pumps, touch screens, pulse oximetry, and electronic board.

**Program Learning Outcome:**  
Student is able to repair and fix medical equipment

**AAMI Core Competency:**  
I. Biomedical Equipment Technology  
C. Medical Equipment  
D. Test Equipment and procedures  
E. Troubleshooting and repair  
F. Actuators and displays

**Course and Learning Objective Alignment**  
4.a. recognizing, analyzing and reading fluidic and pneumatic diagrams  
4.b. analyzing and troubleshooting basic mechanical, fluidic, and pneumatic systems  
4.c. analyzing and calibrating basic mechanical, fluidic and pneumatic systems

**Supporting Content Links** (see online version to use links)  
[How to tear down a medical device](#)  
[Engineering Technology for Healthcare Channel](#)

**Criteria**  
Diagnose and repair pulse oximetry  
Diagnose and repair touch screen monitors  
Diagnose and repair compression pumps  
Diagnose and repair infusion pump  
Complete board replacement

**Recommend Assessment**  
Learner determines root cause issue of medical device problem on at least 5 medical devices successfully. Medical device troubleshooting exercise should include include pumps, touch screens, pulse oximetry, and electronics boards.
Badges

**Badge Name:** Patient Monitor Performance Testing

**Description:** Learner is able to test patient monitor for alarm verification, non-invasive blood pressure calibration, pressure leaks, SP02 calibration

---

**Program Learning Outcome:**
Student is able to perform performance checks and inspect and medical equipment

**AAMI Core Competency:**
I. Biomedical Equipment Technology
D. Test Equipment and procedures
F. Actuators and display
G. Safety regulations and standards

---

**Course and Learning Objective Alignment [COURSE ETS1412]**
2.c. using simulator to verify equipment alarms for patient monitor
2.d. using simulator to verify that the equipment is calibrated properly
2.f. determining and using appropriate methods of testing, trouble shooting and repairing blood pressure monitors

---

**Supporting Content Links (see online version to use links)**

[Engineering Technology for Healthcare Playlist]

---

**Criteria**
- Verify alarms
- Verify NIBP is calibrated
- Test for pressure leakage
- Verify SP02 calibration

**Recommend Assessment**
- Fluke Advantage Training 10-Medical Device Quality Assurance-Patient Monitors
- Patient Monitoring Activity
- Perform manufacturer Preventative maintenance and performance checks on patient monitor
**Badge Name:** Visual Inspection

**Description:** Learner is able to visually inspect medical device hoses, displays, cases, connectors, and document work

---

**Program Learning Outcome:**
Student is able to perform performance checks and inspect and medical equipment

**AAMI Core Competency:**
I. Biomedical Equipment Technology
   A. Basic Concepts of Healthcare and Hospitalization
   C. Medical equipment

**Course and Learning Objective Alignment [COURSE ETI1412]**
4.a documenting and following quality assurance processes needed for quality assurance checks of third party repairs.
4.b. recognizing procedures needed for new equipment receiving, testing and installation
4.d. determining preventative maintenance that meets organizational or regulatory requirements
7.a. analyzing and recognizing procedures needed for new equipment receiving, testing and installation.
"7.e. performing and documenting medical device inspections using required equipment, forms and online documentation systems."

---

**Supporting Content Links (see online version to use links)**
[Engineering Technology for Healthcare Playlist](#)

---

**Criteria**
- Verify hose integrity
- Verify visual display integrity
- Identify case damage
- Verify hose connector integrity
- Perform correct documentation
- Create checklist for visual inspection for 3 types of medical devices
- Use visual inspection checklist and correctly document work

**Recommend Assessment**
Student is given 3 medical devices (patient monitor, infusion pump, and a surgical bed). The student must create a visual checklist for each device, then they must perform and document the visual inspection of the devices.

Earn Fluke Quality Assurance – Introduction
Badges

Badge Name: BMET Communication

Description: Learner is able to work in teams and communicate with healthcare technology management professionals including technicians, nurses, and doctors

Program Learning Outcome:
Student is able to communicate proficiently with clinicians and HTM professionals about medical equipment

AAMI Core Competency:
VIII. Communication skills
A. Presenting technical information to a variety of audiences
B. Writing technical reports
C. Working medical vocabulary
V. Mathematics system
B. Scientific and engineering notation
C. Unit conversions
A. Graphing skills
D. Team communications
E. Listening skills
F. Non-verbal communication

Course and Learning Objective Alignment [COURSE BME1008]
1.e. Defining terminology related to biomedical engineering technology and related medical sciences.
5.g. Demonstrating terminology related to biomedical engineering technology and related medical services
4.c. Developing a personal code of ethics in relation to biomedical engineering technology
3.b. Recognizing major trends in the field of biomedical technology and the type and range of technology used by doctors for patient care
5.c. Measuring and collecting bio-mechanical properties using images

Supporting Content Links (see online version to use links)
Engineering Technology for Healthcare Playlist

Criteria
Read and summarize service manuals
Identify common medical equipment and testing devices
Define medical terminology
Create data tables and create graphs
Communicate technical information in emails and word processing software
Verbally present data
Apply word processing skills for a technical report
Use database and software functions to organize data
Identify best practice in communication

Recommend Assessment
Must achieve exceeds expectations rating from employer/supervisor in communication rating on Likert scale survey during work experience course
How can you use this document

Attribution Requirements

Attribution Creative Commons Attribution (CC BY-SA) - Those who want to use material need only credit the original authors and funding source. If modifications are made, please attribute the work and specify that the work is modified from the original work.
Authors

Brian Bell
Lead Faculty Biomedical Engineering Technology
St. Petersburg College
Bell. Brian@spcollege. edu

Lara Sharp
Program Director
Engineering Technology
St. Petersburg College
Sharp. Lara@spcollege. edu
Acknowledgements

This material is based upon work supported by the National Science Foundation under grant number 1700649. Any opinions, findings and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect those of the National Science Foundation.

Additional Resources

Gain access to free biomedical engineering technology educational content and the digital version of this document

Engineering Technology for Healthcare YouTube Channel