



Course Number and Title: NRG 245 Building Systems Integration

Campus Location:

Georgetown, Dover, Stanton

Effective Date:

2018-51

Prerequisite:

NRG 123, GEN 126

Co-Requisites:

none

Course Credits and Hours:

3.00 credits

2.00 lecture hours/week

2.00 lab hours/week

Course Description:

In this course, students apply the fundamentals of controls and networking to integrate building systems (such as access, lighting, environmental control, and fire alarm management) into a functional building operating system. Emphasis is placed on alarm reporting and remote energy management capabilities. System and building commissioning processes are also covered.

Required Text(s):

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

Additional Materials:

Online materials

Schedule Type:

Classroom Course

Disclaimer:

None

Core Course Performance Objectives (CCPOs):

1. Engage in professional behavior. (CCC 1, 3, 4, 5)
2. Explain the organizational structure of the building automated and control networks (BACnet) protocol.(CCC1, 5; PGC 7)
3. Analyze BACnet applications, and apply proper object and service properties to the integrated device. (CCC 2, 5, 6; PGC 6, 7)
4. Describe the various BACnet network layers and data links, and apply the appropriate communication protocol for the integrated device. (CCC 1, 2; PGC 7)
5. Describe the two BACnet virtual data links, and apply them to communicate with an integrated device (CCC 1, 2, 6; PGC 7)
6. Describe and apply the processes and procedures for BACnet alarm and event reporting, command prioritization, and backup and restore functions. (CCC 1, 2, 5, 6; PGC 5, 6, 7)
7. Describe the basics of local area network (LonTalk) protocol. (CCC 1, 2, 3, 4; PGC 5, 6, 7)

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

Measurable Performance Objectives (MPOs):

Upon completion of this course, the student will:

1. Engage in professional behavior.
 1. Demonstrate punctuality when attending class, participating in off-site projects, and submitting assignments.
 2. Communicate using industry-appropriate language during presentations, reports, and homework.
 3. Demonstrate appropriate professional behavior when working with others.
2. Explain the organizational structure of the building automated and control network (BACnet) protocol.
 1. Describe the criteria used to establish the BACnet protocol.
 2. Illustrate the ISO Open Systems Interconnection (OSI) basic reference model.
 3. Compare the BACnet collapsed protocol architecture with the ISO model.
 4. Describe the function of properties as they apply to BACnet objects.
 5. List the five classes of BACnet services and their purposes.
 6. Summarize the significant BACnet data links and their characteristics.
 7. Sketch and describe a BACnet architecture containing multiple network types.
 8. Explain the BACnet protocol stack and the data flow.
3. Analyze BACnet applications, and apply proper object and service properties to the integrated device.
 1. Describe the three attributes of an object property.
 2. Access a BACnet object profile; identify and describe the common properties associated with it.
 3. Describe a BACnet event, and explain the three forms of event reporting described in the standard protocol.
 4. Describe the difference between an event and an alarm.
 5. List the common properties for BACnet event reporting.
 6. Discuss how priority array values describe the prioritization of object commands.
4. Describe the various BACnet network layers and data links, and apply the appropriate communication protocol for an integrated device.
 1. List the four main tasks supported by the BACnet network layer.
 2. Explain the difference between a router and a gateway.
 3. Describe the BACnet network layer protocol data unit structure.
 4. Identify the common BACnet network layer message types.
 5. Differentiate among local, remote, and global BACnet broadcasts.
 6. Connect devices on two or more dissimilar BACnet networks.
 7. Define *physical address* as it applies to networking.
 8. Describe the PCI/Data portion of a traditional Ethernet frame.
 9. Describe the frame format for local area network (LAN) Logical Link Control (LLC).
 10. Describe the frame format for a BACnet protocol data unit (PDU).
 11. Differentiate between BACnet/Ethernet and BACnet/IP.
 12. Describe the ARCnet PDU frame format.
 13. Explain the function and physical layer characteristics of EIA-485 master-slave/token-passing (MS/TP) communication protocols.
 14. Describe the MS/TP messaging frame format
5. Describe the two BACnet virtual data links, and apply them to communicate with an integrated device.
 1. Explain the advantages of tunneling BACnet messages through the Internet.
 2. Compare and contrast BACnet/IP unicast and broadcast message types.
 3. Illustrate and describe the BACnet/Zigbee node and the protocol stack.
 4. Configure a BACnet Broadcast Management Device (BBMD).
6. Describe and apply the processes and procedures for BACnet alarm and event reporting, command prioritization, and backup and restore functions.
 1. Set up and configure a local area network (LAN) to allow open BACnet protocol communication among multiple devices.
 2. Use an IP network for BACnet communication between multiple devices through tunneling data links.
 3. Connect and configure a BACnet IP network to communicate with an ARCnet LAN.
 4. Connect and configure a BACnet IP network to communicate with an EIA 485 MS/TP LAN.
 5. Set up and configure a BACnet/IP to Zigbee communication network.
7. Describe the basics of local area network (LonTalk) protocol.
 1. Compare and contrast the Lontalk protocol to the BACnet standard.
 2. Describe the configuration of a Lontalk object and its properties.
 3. Connect and configure a Lontalk device to a BACnet/IP network.

Evaluation Criteria/Policies:

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

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

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

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

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

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

1. Utilize building system and energy technology hardware and software to gather data on building lighting systems operation and energy consumption.
2. Utilize building system and energy technology hardware and software to gather data on heating,
3. Evaluate commercial buildings and make recommendations for optimized building performance and occupant comfort.
4. Prepare and present technical reports.
5. Assemble, install, service, and repair direct digital controls (DDC) for building electrical and mechanical systems.
6. Program and explain operational sequences for building equipment and systems.
7. Integrate and commission building systems and components to ensure reliable performance and compliance with building codes.

Disabilities Support Statement:

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