ECT 40 COURSE

LANEY COLLEGE
ENVIRONMENTAL CONTROL TECHNOLOGY

Commercial HVAC Systems Program

ECT 40 Introduction to Control System Networking Course Development

National Science Foundation - National Center for Building Technician Education

5/14/2014

INTRODUCTION TO CONTROL SYSTEM NETWORKING

Course Documentation

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Table of Contents

Catalog description

The installation and use of common digital control system networks is presented; practices for the installation of some of the standards such as MS/TP, ARCNET, LONWORKS, Ethernet networks, etc. will be discussed. This will also include discussion of the benefits of each type of network and diagnosis of common network problems.

Class hours

Lecture 17.5 Hours

Units

Lecture 1 semester unit

Entry skills needed

- Reading level: college-level English technical reading and ability to decode new technical terminology with reference help.
- Writing level: ability to express complex technical concepts in English.
- Math level: college technical math
    1. Perform mathematical operations using real numbers, fractions, decimals and percentages.
    2. Solve simple linear equations.
    3. Demonstrate knowledge converting fractions to decimals and decimals to fractions.
    4. Solve basic math and geometry problems involving area, angles, volume and percentages.
    5. Use algebraic equations to solve heating and cooling load calculation problems.
    6. Solve problems involving ratio and proportions.
    7. Interpret data in graphs in rectangular coordinate systems.
    8. Use and apply Imperial and Metric systems of measurement.
    9. Solve problems involving area and perimeter.

- Introductory-level direct digital control (DDC) skills:
    1. Demonstrate basic competency in electrical wiring skills and an understanding of grounding.
    2. Demonstrate an awareness of binary arithmetic and data representations.
    3. Demonstrate knowledge of basic electronic principles, voltage, current and frequency.
    4. Set up and operate a personal computer.
    5. Understand basic DDC principles.
    6. Prepare written and oral presentations.

Syllabus

See Appendix A for sample syllabus, course schedule, and policies. For lesson topics to include in course, see Exit Skills.

Student learning outcomes

The exit skills listed in the next section support these 3 outcomes:

Network concepts

Understand the concepts of networking including the different types of networks, interoperability, and system integration.

Communication

Recognize how building automation systems (BAS) rely on networking to operate; become knowledgeable enough to be able to communicate controls networking with customers or information technology (IT) staff members.

Troubleshooting

Understand fundamental network troubleshooting skills.

Exit skills

Course content to achieve outcomes listed above:

Networks

1. Explain the benefits of each common type of digital control network.

Lesson Topics:

- Data Communication
- LonWorks System Overview
- LonWorks Network Testing
- BACnet System Overview
- BACnet Installation, Configuration, and Troubleshooting
- BACnet Alarming, Scheduling, and Trending
- Networking and Web-Based Control

Installation

2. Install and test digital control networks.

Lesson Topics:

- System Integration

Interface

3. Interface digital control networks with enterprise, local area, and wide area networks.

Lesson Topics:

- TCP/IP
- Modbus Protocol
- Wireless networks

Synchronization

4. Combine data from multiple sources using time-based or event-based synchronization.

Lesson Topics:

- Building Automation Interoperability
- Control Concepts

Communication

5. Work effectively with IT professionals in enterprise network interfacing.

Lesson Topics:

- Future Trends in Building Automation

Course materials

Principal text

Building Automation System Integration with Open Protocols, American Technical Publishers, In Partnership with NJATC, 2009.

Lecture materials and handouts

- Presentations: textbook has PowerPoint presentations for each chapter.
- Reference: 3 documents including BacNetComp, Intro to LON, LONworks Tech 101.
- Presentation: "LON Lunch Learn," LON application, benefits, devices and architecture. Echelon, 40 slides.
- Presentation: "LONworks Technology," Comprehensive details, architecture, protocols, resources. Control Systems International (CSI), 96 slides.
- Reference: BACnet & LONWORKS Compared And Contrasted. David Fisher, PolarSoft, 2004, explores both systems to help bring into focus the substantial differences between each approach, dispels various popular myths. 17pp.
- Reference: BACnet Primer, Phoenix Controls, 2009. Protocol, interoperability, functional levels, network types, devices, command priority process, terminology. 16pp.
- Reference: BACnet Wiring Practices Guide, TAC, 2007. Hardware, practices, checkout & troubleshooting. 66pp.
- Reference: A Perspective on Open Systems In Building Controls, Tim Balch, Honeywell, 1996. Customer expectations, application of LONmark systems. 5pp.
- Reference: TCP/IP Cheat Sheet, LAN basic terminology. 12pp.

Other reference materials

Materials from manufacturers including: Trane Co., Honeywell Controls, LC Controls, Johnson Controls, Alerton Controls, Delta Controls, Andover Controls, and Siemens Building Automation.

Software needed

None required.

Lab materials

None required, lecture only course.

Lab equipment & instruments required

None required.

Samples of weekly assignments

Textbook review questions for each chapter:

1. What are the advantages of using the engineered design method?

   Answer: The engineered design method is used to create the network program design while off-site. As the design is programmed, infrastructure, device, and network variable configurations are saved in a network database. When programming is complete, the network tool is attached to the network and the entire network program is loaded into the devices during commissioning. This method is particularly useful for large projects where programming responsibilities are distributed to several network designers. Also, this method makes it possible to design the control system before the building construction or infrastructure installation is complete.

2. Between what types of objects can network variable bindings be made?

   Answer: Network variable bindings can be made between any two nodes, as long as they are compatible with the data to be shared. Network variable bindings between function blocks in two different devices are the most common type, but bindings can also be made between two function blocks within the same node, or even between two variable objects in the same function block.

3. What are the two general rules for making network variable bindings?

   Answer: First, a network variable output can only be connected to a network variable input. Second, the network variables in a binding must be of the same type.

Project

None required.

Assessment

Methods

- Pre- and post-tests
- Final exam

Sample test questions

From final exam:

1. Freely programmable nodes are popular for creating industrial process control applications and complex control sequences.

A True
B False

2. The most common media used for LonWorks channels is ___, though other media types are supported.

A twisted-pair cabling
B copper cabling
C fiber optics
D all of the above

3. The setpoint can be one of many controlled variables, such as temperature, ___, dewpoint, and enthalpy.

A humidity
B pressure
C light level
D all of the above

Adaptability to on-line format

This course can be delivered on-line due to its lecture format.

Appendix A – Sample syllabus

Note: see Exit Skills section for lesson topics.

LANEY COLLEGE

Environmental Control Technology

Course: **INTRO to CONTROL SYSTEM NETWORKING**
Course Number: ECT 40
Course Code:
Time: Tuesdays 8:30 PM – 9:30 PM
Instructor:
Office:
Office Hour:
Phone:
Units: 1 unit

Course Description: The installation and use of common digital control system networks is presented. Standards such as MS/TP, ARCNET, LONWORKS, Ethernet networks; benefits of each type of network; and diagnosis of common network problems.

Student Outcomes:

- Demonstrate understanding of building automation interoperability
- Demonstrate understanding of BACnet installation, configuration, and troubleshooting
- Demonstrate understanding of LonWorks systems
- Demonstrate understanding of networking fundamentals
- Demonstrate understanding of system integration

Prerequisites: ECT 021 – Introduction to Direct Digital Controls

Text: Building Automation System Integration with Open Protocols, American Technical Publishers, In Partnership with NJATC, 2009.

Topics Covered:

- Building Automation Interoperability
- Control Concepts
- Data Communication
- LonWorks System Overview
- LonWorks Network Testing
- BACnet System Overview
- BACnet Installation, Configuration, and Troubleshooting
- BACnet Alarming, Scheduling, and Trending
- Networking and Web-Based Control

- System Integration
- TCP/IP
- Modbus Protocol
- Wireless Networks
- Future Trends in Building Automation

Evaluation: The following classroom work and projects will be evaluated as follows.

1.	Problem Based Case Study Exercise	150
2.	Class Participation	400
3.	Homework assignments	100
4.	Final, Midterm, Quizzes	350
		Total: 1000 points

Grading:

91% -100% A
81% - 90% B
71% - 80% C
61% - 70% D
50% - 60% F

Attendance: Students may be dropped from the course if the number of absences exceeds two days' worth of class meetings. However, extenuating circumstances may warrant consideration.

Note: During class, no cell phones, eating, drinking or talking is allowed.

Note: Students are required to wear safety glasses in the lab work area.

Note: It is the student's responsibility to drop classes.

BEST Center Curricula, Resources & Recordings

Academic Programs
Georgia Piedmont Technical College - Building Automation Systems
Milwaukee Area Technical College - Sustainable Facilities Operations
Laney College - Commercial HVAC Systems
City College San Francisco - Commercial Building Energy Analysis & Audits

Professional Development Materials, Presentations & Videos
National Institutes
Building Automation Systems Instructor Workshops
Webinars (e.g., BEST Talks)

Faculty Profile Videos
Reports & Case Studies
Marketing Resources

BEST
Building Efficiency for a Sustainable Tomorrow

NSF National Science Foundation