



## COURSE OUTLINE: RAA205 - AUTOMATION NETWORKING I

Prepared: Mark Allemang

Approved: Corey Meunier, Chair, Technology and Skilled Trades

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| <b>Course Code: Title</b>                                                                                                                                                  | RAA205: INDUSTRIAL AUTOMATION NETWORKING I                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Program Number: Name</b>                                                                                                                                                | 4026: ELECTRICAL TN-PROC<br>4073: ROBOTICS & AUTOMATIO                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Department:</b>                                                                                                                                                         | ROBOTICS GRADUATE CERTIFICATE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Semesters/Terms:</b>                                                                                                                                                    | 21W                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Course Description:</b>                                                                                                                                                 | The student will study the technology and protocols used in industrial networks for process automation. The TCP/IP 4 layer model will form the basis of the course with a comparison to the OSI 7 layer model. The theory will be strengthened with hands-on labs in cable making, protocol analysis (RS232, RS485, TCP/IP) as well as building simple client/server networks. Industrial networks topics such as Ethernet/IP, DeviceNET and CAN BUS will also be studied.                                                                                                                                                                                                  |
| <b>Total Credits:</b>                                                                                                                                                      | 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Hours/Week:</b>                                                                                                                                                         | 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Total Hours:</b>                                                                                                                                                        | 60                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Prerequisites:</b>                                                                                                                                                      | There are no pre-requisites for this course.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Corequisites:</b>                                                                                                                                                       | There are no co-requisites for this course.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Substitutes:</b>                                                                                                                                                        | ELR251                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Vocational Learning Outcomes (VLO's) addressed in this course:</b><br><br>Please refer to program web page for a complete listing of program outcomes where applicable. | <p><b>4026 - ELECTRICAL TN-PROC</b></p> <p>VLO 11 Install, test and troubleshoot telecommunication systems under the supervision of a qualified person.</p> <p><b>4073 - ROBOTICS &amp; AUTOMATIO</b></p> <p>VLO 1 Construct and evaluate robotic control programs for various scenarios against which to model the functionality and stability of automation systems.</p> <p>VLO 2 Plan and lead the installation of new industrial equipment and its physical and digital integration with existing systems.</p> <p>VLO 7 Formulate and use a variety of troubleshooting techniques on new and legacy electromechanical equipment, processes, systems and subsystems.</p> |
| <b>Essential Employability Skills (EES) addressed in this course:</b>                                                                                                      | <p>EES 3 Execute mathematical operations accurately.</p> <p>EES 4 Apply a systematic approach to solve problems.</p> <p>EES 6 Locate, select, organize, and document information using appropriate technology and information systems.</p> <p>EES 7 Analyze, evaluate, and apply relevant information from a variety of sources.</p>                                                                                                                                                                                                                                                                                                                                        |
| <b>Course Evaluation:</b>                                                                                                                                                  | Passing Grade: 50%, D                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

In response to public health requirements pertaining to the COVID19 pandemic, course delivery and assessment traditionally delivered in-class, may occur remotely either in whole or in part in the 2020-2021 academic year.



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|                                                                                                       | A minimum program GPA of 2.0 or higher where program specific standards exist is required for graduation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                  |                                          |                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                  |                                          |                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                  |                                          |                                                     |                                                                                                         |
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| <b>Other Course Evaluation &amp; Assessment Requirements:</b>                                         | <p>To pass the course, the student must achieve a passing grade (50%) in both the theory and the lab part of this course. For example, it is not possible to pass the course if a student has a failing average in the three written tests but is passing the lab portion, (or vice versa).</p> <p>Grade<br/>Definition Grade Point Equivalent<br/>A+ 90 - 100% 4.00<br/>A 80 - 89%<br/>B 70 - 79% 3.00<br/>C 60 - 69% 2.00<br/>D 50 - 59% 1.00<br/>F (Fail) 49% and below 0.00</p> <p>CR (Credit) Credit for diploma requirements has been awarded.<br/>S Satisfactory achievement in field /clinical placement or non-graded subject area.<br/>U Unsatisfactory achievement in field/clinical placement or non-graded subject area.<br/>X A temporary grade limited to situations with extenuating circumstances giving a student additional time to complete the requirements for a course.<br/>NR Grade not reported to Registrar's office.<br/>W Student has withdrawn from the course without academic penalty.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                  |                                          |                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                  |                                          |                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                  |                                          |                                                     |                                                                                                         |
| <b>Course Outcomes and Learning Objectives:</b>                                                       | <table> <tr> <th>Course Outcome 1</th><th>Learning Objectives for Course Outcome 1</th></tr> <tr> <td>1. Describe telecommunication networks in general and begin building a telecommunications vocabulary.</td><td>           1.1 List and describe the elements common to all telecommunication networks.<br/>           1.2 Define a network<br/>           1.3 Define and distinguish LAN, WAN, CAN, MAN<br/>           1.4 Compare and contrast various types of networks including client/server, peer to peer.<br/>           1.5 Describe the term NOS network operating systems<br/>           1.6 Describe physical topologies (bus,ring,star), and associated media access control methods (logical topology)<br/>           1.7 Compare circuit switching and packet switching<br/>           1.8 Differentiate simplex, full/half duplex<br/>           1.9 Differentiate multi-access vs point-to-point links         </td></tr> <tr> <th>Course Outcome 2</th><th>Learning Objectives for Course Outcome 2</th></tr> <tr> <td>2. Identify the various telecommunication standards organizations and their associated standards</td><td>           2.1 List and describe the 7 layers of the OSI model and<br/>           2.2 Compare them to the 4 layers of the TCP/IP model<br/>           2.3 Identify various protocols at each layer and describe their purpose<br/>           2.4 Identify the method of addressing at various layers and the associated protocol data units<br/>           2.5 List the following standards organizations and identify the important telecommunication standards from each: ANSI, EIA/TIA, IEEE, ISO, ITU, ISOC, IANA AND ICANN         </td></tr> <tr> <th>Course Outcome 3</th><th>Learning Objectives for Course Outcome 3</th></tr> <tr> <td>3. Analyze the various methods of transmitting data</td><td>3.1 Describe the EIA/TIA RS232C standard and capture and analyze a data transmitted using this standard</td></tr> </table> | Course Outcome 1 | Learning Objectives for Course Outcome 1 | 1. Describe telecommunication networks in general and begin building a telecommunications vocabulary. | 1.1 List and describe the elements common to all telecommunication networks.<br>1.2 Define a network<br>1.3 Define and distinguish LAN, WAN, CAN, MAN<br>1.4 Compare and contrast various types of networks including client/server, peer to peer.<br>1.5 Describe the term NOS network operating systems<br>1.6 Describe physical topologies (bus,ring,star), and associated media access control methods (logical topology)<br>1.7 Compare circuit switching and packet switching<br>1.8 Differentiate simplex, full/half duplex<br>1.9 Differentiate multi-access vs point-to-point links | Course Outcome 2 | Learning Objectives for Course Outcome 2 | 2. Identify the various telecommunication standards organizations and their associated standards | 2.1 List and describe the 7 layers of the OSI model and<br>2.2 Compare them to the 4 layers of the TCP/IP model<br>2.3 Identify various protocols at each layer and describe their purpose<br>2.4 Identify the method of addressing at various layers and the associated protocol data units<br>2.5 List the following standards organizations and identify the important telecommunication standards from each: ANSI, EIA/TIA, IEEE, ISO, ITU, ISOC, IANA AND ICANN | Course Outcome 3 | Learning Objectives for Course Outcome 3 | 3. Analyze the various methods of transmitting data | 3.1 Describe the EIA/TIA RS232C standard and capture and analyze a data transmitted using this standard |
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| Course Outcome 2                                                                                      | Learning Objectives for Course Outcome 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                  |                                          |                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                  |                                          |                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                  |                                          |                                                     |                                                                                                         |
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|  | at the Physical Layer                                                                                                     | 3.2 Construct a nul-modem connection between two devices<br>3.3 Exchange single character data between the devices and then exchange a file<br>3.4 Describe how parity can be used as a method for error detection<br>3.5 Identify fiber optic media types, capabilities and describe the various potential impairments<br>3.6 List and describe various methods for encoding data into electrical signals and identify potential electrical impairments<br>3.7 List and describe various modulation methods & telephone channel capacity<br>3.8 List and describe various devices that operate at the physical layer including repeaters, hubs, transceivers.<br>3.9 List the components of structured network cabling.<br>3.10 Identify the various standards that apply to structured cabling<br>3.11 Describe the purpose of, identify and construct network patch cables including straight through, crossover and rollover<br>3.12 Compare and contrast Twisted Pair cabling vs Coaxial cabling regarding: construction, application, advantages/disadvantages for each                             |
|  | <b>Course Outcome 4</b>                                                                                                   | <b>Learning Objectives for Course Outcome 4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|  | 4. Describe the operation of protocols and devices at the OSI Data link layer and explain how they support communications | 4.1 Explain the role of Data Link layer protocols in data transmission.<br>4.2 Describe how the Data Link layer prepares data for transmission on network media.<br>4.3 Describe the different types of media access control methods.<br>4.4 Identify the common logical network topologies and describe how the logical topology determines the media access control method for that network.<br>4.5 Explain the purpose of encapsulating packets into frames<br>4.6 Describe the Layer 2 frame structure and identify generic fields.<br>4.7 Explain the role of the frame header and trailer fields, including addressing, type of protocol, and Frame Check Sequence.<br>4.8 Describe the devices that operate at the data link layer including bridges, switches and the NIC.<br>4.9 Compare various industrial network standards (HART, CANBUS) and their characteristics at the 4.10 Data link layer<br>4.11 Describe how ARP is used to resolve an IP address to a MAC address<br>4.12 Utilize software such as Wireshark to analyze packets (and frames) at the lower 3 layers of the OSI model. |
|  | <b>Course Outcome 5</b>                                                                                                   | <b>Learning Objectives for Course Outcome 5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|  | 5. Describe the features of the Network layer protocols and services and explain the fundamental concepts of              | 5.1 Identify the role of the Network layer as it describes communication from one end device to another end device.<br>5.2 Examine the most common Network layer protocols the Internet Protocol (IP), and its features for providing                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

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|  | routing                                                                             | connectionless and best-effort service<br>5.3 Understand the principles used to guide the division, or grouping, of devices into networks.<br>5.4 Understand the hierarchical addressing of devices and how this allows communication between networks.<br>5.5 Describe the fundamentals of routes, next-hop addresses, and packet forwarding to a destination network.<br>5.6 Utilize switches and TRUNK ports to build VLANs and use a router to carry traffic between them                                                                                                                                                                                                                   |
|  | <b>Course Outcome 6</b>                                                             | <b>Learning Objectives for Course Outcome 6</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|  | 6. Calculate, and apply subnet masks and IP addresses to fulfill given requirements | 6.1 Explain the structure IP addressing and demonstrate the ability to convert between 8-bit binary and decimal numbers.<br>6.2 Given an IPv4 address, classify by type and describe how it is used in the network.<br>6.3 Explain how addresses are assigned to networks by ISPs and within networks by administrators.<br>6.4 Determine the network portion of the host address and explain the role of the subnet mask in dividing networks.<br>6.5 Given IPv4 addressing information and design criteria, calculate the appropriate addressing components.<br>6.6 Use common testing utilities to verify and test connectivity and operational status of the IP protocol stack on a device. |
|  | <b>Course Outcome 7</b>                                                             | <b>Learning Objectives for Course Outcome 7</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|  | 7. Describe the features of the Transport layer protocols and services              | 7.1 Explain the need for the Transport layer.<br>7.2 Identify the role of the Transport layer as it provides the end-to-end transfer of data between applications.<br>7.3 Describe the role of two TCP/IP Transport layer protocols: TCP and UDP.<br>7.4 Explain the key functions of the Transport layer, including reliability, port addressing, and segmentation.<br>7.5 Identify when it is appropriate to use TCP or UDP and provide examples of applications that use each protocol                                                                                                                                                                                                       |
|  | <b>Course Outcome 8</b>                                                             | <b>Learning Objectives for Course Outcome 8</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|  | 8. Describe & utilize the Application Layer & its protocols.                        | 8.1 Describe how the functions of the three upper OSI model layers provide network services to end user applications.<br>8.2 Define how people use the Application Layer to communicate across the telecommunication network.<br>8.3 Describe the function of well-known TCP/IP applications, such as the World Wide Web and email, and their related services (HTTP, DNS, SMB, DHCP, SMTP, SNMP, and Telnet).<br>8.4 Explain how protocols ensure services running on one kind of device can send to and receive data from many different network devices.                                                                                                                                     |
|  | <b>Course Outcome 9</b>                                                             | <b>Learning Objectives for Course Outcome 9</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|  | 9. Describe the nature of the Ethernet IP networking protocol.                      | 9.1 Differentiate ETHERNET/IP from standard ETHERNET.<br>9.2 Describe the CIP Common Information Protocol<br>9.3 Analyze Ethernet/IP communications using Wireshark                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|  |                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

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|                                               | <b>Course Outcome 10</b>                                                                               | <b>Learning Objectives for Course Outcome 10</b>                                                                                                                                                                                      |
|                                               | 10. Describe the nature of the DeviceNET and CANBUS networking protocols.                              | 10.1 Differentiate DeviceNET as the high level and CANBUS as the low level protocol.<br>10.2 Describe the physical and Datalink layer characteristics of CANBUS.<br>10.3 Describe the signaling and arbitration capability of CANBUS. |
| <b>Evaluation Process and Grading System:</b> | <b>Evaluation Type</b>                                                                                 | <b>Evaluation Weight</b>                                                                                                                                                                                                              |
|                                               | Assignments and Quizzes                                                                                | 40%                                                                                                                                                                                                                                   |
|                                               | Tests                                                                                                  | 60%                                                                                                                                                                                                                                   |
| <b>Date:</b>                                  | June 11, 2020                                                                                          |                                                                                                                                                                                                                                       |
| <b>Addendum:</b>                              | Please refer to the course outline addendum on the Learning Management System for further information. |                                                                                                                                                                                                                                       |

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