ESE-3014 Embedded Systems Communication Protocol and Security

Computer Studies

Course Number:	**Co-Requisites:**	**Pre-Requisites:**
ESE-3014	N/A	ESE-2005
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Approved by:	Chris Slade, Dean School of Business	
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Approved for Academic Year:	2020-2021	
Normative Hours:	60.00	

Course Description

This course serves as an introduction to popular communication protocols used in embedded systems. In addition, the basics of communications and communications security is presented. A survey of I2C, SPI, RS-232/RS-485, IrDA infrared, JTAG, USB, Bluetooth, IEEE 802.11 WiFi, IEEE 802.3 Ethernet, CAN and GPS protocols and systems is covered. Each protocol is explored during laboratory sessions to reinforce presented theory.

Course Learning Outcomes/Course Objectives

1. Describe the basics of communication systems.

    1.1   List and describe the elements of an electrical communication system.

    1.2   Describe the elements of a digital communication system.

    1.3   Explain the differences between an analog and digital communication system.

    1.4   Describe communication channels and their characteristics.

    1.5   Describe mathematical models for communication channels.

    1.6   Describe the effect of noise on analog communication systems.

    1.7   Explain analog and digital modulation techniques.

    1.8   Explain the effects of error correction and coding on communications.

2. Explain the method and purpose of communications security and the importance of security in machine to machine and device to device communication.

    2.1   Explain the purpose of communications security.

    2.2   Describe authentication techniques.

2.3   Describe authorization techniques.

2.4   Describe cryptography and encryption.

2.5   Describe public key private key exchange.

2.6   Describe modern cryptographic techniques RSA and AES.

3. **Describe the I2C protocol and establish communications between devices using I2C.**

3.1   Draw a schematic of the I2C protocol.

3.2   List the roles for nodes connected to the bus.

3.3   List the potential modes of operation for a given bus device.

3.4   Describe the basic types of messages.

3.5   Describe the I2C protocol.

3.6   Describe the I2C physical layer.

3.7   Describe the I2C addressing.

3.8   Read and explain the I2C timing diagram.

3.9   Write an application that transfers data between two devices using the I2C protocol.

4. **Explain the SPI protocol and establish communications between devices using SPI.**

4.1   Describe single master single slave topology.

4.2   Describe single master multiple slave topology.

4.3   List the advantages and disadvantages of the SPI protocol.

4.4   Describe the SPI protocol.

4.5   Write an application that transfers data between two devices using the SPI protocol.

5. **Elucidate the RS-232 and the RS-485 protocols and establish communications between devices using RS-232.**

5.1   Explain the difference between a DTE and a DCE.

5.2   List some of the advantages and disadvantages of the RS-232 standard.

5.3   Describe the RS-232 protocol's physical layer.

5.4   List the common data and control signals used in the RS-232 protocol and their pin assignments.

5.5   Explain the meaning of RTS/CTS/RTR.

5.6   Explain the purpose of RTS/CTS/RTR.

5.7   List some of the advantages of RS-485 over RS-232.

5.8   Write an application that transfers data between two devices using the RS-232 protocol.

6. **Describe the IrDA infrared protocol and establish communications between devices using IrDa infrared.**

6.1   Explain the main purpose of the IrDA group.

6.2   Explain the main purpose of the IrDA protocols.

6.3   Describe the physical layer of the IrDA protocols (IrPHY).

6.4   Describe the link layer of the IrDA protocols (IrLAP).

6.5   Describe the link management layer of the IrDA protocols (IrLMP).

6.6   Describe the OBEX and TinyTP protocols.

6.7   Write an application that exchanges data using IrDA devices.

7. Explain how JTAG works and its purpose in the context of embedded systems.

7.1   Explain the original purpose of the JTAG protocol.

7.2   Explain the usage of JTAG today in the context of embedded systems.

7.3   List and describe the JTAG connector pins.

7.4   Download, execute and debug an application on an embedded device using the JTAG connection.

8. Describe the USB protocol and establish communications between devices using USB.

8.1   List the different types of USB speeds available.

8.2   List the different types of USB transfers available.

8.3   Explain the purpose of each of the different types of USB transfers.

8.4   List and describe the different types of USB connectors.

8.5   List the advantages and disadvantages of the USB protocol.

8.6   List and describe the different types of USB endpoints.

8.7   List the different types of USB descriptors.

8.8   Write an application to transfer data between two devices using USB.

9. Explain the basics of the IEEE 802.3 Ethernet protocol and establish communications between devices using IEEE 802.3 Ethernet.

9.1   Describe 10Base-T, 100Base-TX and 1000Base-T Ethernet.

9.2   Explain the purpose of a hub.

9.3   Explain the purpose of a bridge.

9.4   Explain the purpose of a switch.

9.5   Explain the purpose of a router.

9.6   Explain the spanning tree protocol.

9.7   Explain the spanning tree protocol.

9.8   Describe how switches use MAC addresses to forward data frames.

9.9   Describe how routers use IP addresses to forward data packets.

9.10   Write an application to transfer data between two devices using Ethernet.

10. Describe the CAN protocol and establish communications between devices using CAN.

10.1   Describe the CAN architecture.

10.2   Explain the arbitration procedure used by the CAN protocol.

10.3   List and explain the layers used in the CAN protocol.

10.4   Describe the base and extended frame formats.

10.5   Write an application that transfers data between two devices using the CAN protocol.

11. **Explain how Bluetooth communication works and establish communications between devices using Bluetooth.**

11.1   Explain the purpose of the Bluetooth protocol.

11.2   List the different modulation schemes used by the PHY layer of the Bluetooth protocol.

11.3   List the type of information available from a Bluetooth device while in discoverable mode.

11.4   List and describe the different types of Bluetooth pairing mechanisms.

11.5   Write an application that transfers data between two devices using Bluetooth.

12. **Explain how IEEE 802.11 WiFi works and establish communications between devices using IEEE 802.11 WiFi.**

12.1   List the two physical layer modulation schemes used by 802.11 WiFi.

12.2   Describe the main differences between IEEE 802.11b/g/n and IEEE 802.11a/ac.

12.3   Explain the differences between a WiFi access point and a WiFi station.

12.4   List the different types of security used in WiFi networks.

12.5   Explain the differences between Ad-Hoc and Infrastructure modes.

12.6   Write an application that transfers data between two devices using IEEE 802.11 WiFi.

13. **Explain how GPS works and establish communications between devices using GPS.**

13.1   Explain the fundamentals of the GPS navigation system.

13.2   List the three segments of a GPS system.

13.3   Write an application that receives NMEA sentences from a connected GPS receiver.

Relationship to Vocational Learning Outcomes

This course provides the opportunity for you to achieve the following Program Vocational Learning Outcomes (VLO) which will be taught and evaluated at an taught (T), assessed (A) or culminating peformance (CP) level:

EMBT - Embedded Systems Engineering Design

VLO 1   Select appropriate design tools to meet quality standards and customer requirements when developing embedded systems products. (T, A)

VLO 2   Solve systems design problems through integration of hardware, software, sensors and actuators. (T, A)

VLO 3   Design, develop, test, configure and maintain embedded systems. (T, A)

| VLO 5 | Communicate effectively with diverse teams to disseminate ideas, requirements, implementations, findings and outcomes to complete embedded systems projects. (T, A) |

Learning Resources

a. Required
None

b. Supplemental
None

Student Evaluation

Laboratory Sessions 100%
10 Labs at 9% each
1 lab at 10%

Grade Scheme

The round off mathematical principle will be used. Percentages are converted to letter grades and grade points as follows:

Mark (%)	Grade	Grade Point	Mark (%)	Grade	Grade Point
94-100	A+	4.0	67-69	C+	2.3
87-93	A	3.7	63-66	C	2.0
80-86	A-	3.5	60-62	C-	1.7
77-79	B+	3.2	50-59	D	1.0
73-76	B	3.0	0-49	F	0.0
70-72	B-	2.7			

Prior Learning Assessment and Recognition

Students who wish to apply for prior learning assessment and recognition (PLAR) need to demonstrate competency at a post-secondary level in all of the course learning requirements outlined above. Evidence of learning achievement for PLAR candidates includes:
- Other: If yes has been selected, you may choose to contact the Counselling Department for advice on Prior Learning Assessment.

Course Related Information

The course is designed primarily to deliver more emphasis on hands on experience via laboratory sessions. Each unit covered will be practically explored in laboratory.

College Related Information

Academic Integrity

Lambton College is committed to high ethical standards in all academic activities within the College, including research, reporting and learning assessment (e.g. tests, lab reports, essays).
The cornerstone of academic integrity and professional reputation is principled conduct. All scholastic and academic activity must be free of all forms of academic dishonesty, including copying, plagiarism and cheating.

Lambton College will not tolerate any academic dishonesty, a position reflected in Lambton College policies. Students should be familiar with the Students Rights and Responsibilities Policy, located at lambtoncollege.ca. The policy states details concerning academic dishonesty and the penalties for dishonesty and unethical conduct.

Questions regarding this policy, or requests for additional clarification, should be directed to the Lambton College Student Success Department.

Students with Disabilities
If you are a student with a disability please identify your needs to the professor and/or the Accessibility Centre so that support services can be arranged for you. You can do this by making an appointment at the Accessibility Centre or by arranging a personal interview with the professor to discuss your needs.

Student Rights and Responsibility Policy
Acceptable behaviour in class is established by the instructor and is expected of all students. Any form of misbehaviour, harassment or violence will not be tolerated. Action will be taken as outlined in Lambton College policy.

Date of Withdrawal without Academic Penalty
Please consult the Academic Regulations and Registrar's published dates.

Waiver of Responsibility
Every attempt has been made to ensure the accuracy of this information as of the date of publication. The content may be modified, without notice, as deemed appropriate by the College.

Students should note policies may differ depending on the location of course offering. Please refer to campus location specific policies:
LAMBTON COLLEGE POLICIES – applicable to all Lambton College students.
- Student Rights & Responsibilities & Discipline policy (2000-5-1)
- Test & Exam Writing Protocol (2000-1-6)
- Evaluation of Students (2000-1-3)
- (https://www.lambtoncollege.ca/custom/Pages/Policies/Policies.aspx)
CESTAR COLLEGE:
- https://www.lambtoncollege.ca/Programs/International/Lambton_in_Toronto/Student_Policies/
QUEENS COLLEGE:
- https://www.lambtoncollege.ca/Programs/International/Lambton_in_Mississauga/Student_Policies/
Note: It is the student's responsibility to retain course outlines for possible future use to support applications for transfer of credit to other educational institutions.