Sheridan Institute of Technology
School of Mechanical and Electrical Engineering Technology (M.E.E.T.)
Faculty of Applied Science and Technology (F.A.S.T.)

Class Plan

Lectures remote
Labs on-campus

Course: Wireless Communication Systems (TELE-28649) – 5th Semester.
Prerequisite: Communication Systems (ENGI-28779) – 4th Semester.
Course Lead: Mouhamed Abdulla, Ph.D., Professor of Electrical Engineering.
Program: Electronics Engineering Technology.
Semester: Winter 2022
Total Hours: 56.0 hrs (4 hrs/week x 14 weeks).
Credits: 4.0 cr.
Section:

Lectures	*Laboratory*
79329	**79328**

- *Class Plan:* The dates and activities indicated in this class plan are subject to change due to unforeseen circumstances. Any such changes to this class plan will be announced on SLATE. This means you will need to monitor SLATE on a regular basis.
- *Lectures:* We will have **Live Virtual Classroom** sessions every week. Attendance to the lecture is not mandatory, but it is highly encouraged. The link to login is available on SLATE. Some lectures are also available in recorded format so that students can go through the lectures at flexible times and navigate through the topics at their own pace. A **Gmail** account is needed to subscribe to this channel: **https://www.youtube.com/mouhamedabdullaphd**
- *Evaluations:* All evaluations (Quizzes, Midterm and Final) are administered electronically using the **Quiz tool on SLATE**. Students are expected to have **access to the internet and a computer**. It is the responsibility of the student to ensure that their technology is working, and they login to SLATE's Quiz tool on time. **Lockdown Browser** will be in effect during evaluations. More on this will be explained in class.

Ontario's Ministry of Advanced Education and Skills Development:

Essential employability skills emphasized in this course:

- Communication Skills:
  - Communicate clearly, concisely, and correctly in the written, spoken, visual form that fulfills the purpose and meets the needs of the audience.
  - Respond to written, spoken, or visual messages in a manner that ensures effective communication.
- Critical Thinking and Problem-Solving Skills:
  - Use a variety of thinking skills to anticipate and solve problems.
  - Apply a systematic approach to solve problems.
- Information Management Skills:
  - Locate, select, organize, and document information using appropriate technology and information systems.
  - Analyze, evaluate, and apply relevant information from a variety of sources.
- Personal Skills:
  - Take responsibility for one's own actions, decisions, and consequences.
  - Manage the use of time and other resources to complete projects.
- Interpersonal Skills:
  - Interact with others in groups or teams in ways that contribute to effective working relationships and the achievement of goals.
  - Show respect for the diverse opinions, values, belief systems, and contributions of others.
- Numeracy:
  - Execute mathematical operations accurately.

Course Description:

This course presents the fundamental principles of wireless communications, including the history and applications of diverse RF technologies (**Wi-Fi**, **BT/BLE**, **ZigBee**, **NFC**, **RFID**, **4G/LTE**, **5G/NR**, **LTE-M/NB-IoT**, **LoRa/LoRaWAN**, **V2X**, **DSRC**, **SatCom, and GPS**). With a focus on **system-level communications**, topics related to **transceivers**, **modems**, **transmission modes**, **channel access schemes** (**FDMA**, **TDMA**, **CDMA**, **OFDMA**, **NOMA**), **RF spectrum**, **frequency allocation**, **spectrum management**, **Licensed** and **ISM bands** will be presented. Specifications and key performance indicators (KPI) of wireless systems and channels, such as **operating frequency**, **channel bandwidth**, **AWGN**, **SNR**, **SINR**, **RSSI**, **BER**, **channel capacity**, **spectral efficiency**, **path loss**, **FSPL**, **shadowing**, **multipath fading, and Link Budget** will be discussed and evaluated for different RF propagation scenarios and antennas. Concepts in **cellular communications**, including **DL/UL**, **coverage**, **outage**, **reliability**, **network modeling**, **frequency reuse**, **cellular sectoring**, **clustering**, **CCI** and **ACI** will be explained. Special attention will be given to advancements in **mobile communications**, **3GPP Standardization**, **5G radio access technology** and use cases (**eMBB**, **URLLC**, **mMTC**), **mobile-IoT**, **satellite-IoT**, and the path towards **6G** with **AI**. Through lectures, computer simulation and laboratory projects, students explore **time** and **frequency** representation of **signals** as well as the performance and reliability of the communication systems. Students attain skillset to work with **RF test equipment**, including **RF function generator**, **spectrum analyzer**, **oscilloscope**, **ESP32 boards** and **RF sensors**.

Grading Scheme:

Students will demonstrate their learning by the following evaluations:

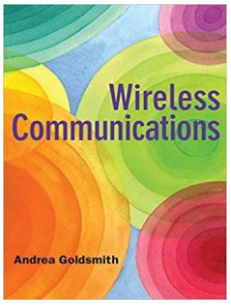
- **Exams (60%):**
  - Midterm Test 30% (week 7; 90 min)
  - Final Exam 30% (week 14; 90 min)
- **Quizzes (10%):**
  - Quiz 1 5% (week 4; 20 min)
  - Quiz 2 5% (week 11; 20 min)
- **Lab Work (30%):**
  - Lab Project 1 7.5% (weeks 1, 2 and 3)
  - Lab Project 2 7.5% (weeks 4, 5 and 6)
  - Lab Project 3 7.5% (weeks 8, 9 and 10)
  - Lab Project 4 7.5% (weeks 11, 12 and 13)

** Remarks on Evaluation:*

- *Pass Provision:* To obtain a passing grade in this course, students must achieve an overall course grade **≥ 50%**. A failure to meet this requirement will result in an **F grade**.
- *Missed evaluations*: Missing an evaluation will result in a **grade of zero**. See the sheet on missed evaluations posted to the Student Success in Engineering Virtual Community on SLATE for more information.
- *Closed Book Evaluation*: Quizzes, Midterm and Final are **closed book** evaluations. No formulas will be provided.
- *Calculators*: Some **acceptable** types of **calculators** are allowed during written evaluation (Quizzes, Midterm, and Final). Other electronic devices (including cellphones) are not permitted.
- *Quizzes*: Quizzes will be held as scheduled in the timetable outlined in this class plan.
- *Assignments*: There are no mandatory homework assignments in this course. However, students are encouraged to solve as many problems as possible from the lectures, and from relevant chapters of the textbook.
- *Laboratory Work*: Labs will be held weekly. Lab handouts will be posted on SLATE on a regular basis. All labs are performed individually. Lab projects must be submitted on SLATE by the due deadline. All lab projects bear equal weight. Late lab report submissions will result a **10%** deduction **per day** up to a maximum of **3 days**; after this period, no lab report submission will be accepted. Plagiarized work will result in severe consequences as stipulated by the college and the school guidelines.
- *Student Progress*: Students are responsible for **monitoring** their **own progress** in the course. Grades will be posted regularly on SLATE.

Recommended Textbook:

- Title: Wireless Communications (Aug. 2005)
- Author: Prof. Andrea Goldsmith (Dept. of Electrical Eng., Stanford University)
- Publisher: Cambridge University Press
- Pages: 674 pages (we will focus on a select number of chapters)
- ISBN-13: 978-0521837163
- Cost - Hardcopy: ~ $100.00 CAD (Amazon).



** Remark 1: Students are expected to use this textbook for independent study. The content of any evaluation component (i.e., labs, quizzes, midterm and final) may include references from this source.*

** Remark 2: This book is also the reference textbook for: **ENGI-28779** (Communication Systems).*

Weekly Timetable:

Small variations in this schedule are normal and may be made to accommodate the pace of student learning. Incomplete material may be carried forward to the next lecture. These variations will not cause a revised Course Outline to be published.

Weeks	*Lecture Sessions*	*Lab. Work*
Week 1: Jan. 10 → Jan. 14, 2022.	**Lec. 1 – Intro. to Wireless Com.**: Course Logistics, History of Communications, Applications of RF Technologies, Review of end-to-end Communications.	**Lab Project 1:** (**7.5%**) **Wi-Fi Communications** (ESP32, Sensors, Smartphone)
Week 2: Jan. 17 → Jan. 21, 2022.	**Lec. 2 – System-Level Com.**: OSI Model, Wireless Standards, System-level Com., TX/RX Design, Transceivers, Modems, Transmission Modes, Performance Evaluation, Average BER, Target BER, RF Test equipment.	
Week 3: Jan. 24 → Jan. 28, 2022.	**Lec. 3 – RF Spectrum**: EM Spectrum, RF Spectrum, Spectrum Management, Freq. Allocations, Operating Freq. of Tech. (e.g., AM, FM, NFC, RFID, Wi-Fi, BT, ZigBee, 4G/LTE, 5G/NR, V2X, GPS, SatCom), Spectrum Licensing, ISM Bands.	
Week 4: Jan. 31 → Feb. 04, 2022.	**Quiz 1**: Lec. 1, 2 and 3 (**5%**, 20 min). **Lec. 4 – Wireless Com. Channel**: Channel Deterioration Factors, Distortion, Attenuation, Noise (AWGN), Power Levels, SNR, SNR vs. BER. Channel	**Lab Project 2:** (**7.5%**) **BLE Communications** (ESP32, Sensors, Smartphone)
Week 5: Feb. 07 → Feb. 11, 2022.	**Lec. 5 – Wireless Com. Metrics**: RF Interference, Multipath Fading, Reflection, Scattering, Diffraction, Received Signal Strength Indicator (RSSI), RSSI vs. SNR, SNR vs. SINR, Channel Bandwidth, Channel Capacity, Spectral Efficiency.	
Week 6: Feb. 14 → Feb. 18, 2022.	**Lec. 6 – Antennas and Propagation**: Type of Antennas, Isotropic Antenna, Omni-directional Antenna, Directional Antenna, Cellular Antennas, Propagation Patterns, Antenna Gain, Antenna Efficiency.	
Week 7: Feb. 21 → Feb. 25, 2022.	**Midterm Test**: Lec. 1, 2, 3, 4, 5 and 6. (**30%**, 90 min, no formulas, closed book).	----------
Reading Week: Feb. 28 → Mar. 04, 2022.	No classes and labs all week.	
Week 8: Mar. 07 → Mar. 11, 2022.	**Lec. 7 – Link Budget**: Point-to-Point Wireless Com., Friis Channel Model, Free Space Path Loss (FSPL), Link Budget, Problem Solving.	**Lab Project 3:** (**7.5%**) **RF Channel Simulation** (MATLAB, Simulink)
Week 9: Mar. 14 → Mar. 18, 2022.	**Lec. 8 – Path Loss**: Path Loss Models, RF Losses, Have-wave Dipole Antenna with Coaxial Cable, LOS, WLOS, NLOS Propagation, Problem Solving Strategies.	
Week 10: Mar. 21 → Mar. 25, 2022.	**Lec. 9 – Estimating PL Parameters**: Path Loss Models, Estimating Path Loss Parameters, Problem Solving.	
Week 11: Mar. 28 → Apr. 01, 2022.	**Quiz 2**: Lec. 6 and 7 (**5%**, 20 min). **Lec. 10 – Overview of Mobile Communication**: Fundamentals of Mobile Com., 3GPP Standardization, Cellular Architecture, Radio Access Network, Core Network, Backbone Network, 5G Use Cases (eMBB, URLLC, mMTC).	**Lab Project 4:** (**7.5%**) **Mobile Communications** (Smartphone, eNB)
Week 12: Apr. 04 → Apr. 08, 2022.	**Lec. 11 – Fundamentals of Cellular Com.**: DL/UL Com., Signal Strength, Com. Range, Coverage, Outage, Cellular Network Models, Freq. Reuse, Cellular Sectoring, Cellular Clustering, Co-Channel	

	Interference, Channel Access Schemes (FDMA, TDMA, CDMA, OFDMA, NOMA).	
Week 13: Apr. 11 → Apr. 15, 2022.	**Lec. 12 – Introduction to IoT Com.**: IoT Technologies, Lora, LoRaWAN, LTE-M, NB-IoT, Satellite-IoT, 5G-IoT, Vehicular IoT.	
Week 14: Apr. 18 → Apr. 22, 2022.	**Final Exam**: Lec. 7, 8, 9, 10, 11 and 12. (**30%**, 90 min, no formulas, closed book).	----------

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- **Academic Integrity**: The principle of academic integrity requires that all work submitted for evaluation and course credit be the original, unassisted work of the student. Cheating or plagiarism including borrowing, copying, purchasing, or collaborating on work, except for group projects arranged and approved by the professor, or otherwise submitting work that is not the student's own, violates this principle and will not be tolerated. Students who have any questions regarding whether specific circumstances involve a breach of academic integrity are advised to review the Academic Integrity Policy and procedure and/or discuss them with the professor.
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- **Accessible Learning**: Accessible Learning coordinates academic accommodations for students with disabilities. For more information or to register, please see the Accessible Learning website (Statement added September 2016).
- **Course Outline Changes**: The information contained in this Course Outline including but not limited to faculty and program information and course description is subject to change without notice. Any changes to course curriculum and/or assessment shall adhere to approved Sheridan protocol. Nothing in this Course Outline should be viewed as a representation, offer and/or warranty. Students are responsible for reading the Important Notice and Disclaimer which applies to Programs and Courses.
- **Respondus Statement of Use:** Sheridan College has selected the Respondus suite of products; Respondus Lockdown Browser and Respondus Monitor as the automated online quiz invigilation platform. One, or multiple, evaluation component(s) in this course will use Respondus for test/exam invigilation to maintain academic integrity. Visit Sheridan's Academic Integrity Website for more information. LockDown Browser is a custom browser that prevents users from accessing any websites or applications while taking tests or exams within SLATE. Respondus Monitor records you while taking your test/exam and requires that students have a webcam and microphone on their computer device. Only the faculty member teaching your course will have access to the summary recordings from Respondus Monitor. Exam recordings will be used for the sole purpose of validating the integrity of the assessment process and will be retained in accordance with the normal retention guidelines. The Respondus Monitor software has been carefully reviewed by Sheridan for privacy and data retention protections and compliance with Sheridan policies from an institutional perspective. You may also view the Respondus Privacy Statement. Please contact your faculty member if you have any questions or concerns. For system requirements and tips on troubleshooting the Respondus tools visit Sheridan's Teaching with Technology Website scroll down to the "For Students" section.