

Western University
Faculty of Engineering
Department of Electrical and Computer Engineering

ECE 4433b – Digital Communications Systems
(January 8, 2018 to April 11, 2018)

Course Outline 2017-18

Description:

The objective of the course is to provide an in-depth understanding of the principles involved in the design, analysis, and implementation of modern digital communication systems. Also, the goal is to provide technical knowledge needed by next-generation communication engineers and technologists for designing better digital communication systems. At the end of the course, the students will be able to design and implement error free and efficient data communication systems.

Instructor:

Dr. Raveendra Rao, P.Eng., SMIEEE
TEB-341, 519-661-2111x88231, rrao@uwo.ca

Contact hours:

Lecture: 3 hours/week
Laboratory: 3 hours/two weeks

Consultation hours:

The instructor will also be available for additional consultation by appointment through e-mail. All e-mail correspondence to instructor should bear the Subject as: ECE 4433. Allow at least 2 working days for a response.

Academic Calendar Copy:

Transceiver design for digital communication systems, design goals and tradeoffs. Deterministic and random signals. Digital modulation techniques, optimal receiver design, performance analysis under noisy conditions. Digital communication through bandlimited channels. Characteristics of wireless channel, intersymbol interference, channel estimation, adaptive equalization. Synchronization techniques. Multiple access techniques, CDMA, TDMA, FDMA. Principles of OFDM, cyclic prefix, in-band pilots, PAPR, applications of OFDM.

Course time table:

Lectures (Section 001): Monday: 6.30 to 9.30 PM in SEB-1056
Laboratory (Sections 002) will be held in SEB-1012
Tuesday - 9.30 AM to 12.30 PM

Prerequisite(s): [ECE 3331A/B](#), [ECE 3370A/B](#), [Statistical Sciences 2141A/B](#), [Applied Mathematics 3415A/B](#)

Extra Information: 3 lecture hours, 1.5 laboratory hours, 0.5 course

CEAB Units: ES 70%, ED 30%

Units: SI

Topics:

1. Digital communication system, design goals, and tradeoffs
2. Review of deterministic and random signals
3. Forward error correction coding techniques
4. Digital modulation techniques-amplitude, phase, and frequency
5. Optimum receiver design and performance analysis
6. Baseband and passband transmission system design
7. Intersymbol interference, equalization, and synchronization techniques
8. Multiple access techniques-FDMA, TDMA, and CDMA
9. Orthogonal Frequency Division Multiplexing (OFDM) system and applications
10. Selected topics in modern communication systems

Specific Learning Objectives:

1. Calculate power, bandwidth, & receiver complexity of a typical digital communication system and understand the tradeoffs in such a system
2. Understand communication channels and models used to represent them
3. Design channel encoders/decoders for linear block & convolutional forward error control coding techniques
4. Design and analyze digital modulation techniques and corresponding optimum receivers. Calculate and simulate their bit error rate performance.
5. Understand and design baseband data transmission systems
6. Understand and design FDMA, TDMA, CDMA, and spread-spectrum systems
7. Design and analysis of OFDM systems

Text Book:

J.G.Proakis & Masoud Salehi, Fundamentals of Communication Systems (2nd edition), Prentice Hall, 2014, ISBN-13: 978-0-13-335485-0

References Material:

S. Haykin, Communication Systems, 4th Edition, John Wiley and Sons, 2001, ISBN: 0-471-1786-4.
 B.P.Lathi and Z. Ding, Modern Digital and Analog Communication Systems, 4th Edition, Oxford University Press, ISBN: 978-0-19-533145-5
 R. K. Rao, Course Notes, would be posted to the course website
 MATLAB, student version with Simulink, Release 12 or latest, www.mathworks.com/store.

General Learning Objectives

Knowledge Base	3/3	Use of Engineering Tools		Impact on Society and the Environment	
Problem Analysis	3/3	Individual and Team Work		Ethics and Equity	
Investigation	3/2	Communication Skills		Economics and Project Management	
Design	3/2	Professionalism		Life-Long Learning	

Notation: x/y , where x is the cognitive level (1: Remember, 2: Understand, 3: Apply) at which the attribute is assessed and y is the academic level (1: Beginner, 2: Intermediate, 3: Advanced) at which the attribute is

Course Evaluation:

Course Component	Weight	Penalty (English)	Penalty (Final Answers)
Homework Assignments (maximum 4)	10%	10%	25%
Laboratory Exercises (maximum 5)	20%	20%	25%
Midterm Examination (2 hours)	20%	5%	25%
Final Examination (3 hours)	50%	5%	25%

To obtain a passing grade in the course, a mark of 50% or more must be achieved on the final examination as well as on the midterm examination and the overall grade must be greater than or equal to 50%. A final examination or midterm test mark < 50% will result in a final course grade of 48% or less.

In accordance with the policy of the University, the grade assigned to all written and oral work presented in English shall take into account syntax, diction, grammar and spelling. In the professional life of an engineer, the manner in which oral and written communications are presented is extremely important. An engineering student must develop these skills as an integral part of the undergraduate program. To encourage the student to do so, the grades assigned to all written and oral work will take into account all aspects of presentation including conciseness, organization, neatness, use of headings, and the preparation and use of tables and figures and correctness of final answers in solutions.

All work will be marked first for content after which a penalty not to exceed the maximum shown above would be applied.

Homework Assignments and Exercises:

A maximum of 4 homework assignments will be administered during the course. Assignments would be posted on the course website. Assignment schedule is given below:

Assignment Release Date	Assignment Submission Date
January 29, 2018	February 12, 2018
February 12, 2018	February 26, 2018
February 26, 2018	March 12, 2018
March 12, 2018	March 26, 2018

Solutions to all homework assignments must be submitted in the locker assigned to the course. The first page of submission must clearly indicate assignment #, name of student, and student ID. Several exercises would be posted to the course website from time to time during the course. There is no need to submit solutions to these exercises. You are encouraged to solve them to obtain firm grasp of the concepts and topics taught in the course.

Laboratory Exercises:

A maximum of 5 laboratory exercises will be administered during the course. Students are required to complete these exercises and submit them to TA. Laboratory exercises and their schedule would be posted on the course website.

Midterm Test:

Date/Time: February 26, 2018/6.30 to 8.30 PM

Duration: 2 hours

Format: Closed book (only a non-programmable calculator is permitted)

Location: TBA

Final Examination:

Date and Time: TBA

Duration: 3 Hours

Format: Closed Book (only a non-programmable calculator is permitted)

Location: TBA

Late Submission Policy: All submissions are due by 4.30 PM on due dates. Late submissions will be penalized 25% per day and the maximum penalty is 100%

Assignment Submission Locker: Locker 209 located on the second floor of TEB.

Use of English: In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests, and examinations for improper use of English. Additionally, poorly written work with the exception of the final examination may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

Attendance: All classes, laboratories, and tutorials are mandatory unless otherwise stated. Any student who, in the opinion of the instructor, is absent too frequently from class, laboratory, or tutorial periods will be reported to the Dean (after due warning has been given). On the recommendation of the department, and with the permission of the Dean, the student will be debarred from taking the regular final examination in the course.

Absence Due to Illness or Other Circumstances: Students should immediately consult with the instructor or department Chair if they have any problems that could affect their performance in the course. Where appropriate, the problems should be documented (see the attached “Instructions for Students Unable to Write Tests or Examinations or Submit Assignments as Scheduled”). The student should seek advice from the instructor or department Chair regarding how best to deal with the problem. Failure to notify the instructor or department Chair immediately (or as soon as possible thereafter) will have a negative effect on any appeal.

For more information concerning medical accommodations, see the relevant section of the Academic Handbook: http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_medical.pdf

For more information concerning accommodations for religious holidays, see the relevant section of the Academic Handbook: http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_religious.pdf

Missed Midterm Examinations: If a student misses a midterm examination, the exam will not be rescheduled. The student must follow the Instructions for Students Unable to Write Tests and provide documentation to their department within 24 hours of the missed test. The department will decide whether to allow the reweighting of the test, where reweighting means the marks normally allotted for the midterm will be added to the final exam. If no reasonable justification for missing the test can be found, then the student will receive a mark of zero for the test.

If a student is going to miss the midterm examination for religious reasons, they must inform the instructor in writing within 48 hours of the announcement of the exam date or they will be required to write the exam.

Cheating and Plagiarism: Students must write their essays and assignments in their own words. Whenever students take an idea or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. University policy states that cheating, including plagiarism, is a scholastic offence. The commission of a scholastic offence is attended by

academic penalties, which might include expulsion from the program. If you are caught cheating, there will be no second warning.

All required papers may be subject to submission for textual similarity review to commercial plagiarism-detection software under license to the University for the detection of plagiarism. All papers submitted will be included as source documents on the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between the University of Western Ontario and Turnitin.com (<http://www.turnitin.com>).

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, in the relevant section of the Academic Handbook: http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf

Use of Electronic Devices: Students may use laptops, tablet computers, or smart phones *only* to access the course OWL site during lectures and tutorials. Use of *nonprogrammable* calculators *only* is permitted during examinations. No other electronic devices may be used at any time during examinations.

Use of Personal Response Devices (“Clickers”): If clickers are used in a course, include a statement describing how they will be used that conforms to the requirements given on p. 2 and p. 4 of the course outlines policies in the Academic Handbook,

http://www.uwo.ca/univsec/pdf/academic_policies/exam/courseoutlines.pdf

Omit this section if your course does not use clickers.

Policy on Repeating All Components of a Course: Students who are required to repeat an Engineering course must repeat all components of the course. No special permissions will be granted enabling a student to retain laboratory, assignment, or test marks from previous years. Previously completed assignments and laboratories cannot be resubmitted by the student for grading in subsequent years.

Internet and Electronic Mail: A course website (<https://owl.uwo.ca/portal/>) would be maintained and course outline, power point presentations, assignments, practice exercises, laboratory exercises, submission deadlines, announcements, notes etc. would be posted on the website for electronic viewing and download in Portable Document Format (PDF). Students are responsible for regularly checking their Western e-mail and the course website and be aware of information that would be posted about the course.

Accessibility: Please contact the course instructor if you require material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 519-661-2111 ext. 82147 for any specific question regarding an accommodation.

Support Services:

Office of the Registrar, <http://www.registrar.uwo.ca/>

Student Development Centre, <http://www.sdc.uwo.ca/>

Engineering Undergraduate Services, <http://www.eng.uwo.ca/undergraduate/>

USC Student Support Services, <http://westernusc.ca/services/>

Students who are in emotional/mental distress should refer to Mental Health @ Western, http://www.health.uwo.ca/mental_health/, for a complete list of options about how to obtain help.

INSTRUCTIONS FOR STUDENTS UNABLE TO WRITE TESTS OR EXAMINATIONS OR SUBMIT ASSIGNMENTS AS SCHEDULED

IF, ON MEDICAL OR COMPASSIONATE GROUNDS, YOU ARE UNABLE TO WRITE TERM TESTS OR FINAL EXAMINATIONS OR COMPLETE COURSE WORK BY THE DUE DATE, YOU SHOULD FOLLOW THE INSTRUCTIONS LISTED BELOW. YOU SHOULD UNDERSTAND THAT ACADEMIC RELIEF WILL NOT BE GRANTED AUTOMATICALLY ON REQUEST. YOU MUST DEMONSTRATE TO YOUR DEPARTMENT (OR THE UNDERGRADUATE SERVICES OFFICE) THAT THERE ARE COMPELLING MEDICAL OR COMPASSIONATE GROUNDS THAT CAN BE DOCUMENTED BEFORE ACADEMIC RELIEF WILL BE CONSIDERED. DIFFERENT REGULATIONS APPLY TO TERM TESTS, FINAL EXAMINATIONS AND LATE ASSIGNMENTS. PLEASE READ THE INSTRUCTIONS CAREFULLY. (SEE THE 2017 UWO ACADEMIC CALENDAR).

A. GENERAL REGULATIONS & PROCEDURES

1. All first year students will report to the Undergraduate Services Office, SEB 2097, for all instances.
2. If you are an upper year student and you are missing a test/assignment/lab or exam that is worth MORE THAN 10% of your final grade, you will report to the Undergraduate Services Office, SEB 2097. Otherwise, you will report to your department office to request relief.
3. Check the course outline to see if the instructor has a policy for missed tests, examinations, late assignments or attendance.
4. Documentation must be provided as soon as possible. If no one is available in your Department office or the Undergraduate Services Office, leave a message clearly stating your name & student number and reason for your call. The department telephone numbers are given at the end of these instructions.
5. If you decide to write a test or an examination you should be prepared to accept the mark you earn. Rewriting tests or examinations or having the value of a test or examination reweighted on a retroactive basis is not permitted.

B. TERM TESTS

1. If you are in first year and you are unable to write a term test, contact the Undergraduate Services Office, SEB 2097 PRIOR to the scheduled date of the test.
2. If you are an upper year student and you are unable to write a term test, inform your instructor PRIOR to the scheduled date of the test. If the instructor is not available, leave a message for him/her at the department office. If the test is worth MORE THAN 10% of your final grade you will report to the Undergraduate Services Office, SEB 2097 to request relief. Otherwise, you will report to your department office to request relief.
3. Be prepared to provide supporting documentation to the Department Chair and/or the Undergraduate Services Office (see next page for information on documentation).
4. Discuss with the instructor if and when the test can be rescheduled. **N.B.** The approval of the Chair or the Undergraduate Services Office is required when rescheduling term tests.

C. FINAL EXAMINATIONS

1. If you are unable to write a final examination, contact the Undergraduate Services Office PRIOR TO THE SCHEDULED EXAMINATION TIME to request permission to write a Special Final Examination. If no one is available in the Undergraduate Services Office, leave a message clearly stating your name & student number.
2. Be prepared to provide the Undergraduate Services Office with supporting documentation (see next page for information on documentation) the next day, or as soon as possible (in cases where students are hospitalized). The following circumstances are not considered grounds for missing a final examination or requesting special examinations: common cold, sleeping in, misreading timetable and travel arrangements.
3. In order to receive permission to write a Special Examination, you must obtain the approval of the Chair of the Department **and** the Associate Dean and in order to apply you must sign a "Recommendation for a Special Examination Form" available in the Undergraduate Services Office. The Undergraduate Services Office will then notify the course instructor(s) and reschedule the examination on your behalf.

N.B. It is the student's responsibility to check the date, time and location of the Special Examination.

D. LATE ASSIGNMENTS

1. Advise the instructor if you are having problems completing the assignment on time (**prior** to the due date of the assignment).
2. Be prepared to provide documentation if requested by the instructor (see reverse side for information on documentation).
3. If you are granted an extension, establish a due date. The approval of the Chair of your Department (or the Associate Dean if you are in first year) is not required if assignments will be completed prior to the last day of classes.
4.
 - i) Extensions beyond the end of classes must have the consent of the instructor, the department Chair and the Associate Dean. Documentation is mandatory.
 - ii) A Recommendation of Incomplete Form must be filled out indicating the work to be completed and the date by which it is due. This form must be signed by the student, the instructor, the department Chair and the Associate Dean.

E. SHORT ABSENCES

If you miss a class due to a minor illness or other problem, check your course outlines for information regarding attendance requirements and make sure you are not missing a test, laboratory or assignment. Cover any readings and arrange to borrow notes from a classmate.

F. EXTENDED ABSENCES

If you are absent more than one week or if you get too far behind to catch up, you should consider reducing your workload by dropping one or more courses. (Note drop deadlines listed below). You may want to seek advice from the academic counsellor in your Department or Ms. Karen Murray in the Undergraduate Services Office, if you are in first year.

G. DOCUMENTATION

If you consulted an off-campus doctor or Student Health Services regarding your illness or personal problem, **you must provide the doctor with a Student Medical Certificate** to complete at the time of your visit and then bring it to the Department (or the Undergraduate Services Office). **This note must contain the following information: severity of illness, effect on academic studies and duration of absence. Regular doctor's notes will not be accepted; only the Student Medical Certificate will be accepted.**

In Case of Serious Illness of a Family Member: Provide a Student Medical Certificate to your family member's physician to complete and bring it to the Department (or the Undergraduate Services Office if you are in first year).

In Case of a Death: Obtain a copy of the death certificate or the notice provided by the funeral director's office. You must include your relationship to the deceased and bring it to the Department (or the Undergraduate Services Office if you are in first year).

For Other Extenuating Circumstances: If you are not sure what documentation to provide, ask the Departmental Office (or the Undergraduate Services Office if you are in first year) for direction.

Note: Forged notes and certificates will be dealt with severely. To submit a forged document is a scholastic offence (see below).

H. ACADEMIC CONCERNS

1. You need to know if your instructors have a policy on late penalties, missed tests, etc. This information may be included on the course outlines. If not, ask your instructor(s).
2. **You should also be aware of attendance requirements in some courses. You can be debarred from writing the final examination if your attendance is not satisfactory.**
3. If you are in academic difficulty, check out the minimum requirements for progression in the calendar. If in doubt, see your academic counsellor.

Calendar References: Check these regulations in your 2017 Western Academic Calendar available at www.westerncalendar.uwo.ca.

Absences Due to Illness: <http://westerncalendar.uwo.ca/2017/pg117.html>
Academic Accommodations for Students with Disabilities: <http://westerncalendar.uwo.ca/2017/pg118.html>
Academic Accommodations for Religious or Holy Days: <http://westerncalendar.uwo.ca/2017/pg119.html>
Course Withdrawals: <http://westerncalendar.uwo.ca/2017/pg157.html>
Examinations: <http://westerncalendar.uwo.ca/2017/pg129.html>
Scheduling of Term Assignments: <http://westerncalendar.uwo.ca/2017/pg135.html>
Scholastic Offences: <http://www.westerncalendar.uwo.ca/2017/pg111.html>
Student Medical Certificate: http://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf
Engineering Academic Regulations: <http://www.westerncalendar.uwo.ca/2017/pg1442.html>

Note: These instructions apply to all students registered in the Faculty of Engineering regardless of whether the courses are offered by the Faculty of Engineering or other faculties in the University.

Drop Deadlines:

First term half course (i.e. "A" or "F"):	November 5, 2017
Full courses and full-year half courses (i.e. "E", "Y" or no suffix):	November 30, 2017
Second term half or second term full course (i.e. "B" or "G"):	March 7, 2017

Contact Information:

Undergraduate Services Office:	SEB 2097	Telephone: (519) 661-2130	E-mail: engugrad@uwo.ca
Dept. of Chemical and Biochemical Engineering & Green Process Engineering:	TEB 477	Telephone: (519) 661-2131	E-mail: cbeugrad@uwo.ca
Dept. of Civil and Environmental Engineering:	SEB 3005	Telephone: (519) 661-2139	E-mail: civil@uwo.ca
Dept. of Electrical and Computer Engineering, Software Engineering & Mechatronics Engineering:	TEB 279	Telephone: (519) 661-3758	E-mail: eceugrad@uwo.ca
Dept. of Mechanical and Materials Engineering:	SEB 3002	Telephone: (519) 661-4122	E-mail: mmeundergraduate@uwo.ca