ECE 5000: Introduction to Analog and Digital Communications

Course Description

Communications channel modeling, analog communication schemes, digital communication schemes, error rate analysis, and error control coding.

Prior Course Number: 501, 702
Transcript Abbreviation: Intro Ana Dig Comm
Grading Plan: Letter Grade
Course Deliveries: Classroom
Course Levels: Undergrad, Graduate
Student Ranks: Junior, Senior, Masters, Doctoral
Course Offerings: Autumn, Spring
Flex Scheduled Course: Never
Course Frequency: Every Year
Course Length: 14 Week
Credits: 3.0
Repeatable: No
Time Distribution: 3.0 hr Lec
Expected out-of-class hours per week: 6.0
Graded Component: Lecture
Credit by Examination: No
Admission Condition: No
Off Campus: Never
Campus Locations: Columbus
Prerequisites and Co-requisites: Prereq: 3050, and Stat 3470 or Physics 3700; or Grad standing.
Exclusions:
Cross-Listings:

Course Rationale: Existing course.

The course is required for this unit's degrees, majors, and/or minors: No
The course is a GEC: No
The course is an elective (for this or other units) or is a service course for other units: Yes

Subject/CIP Code: 14.1001
Subsidy Level: Doctoral Course

Programs

Abbreviation	Description
CpE	Computer Engineering
EE	Electrical Engineering

Course Goals

Be competent in the fundamentals of communication channel modeling (e.g., filterplus-noise model, multipath propagation, complex-baseband model)
Master fundamental techniques for analog communication (e.g., AM, QAM, VSB, FM)
Be competent in random signals and noise (e.g., Marcums Q function, power spectrum, autocorrelation, filtering of a random signal)

Master concepts in pulse-shaped digital communications (e.g., pulse shaping, matched filtering, raised-cosine pulses, Nyquist criterion)
Be competent in error analysis of un-coded digital communications (e.g., eye and constellation diagrams, decision regions, gray coding)
Be familiar with concepts in error control coding
Be familiar with communication over dispersive channels (e.g., equalization) and parallel digital communication schemes (e.g., CDMA or OFDM).
Be competent in using a high-level programming language (e.g., Matlab) for communication system simulation and analysis

Course Topics

Topic	Lec	Rec	Lab	Cli	IS	Sem	FE	Wor
Communications problem	2.0							
Review of relevant signals and systems concepts (Fourier transform, Dirac delta, linear systems, filtering)	3.0							
The communications channel model (filter + noise, multipath)	1.0							
Analog communications (e.g., AM, large-carrier AM, QAM, VSB, FM, discriminator)	6.0							
Review of random signals and noise (e.g., power spectrum, autocorrelation, filtering of random processes).	2.0							
The complex-baseband channel model.	2.0							
Pulse-shaped digital communications (pulse shaping, receiver filtering, Nyquist criterion, raised-cosine pulse, matched filtering, square-root raised-cosine pulse)	5.0							
DSP implementation of digital communications (sinc reconstruction, downsampling, discrete-time channel representation, fractional sampling)	2.0							
Error analysis (eye diagram, constellation diagram, symbol alphabets, decision regions, symbol error rate, gray coding)	5.0							
Error control coding	3.0							
Parallel communication (generalizing the pulse shape, generalizing the matched filter, orthogonal pulse shapes like OFDM and CDMA, non-orthogonal pulse shapes, matched filtering)	6.0							
Communication over dispersive channels (effective pulse shape, equalization, CP-OFDM)	3.0							

Representative Assignments

Homework problems with both analytical and Matlab content will be assigned.

Grades

Aspect	Percent
Homework	25%
Two midterm exams	40%
Final exam	35%

Representative Textbooks and Other Course Materials

Title	Author
Wireless Communications (online preprint) (required)	Robert Heath, Jr.
Introduction to Analog and Digital Communications, Openstax CNX (online) (required)	Schniter
A Digital Communication Laboratory, Lulu Press (online) (reference)	Potter & Yang
Digital Communications, 5th ed., McGraw-Hill (reference)	Proakis & Salehi
Introduction to Communication Systems, Cambridge University Press, 2014 (reference)	U. Madhow
Telecommunications Breakdown: Concepts of Communication Transmitted via Software-Defined Radio, Prentice-Hall, 2003 (free at U Wisc) (reference)	C.R. Johnson and W.A. Sethares

ABET-EAC Criterion 3 Outcomes

Course Contribution		College Outcome
***	a	An ability to apply knowledge of mathematics, science, and engineering.
	b	An ability to design and conduct experiments, as well as to analyze and interpret data.
*	c	An ability to design a system, component, or process to meet desired needs.
	d	An ability to function on multi-disciplinary teams.
**	e	An ability to identify, formulate, and solve engineering problems.
	f	An understanding of professional and ethical responsibility.
	g	An ability to communicate effectively.
	h	The broad education necessary to understand the impact of engineering solutions in a global and societal context.
	i	A recognition of the need for, and an ability to engage in life-long learning.
	j	A knowledge of contemporary issues.
**	k	An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

CpE ABET-EAC Criterion 9 Program Criteria Outcomes

Course Contribution		Program Outcome
***	1	an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
*	2	an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
	3	an ability to communicate effectively with a range of audiences
	4	an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
	5	an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
**	6	an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
*	7	an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

EE ABET-EAC Criterion 9 Program Criteria Outcomes

Course Contribution		Program Outcome
***	1	an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

Course Contribution		Program Outcome
*	2	an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
	3	an ability to communicate effectively with a range of audiences
	4	an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
	5	an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
*	6	an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
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Additional Notes or Comments

Added Physics courses to prereqs. Updated prereqs and exclusion to university format.

Changed texts 3/27/12

Add autumn to semesters of offering 4/11/13

Reword goals, update texts, add new outcomes 6/5/2019

Corrected text entry: 1/7/20, ced

Prepared by: Carol Duhigg