Rutgers University, Department of Electrical and Computer Engineering
ABET COURSE SYLLABUS
COURSE: 14:332:427

Course Catalog Description:	14:332:427 Communications Systems Design (3) Design methods and laboratory experiments dealing with practical aspects of analog and digital communications schemes. Experiments involve component-level circuit construction, interconnection of modular subsystems, and use of interactive, graphics-based, system simulation software packages.
Pre-Requisite Courses:	14:332:322 Principles of Communications Systems 14:332:366 Digital Electronics
Co-Requisite Courses:	14:332:463 Analog Electronics
Pre-Requisite by Topic:	1. Periodic and Aperiodic Signals 2. Fourier Series and Transforms 3. Linear Systems Theory 4. Probability and Random Processes 5. Simple Gaussian Noise Processes 6. AM/FM/PM Modulation 7. ASK/FSK/PSK Modulation
Textbook & Materials:	P. H. Young, *Electronic Communication Techniques*, Fifth Edition, Prentice-Hall, 2004. C. W. Sayre, *Complete Wireless Design*, McGraw Hill, 2001. J. G. Proakis, M. Salehi and G. Bauch, *Contemporary Communication Systems Using MATLAB and Simulink* Second Edition, Thomson Engineering, 2004
References:	**M. C.** Jeruchim, P. Balaban and K. S. Shanmugan, *Simulation of Communication Systems*, Plenum Press, 1992. C. Bowick, *RF Circuit Design*, Newnes Publishing, 1982. S. R. Bullock, *Transceiver and System Design for Digital Communications*, Second Edition, Noble Publishing, 2000. K. McClaning and T. Vito, *Radio Receiver Design*, Noble Publishing, 2000. W. Tomasi, *Advanced Electronic Communications Systems*, Fifth Edition, Prentice-Hall, Inc., 2001. S. Haykin, *Communication Systems*, Fourth Edition, John Wiley and Sons, Inc., 2001.
Overall Educational Objective:	1. To develop skills in component-level circuit construction, as well as modular interconnection of subsystems, needed to build physical communications systems.

2. To develop skills in the use of industry-relevant electronic test and measurement equipment typically encountered by a design engineer.

3. To use industry-relevant software communications systems simulation methods for the purpose of evaluating overall communication system performance.

4. To understand the functionality of analog and digital communications modulation and demodulation by building, testing and analyzing circuits.

5. To study and implement essential subsystems such as carrier acquisition and recovery, receiver front-end, and superheterodyne receiver architectures.

Course Learning Outcomes: A student who successfully fulfills the course requirements will have demonstrated:

1. An ability to use electronic test and measurement equipment over frequencies from baseband to RF.

2. An ability to design, build, test and analyze circuits and systems relevant to communications systems.

3. An ability to write informal and formal technical reports.

4. An ability to orally present technical concepts to a group.

How Course Outcomes are Assessed:
Prelab Problems (20%)
Laboratory Reports (40%)
Laboratory Technique (10%)
Final Exam and Oral Presentations (30%)

N = None S = Supportive H = Highly related

Outcome	**Level**	**Proficiency assessed by**
(a) an ability to apply knowledge of Mathematics, science, and engineering	H	Prelab Problems, Final Exam
(b) an ability to design and conduct experiments and interpret data	H	Lab Exercises
(c) an ability to design a system, component or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	S	Lab Exercises
(d) an ability to function as part of a multi-disciplinary team	S	Lab Reports. Laboratory Technique
(e) an ability to identify, formulate, and solve ECE problems	H	Prelab Problems, Lab Exercises
(f) an understanding of professional and ethical responsibility	S	Laboratory Technique
(g) an ability to communicate in written and oral form	H	Lab Reports, Oral Presentations
(h) the broad education necessary to understand the impact of electrical and computer engineering solutions in a global, economic, environmental, and societal context	N	
(i) a recognition of the need for, and an ability to engage in life-long learning	S	Prelab Problems, Lab Exercises
(j) a knowledge of contemporary issues	N	
(k) an ability to use the techniques, skills, and modern engineering tools necessary for electrical and computer engineering practice	H	Prelab Problems, Lab Exercises
Basic disciplines in Electrical Engineering	H	Prelab Problems, Lab Exercises
Depth in Electrical Engineering	S	Prelab Problems, Lab Exercises
Basic disciplines in Computer Engineering	N	
Depth in Computer Engineering	N	
Laboratory equipment and software tools	H	Prelab Problems, Lab Exercises
Variety of instruction formats	S	Lecture, Lab, Office Hours

Topics Covered week by week:

Week 1: Time and Frequency Analysis; RMS, dBm levels: definition and measurement; Frequency response of active and passive linear circuits; Noise generator and adder circuits for S/N measurements

Weeks 2 and 3: Sinusoidal Oscillators and Tuned Circuits; Bandwidth and amplitude characteristics; Analog and digital crystal oscillators

Week 4: Balanced Modulators; Implementation using discrete components

Weeks 5 and 6: AM Modulation and Demodulation; DSB-SC, DSB-LC, approximation of ASK; IF amplifier stages; Envelope and synchronous detection; Single-sideband system simulation; Active bandpass intermediate frequency (IF) stages; Superheterodyne receivers

Week 7: Phase Locked Loops ; VCO, phase detector, loop filter; Analog and digital implementation methods; PLL properties, effects of loop LPF bandwidth; PLL circuit analyses

Weeks 8 and 9: FM Modulation and Demodulation; PM, FM, approximation of FSK; Tuned circuit discriminator, PLL demodulation methods; FM transmitter and receiver system implementation, Simulation of FM communication systems using CAD methods

Week 10: Pulse Modulation; PWM - measurement of bandwidth, PAM - practical sampling and quantization noise, PCM - line coding techniques

Week 11: Digital Modulation and Demodulation Methods; ASK, FSK, PSK techniques; Measurement of spectral occupancy of modulated signals; Receiver front-end principles; Carrier recovery using PLL and Costas Loop

Weeks 12-14: Digital Data Transmission and Reception; Simulation of digital communication system performance using a communications CAD software package; QPSK modulator and demodulator circuit implementation; Measurement of prototype transmitter/receiver performance

Weeks 15-16: Final Examination and Oral Presentations

Computer Usage: Simulations are conducted using CAD software packages. Simulation of circuit performance using P-Spice. Simulation of system performance using MATLAB along with the Communications and Signal Processing toolboxes. Laboratory reports are prepared using word processing and graphics development software.

Laboratory Experiences: Extensive laboratory experience is the course focus. Three-hour laboratory sessions are held weekly with teams of two students per group. Hands-on usage of electronic test and measurement equipment, along with circuit and system implementations, is required for the topics covered in the course.

Design Experiences: Moderate design experience related to circuit development at both the discrete component-level and integrated circuit-level of implementation. Moderate design experience at the system-level via simulations involving the effects of various parameters on overall system performance.

Independent Learning Experiences:
1. Prelab problem solutions.
2. Use of available technical resources (library, corporate publications, Internet).
3. Circuit designs to implement specific functions.
4. Development of simulations to assess system performance.
5. Technical writing - Discussion of Results for all laboratory exercises.

Contribution to the Professional Component:
(a) College-level mathematics and basic sciences: 0 credit hours
(b) Engineering Topics (Science and/or Design): 3 credit hours
(c) General Education: 0 credit hours
Total credits: 3

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