Electronics Communications: Course Materials

This page contains **Syst** Electronics Communications course materials and relevant information. Toggle the tabs below to view all the content of this course area.

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Traditional View

A communications course with an emphasis on radio used to be a common part of most AAS degree programs in electronics. Many of these courses prepared the student to pass the FCC General Radiotelephone Operator's License (GROL). But with the event of the digital revolution and the emergence of the microcomputer, most schools dropped any communications course for new digital and micro courses. Today, that agenda remains in place. If a college has a communications course it is most likely an elective and in many cases may be more focused on computer networking than communications and wireless in general.

Overall the AAS degree programs essentially ignore communications in favor of the traditional core courses plus strong digital and micro courses. Other than a real shortage of time available in the curriculum and lab costs, the reasons for this neglect are not known. Yet, communications dominates electronics today more than ever making a communications course almost a must in most curricula. Most electronic tech jobs have a communications aspect.

While few schools offer a communications course today, the communications side of the electronics field is booming along with the jobs. In fact, the communications sector of electronics (semiconductors, equipment, systems, etc.) is the largest in the industry even bigger than the computer segment. Most of that is thanks to the cellular telephone business. With over one billion cell phones sold each year and the huge infrastructure to support them, it is a huge success and many jobs are available. And a forthcoming boom in wireless broadband should further increase the need for communications knowledge and expertise. For this reason, colleges should rethink their curricula and bring back the communications course as it is more relevant than ever.

The traditional courses emphasized modulation methods, transmitter and receiver circuits, antennas and transmission lines and often included an introduction to TV or radar. Such courses are no longer as relevant. While modulation methods are certainly important, more complex methods of modulation and multiplexing (access) have been added (QAM, OFDM, etc.). Individual circuits are less relevant as most circuitry is embedded into integrated circuits. And many new communications techniques have come forth in the past several decades. So any modern communications course must incorporate all the related cellular technology as well as an introduction to networking.

New Systems View

The communications sector dominates the electronics industry. It produces the greatest revenue of any other sector and enjoys the largest percentage of employment. Computers and software are second to communications followed by control and instrumentation. Today, virtually all electronic products are either communications products (e.g. cell phones) or incorporate some form of communications such a wireless LAN and Ethernet in PCs and laptops. Consumer electronics, medical electronics, and all other sectors enjoy some form of communications enhancement, many of these are wireless. More and more, a technician needs to know about communications especially basic computer networking (Ethernet is in everything) and wireless.

The eSyst project recognizes the importance of communications in electronics and strongly recommends that all colleges add or rejuvenate a communications course and make it a required part of the curricula. A technician not educated in these essential fundamentals is at a distinct disadvantage going to work in an industry that today is largely communications oriented.

Wireless and networking are system level operations and a perfect fit with the eSyst concepts. It is difficult to name an electronic product or application that does not have some form of connectivity either wired or wireless. Most techs need to be aware of how these communications sub systems impact other products.

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Electronics Communications Instructional Materials List
Last Update: June 27, 2013

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1. Instructor Presentation: Serial Digital Interface
   Basic electronics systems operations all contain the generation, transfer, and reception of electronic data. One of the most common but not usually covered interfaces is Serial Input and Output (I/O). This presentation covers the standard ways of getting data in and out of digital circuits, equipment, and computer systems.

2. Instructor Presentation: Bluetooth
   This tutorial introduces you to the popular wireless technology called Bluetooth.

Bluetooth is a short-range wireless technology used for cell phone headsets, cordless audio home transmissions, and for some computer peripheral connections. The tutorial summarizes the physcal layer details including frequency of operation, modulation, access, and networking. The different versions of Bluetooth are explained. Common applications are discussed.

3. Student Guide: SDR Lab
   Software Defined Radio (SDR) familiarization lab. Most radios today use an embedded processor running digital signal processing (DSP) software to perform some of the primary functions of a transmitter or receiver. The most common example is the cell phone. However, most other radios like TV sets and others have abandoned more traditional superheterodyne methods using down conversion and up conversion in favor of direct conversion and the use of DSP to perform demodulation, modulation, filtering and other functions which in the past were implemented with discrete components or conventional integrated circuits. Because the principles of SDR are now so widespread it is useful for the student to understand at the systems level just how these radios work.

4. Instructor Guide: SDR Lab
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5. Student Guide: Transmission Line Measurements Lab
   Communications equipment, systems and test instruments are generally connected to one another by coaxial cable. For that reason, it is essential that students know the characteristics of transmission lines using coax cable and how to make basic measurements on them.

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7. Instructor Guide: Using Digi International's XBee Modules Lab
   The purpose of this resource is to introduce the instructor to Digi International's XBee wireless modules; and to provide the instructor with several working examples of data being transmitted and received using these modules. Included with this resource are three LabView VI programs.

8. Instructor Guide: Short Range Wireless Experimentation Lab
   The purpose of this laboratory experiment is to provide practical working experience with common short-range wireless equipment. The experiment provides activities to analyze the organization and operation of a common UHF transceiver, range calculation and measurement, and antenna radiation patterns.

9. Student Guide: Short Range Wireless Experimentation Lab
   The purpose of this laboratory experiment is to provide practical working experience with common short-range wireless equipment. The experiment provides activities to

analyze the organization and operation of a common UHF transceiver, range calculation and measurement, and antenna radiation patterns.

* Instructors should contactmike.lesiecki@domail.maricopa.edu , eSyst Director, for an answer key.

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Student Learning Outcomes

Toggle the arrows to view the SLOs. New student learning outcomes (SLOs) are listed in red.

Electronics Communications

1. Name the basic components of any electronic communications system and identify at least 3 different communication media commonly used.
2. Identify the electromagnetic frequency spectrum and name the major frequency bands and examples of applications in each.
3. Define modulation and explain why it is used in communications. Define baseband and broad communications.
4. Explain amplitude and frequency modulation and show how sidebands are generated.
5. Explain the relationship between the serial data rate and the bandwidth needed to pass it without error. Define the Shannon theory.
6. Name the basic ways digital data is transmitted including FSK, BPSK, QPSK and M-QAM and show the basic circuits used to produce this modulation.
7. Draw a block diagram of a modern solid state radio transmitter identifying all the major components and how they work.
8. Draw a block diagram of a modern solid state radio receiver identifying all the major components and how they work.

9. Identify the government services that regulate and manage the frequency spectrum in the US.

10. Explain the make-up of a radio wave and show how it is propagated in the most common wireless applications. Explain and use the Friis free space formula.

11. Name the most common types of antennas in use today.

12. Explain the theory of transmission lines, name the most common types and their specifications and make basic calculations with them.

13. Define reflection coefficient, standing wave ratio (SWR), and make basic calculations with them.

14. Use a Smith chart to plot impedances and to make line and load conversions.

15. Name the most common short range wireless technologies (Bluetooth, Wi-Fi, ZigBee/802.15.4, UWB, ISM band, etc.) and state a common application for each.

16. Name the most common cell phone radio technologies, frequency bands of operation, and explain the modulation and access methods for each.

17. Explain the concept of the cell phone system and how it works.

18. Define WAN, MAN, LAN and PAN and give an example of each.

19. Describe how the Internet works.

20. Give the basic specifications for an Ethernet LAN, state the standards used and describe the data formats and transmission media commonly used.

21. Explain the TCP/IP protocols.

22. Explain how fiber optic data communications works and the components that make it up. Give examples of how it is used.

Laboratory

1. Use a spectrum analyzer or its virtual instrument equivalent to observe the harmonics in complex waveforms and the sidebands produced by different types of modulation.

2. Demonstrate basic digital modulation and demodulation methods such as BPSK, QPSK, FSK and QAM.

3. Plot antenna radiation patterns.

4. Make basic transmission line measurements including attenuation, impedance, and reflections.

5. Demonstrate the use of at least one short range radio technology.

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Detailed Course Outline

Toggle the arrows to view the outlines. New topics are listed below in red.

Communincations Electronics Course

1. Introduction to communications systems
   a. Major components
   b. Signals and noise
   c. Communications media

2. The Electromagnetic Frequency Spectrum
   a. Wavelength
   b. Frequency units and ranges. Band designations
   c. Spectrum overview and applications
   d. Spectrum regulation and regulating bodies

3. Baseband and Broadband Communications
   a. Baseband signals, analog and digital
   b. Broadband signals, analog and digital
   c. Bandwidth of channel and signal characteristics

4. Modulation
   a. Amplitude modulation
   b. Sidebands
   c. OOK and ASK
   d. Frequency modulation
   e. Sidebands
   f. FSK

5. Speed vs. Bandwidth

6. Digital modulation methods
   a. I/Q modulation
   b. BPSK

c. QPSK
d. QAM
e. Spread spectrum
f. OFDM
g. Spectral efficiency

7. Radio transmitters (IC emphasis)
   a. Main components, organization, operation
   b. Frequency synthesizers
   c. Mixers
   d. Filters
   e, Modulators
   f. Power amplifiers
   g. Impedance matching

8. Radio receivers (IC emphasis)
   a. Superhetrodyne principle
   b. Basic circuits and block diagram analysis
   c. Mixers
   d. LNA
   e, Filters
   f. Demodulation (including DSP)

9. Transmission Lines
   a. Types of lines
   b. Line characteristics
   c. SWR
   d. Matching
   e. Measurements
   f. Waveguides
   g. Strip line and microstrip line
   h. Introduction to the Smith chart

10. Antennas
    a. Antenna principles
    b. Reciprocity and polarization
    c. The dipole
    d. The ground plane vertical
    e. Arrays
    f. Yagi-Uda
    g. Parabolic dish
    h. The patch

11. Radio waves and signal propagation
    a. Electromagnetic waves characteristics
    b. Basic propagation methods: ground wave, sky wave, direct wave
    c. VHF, UHF, microwave wave propagation, path loss, calculations

12. Wireless Technologies Overview
    a. Broadcast and Shortwave
    b. Short range: Wi-Fi, Bluetooth, ZigBee, UWB, ISM band, IrDA, RFID, NFC
    c. Wireless broadband: WiMAX, backhaul
    d. The cellular technologies and standards
    e. Video wireless

13. Introduction to Networking
    a. Need, concepts
    b. Topologies

14. The Internet, how it works
    a. Components of the Internet
    b. TCP/IP and other protocols

15. Introduction to Ethernet
    a. The protocols
    b. The standards
    c. Basic hardware and operation
    d. Media options

16. Introduction to fiber optic systems
    a. Fiber cable characteristics and operation
    b. Signal sources: LEDs, lasers
    c. Signal detectors (avalanche diode, PIN)
    d. Standards and hardware (Sonet, transceivers, ADMs)