ITT Technical Institute

ET3330

Telecommunications Systems and Technology

Onsite Course

SYLLABUS

Credit hours: 4.5

Contact/Instructional hours: 56 (34 Theory Hours, 22 Lab Hours)

Prerequisite(s) and/or Corequisite(s):

Prerequisites: ET2530 Electronic Communications or equivalent

Course Description:

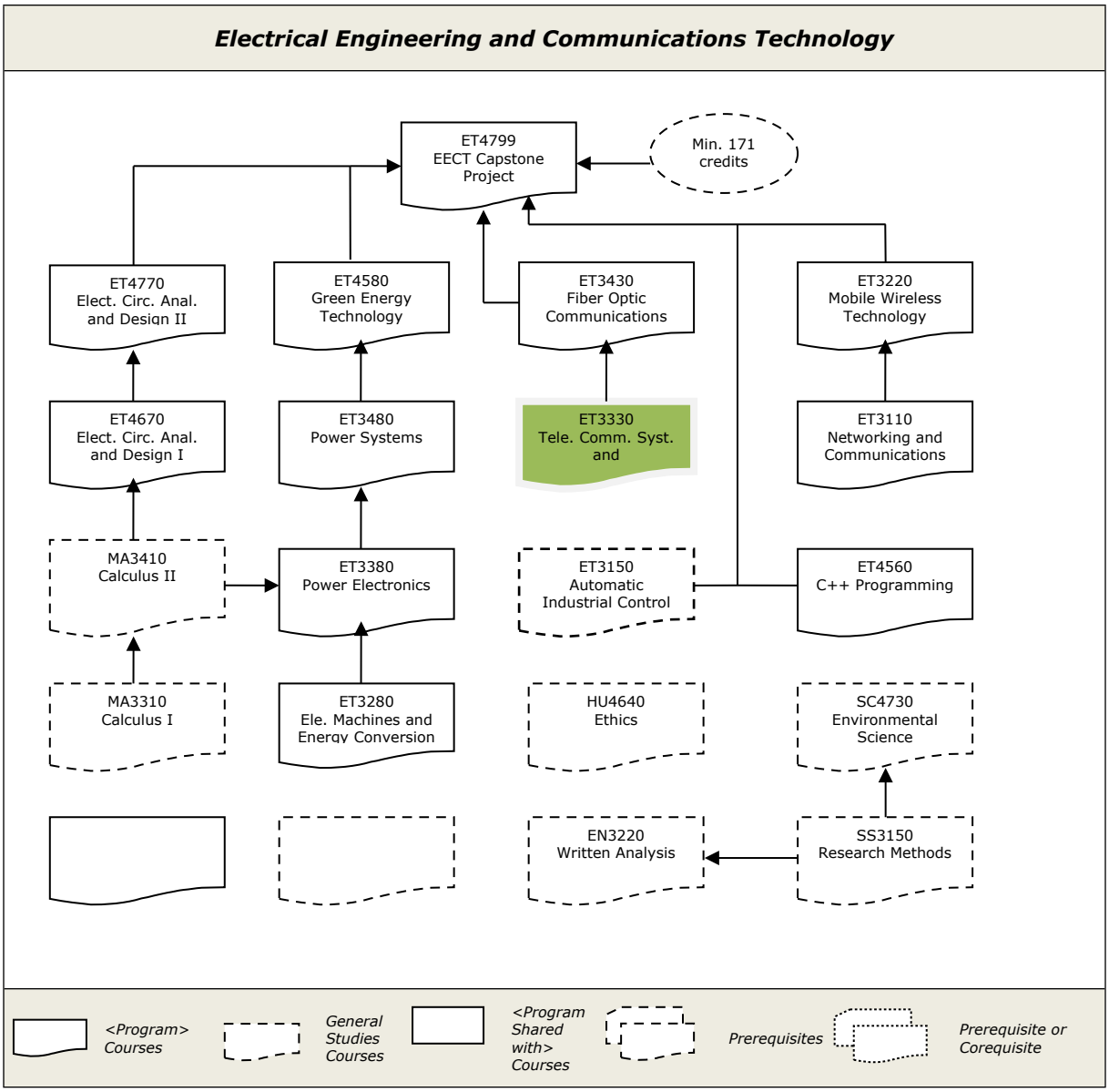
This course explores concepts and applications of telecommunications systems and technology. Emphasis is on technical aspects of digital communications systems with digital signal processing, transmission, reception, storage and retrieval of information.

Where Does This Course Belong?

This course is required for the Electrical Engineering and Communications Technology Bachelor program in the School of Electronics Technology. This program covers the following core areas:

- Process control
- Embedded systems
- Electronic circuit analysis and design
- Data and network communications
- Telecommunications and mobile wireless technology
- Fiber optic communications
- Electrical machines and energy conversion
- Power electronics and power systems
- Green energy technology
- Computer programming

The following diagram demonstrates how this course fits in the program:


Electrical Engineering and Communications Technology
ET4799
EECT Capstone
Project
Min. 171
credits
ET4770
Elect. Circ. Anal.
and Design II
ET4580
Green Energy
Technology
ET3430
Fiber Optic
Communications
ET3220
Mobile Wireless
Technology
ET4670
Elect. Circ. Anal.
and Design I
ET3480
Power Systems
ET3330
Tele. Comm. Syst.
and
ET3110
Networking and
Communications
MA3410
Calculus II
ET3380
Power Electronics
ET3150
Automatic
Industrial Control
ET4560
C++ Programming
MA3310
Calculus I
ET3280
Ele. Machines and
Energy Conversion
HU4640
Ethics
SC4730
Environmental
Science
EN3220
Written Analysis
SS3150
Research Methods
<Program>
Courses
General
Studies
Courses
<Program
Shared
with>
Courses
Prerequisites
Prerequisite or
Corequisite

Course Summary

Major Instructional Areas

1. Digital modulation
2. Digital transmission
3. Digital T-carriers
4. Microwave radio communication and system gain
5. Satellite communications
6. Spread spectrum techniques

Course Objectives

1. Determine the limit for information capacity of a band-limited channel.
2. Describe various digital modulation and demodulation techniques.
3. Determine the probability of error for important modulation methods on channels with known E_b/N_o.
4. Draw constellation diagram for different diagram modulation scheme.
5. List various important pulse modulation methods and discuss the features of each.
6. Describe methods of digitally sampling analog signals including the development of a PCM signal.
7. Define companding and compression.
8. Differentiate among time domain, frequency domain, and wavelength division multiplexing.
9. Describe, in detail, several methods of channel encoding.
10. Describe the North American Digital Hierarchy with emphasis on T1 and T3 carrier systems.
11. Describe microwave radio frequency and different system configuration and its characterizations.
12. Describe the various subsystems of a satellite earth station transmitter and receiver.
13. Compute various parameter values for a satellite communications system design.
14. Classify various spread spectrum techniques and describe their performance.
15. Perform laboratory exercises using system simulation software (Commsim) as well as bench-top test equipment such as signal generators, digital storage scopes, and spectrum analyzers.

Learning Materials and References

Required Resources

Textbook Package	New to this Course	Carried over from Previous Course(s)	Required for Subsequent Course(s)
Tomasi, W. (2012). *Advanced Electronic Communications Systems* (Custom 6th ed.). Boston, MA: Pearson Custom.	■		
Tavaholi, M. (2012). *Digital communication laboratory manual*: *Using VisSim* (Custom 1st ed.). Boston, MA: Pearson Custom.	■		
Other Items	**New to this Course**	**Carried over from Previous Course(s)**	**Required for Subsequent Course(s)**
VisSim/Comm from Visual Solutions		■	
Scientific Calculator	■		

Technology Requirements

All labs must be performed in a computer lab with PCs that have VisSim/Comm software installed.

Recommended Resources

Books, Professional Journals

- Couch, L. (2009). *Digital & analog communication Systems*. (7th ed.). Upper Saddle River, NJ: Pearson Prentice Hall.
- Derickson, D. & Muller, M. (2008). *Digital communications test and measurement*. Upper Saddle River, NJ: Pearson Prentice Hall.
- Glover, I. & Grant, P. (2000) *Digital communication*. (2nd ed.). Upper Saddle River, NJ: Pearson Prentice Hall.
- Pratt, T. & Bostian, C. (2003). *Satellite communications*. (2nd ed.). Indianapolis, IN: Wiley.
- Proakis, J. (2001). *Digital communication*. (4th ed.). Boston, MA: McGraw Hill
- Resengrant, M.A. (2007). *Introduction to telecommunications*. (2nd ed.). Upper Saddle River, NJ. Pearson Prentice Hall.

- Rice, M. (2009). *Digital Communications A discrete-time approach*. Upper Saddle River, NJ: Pearson Prentice Hall.
- Sklar, B. (2001). *Digital communications: Fundamentals and applications*. (2nd ed.). Upper Saddle River, NJ: Pearson Prentice Hall.
- Viterbi, A. & Omura, J. (1979). *Principles of digital communication and coding*. Tokyo: McGraw Hill.
- Ziemer, R. & Peterson, R. (2001). *Introduction to digital communication*. (2nd ed.). Upper Saddle River, NJ: Pearson Prentice Hall.

Videos

- Long, M. (2008). *Satellite technology overview.* United States: Shelburne Films.

Professional Associations

You can access relevant professional association web sites from the ITT Tech Virtual Library by following these links:
ITT Tech Virtual Library> School of Electronics Technology> Professional Organizations

- American Radio Relay League
- American Society for Engineering Education
- IEEE: Institute of Electrical and Electronics Engineers
- International Association for Radio, Telecommunications and Electromagnetics
- Telecommunications Industry Association
- United Telecom Council

ITT Tech Virtual Library (accessed via Student Portal)
Log on to the ITT Tech Virtual Library at http://library.itt-tech.edu/ to access online books, periodicals, and other reference resources selected to support ITT Tech curricula.

ITT Tech Virtual Library>School of Electronics Technology> Recommended Links>
Online magazines and journals > COMMUNICATIONS and ENGINEERING DESIGN Magazine
>Webinars

Information Search

Use the following keywords to search for additional online resources that may be used for supporting your work on the course assignments:

-
- Digital modulation techniques

- Bandwidth efficiency
- Carrier synchronization
- Clock synchronization
- Carrier recovery
- Clock recovery
- Error performance for binary systems
- Pulse-code modulation
- Companding
- T-carriers
- Multiplexing
- Line encoding
- Microwave radio communications
- Microwave diversity
- Microwave system gain
- Fading
- Satellite communications
- Look angle
- Satellite Foot print
- Satellite link budget
- Spread spectrum
- PN code
- Signal jamming
- Gold code

NOTE: All links are subject to change without prior notice.

Course Plan

Suggested Learning Approach

In this course, you will be studying individually and within a group of your peers. As you work on the course deliverables, you are encouraged to share ideas with your peers and instructor, work collaboratively on projects and team assignments, raise critical questions, and provide constructive feedback.

Use the following advice to receive maximum learning benefits from your participation in this course:

DO	DON'T
▪ Do take a proactive learning approach. ▪ Do share your thoughts on critical issues and potential problem solutions. ▪ Do plan your course work in advance. ▪ Do explore a variety of learning resources in addition to the textbook. ▪ Do offer relevant examples from your experience. ▪ Do make an effort to understand different points of view. ▪ Do connect concepts explored in this course to real-life professional situations and your own experiences.	▪ Don't assume there is only one correct answer to a question. ▪ Don't be afraid to share your perspective on the issues analyzed in the course. ▪ Don't be negative about the points of view that are different from yours. ▪ Don't underestimate the impact of collaboration on your learning. ▪ Don't limit your course experience to reading the textbook. ▪ Don't postpone your work on the course deliverables – work on small assignment components every day.

Course Outline

Unit 1: DIGITAL MODULATION

Out-of-class work:
10 hours

Upon completion of this unit, students are expected to:

- Define digital communications.
- Define bit, bit rate, baud, and minimum bandwidth.
- Explain Shannon's limit for information capacity.
- Describe digital amplitude modulation.
- Describe frequency-shift keying.
- Explain binary phase-shift keying (BPSK).
- Calculate minimum Nyquist bandwidth for different PSK.
- Describe continuous-phase frequency-shift keying.
- Describe quaternary, eight, and 16 PSK.

READING ASSIGNMENT	GRADED ACTIVITIES / DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Tomasi, Chapter 2, pp. 47-79, stop at 2-6 Quadrature-Amplitude Modulation	Lab	Unit 1 Lab 1: VisSim: Wiring Sources, Displays, and Simulation Properties	2.5%
	Assignments	Unit 1 Assignment 1: Information Capacity Calculation, Telephone Line versus DSL	1.5%
		Unit 1 Assignment 2: Textbook Problems – Digital Modulation Bandwidth and Baud	1%

Unit 2: DIGITAL MODULATION (CONT.)

Out-of-class work:
10 hours

Upon completion of this unit, students are expected to:

- Describe quadrature-amplitude modulation.
- Define bandwidth efficiency.
- Draw constellation diagram for different digital modulation scheme.
- Compare bandwidth needed for different digital modulation technique.
- Explain carrier recovery.
- Explain clock recovery.
- Define probability of error and bit error rate.

READING ASSIGNMENT	GRADED ACTIVITIES / DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Tomasi, Chapter 2, pp. 79-104, start at 2-6 Quadrature-	Lab	Unit 2 Lab 1: VisSim: Signals, Amplification (Gain), Noise, Complex Math, and Random Signal Generation	2.5%
	Assignments	Unit 2 Assignment 1: Performance Comparison	1.5%

Amplitude Modulation		of Various Digital Modulation Schemes	
		Unit 2 Assignment 2: Textbook Problems – Digital Modulation Bandwidth Efficiency and Noise Performance	1%

Unit 3: DIGITAL TRANSMISSION

Out-of-class work:
10 hours

Upon completion of this unit, students are expected to:

- Define digital transmission.
- Describe advantages of digital transmission.
- Describe disadvantages of digital transmission.
- Describe pulse code modulation.
- Describe the Nyquist sampling theorem.

READING ASSIGNMENT	GRADED ACTIVITIES / DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Tomasi, Chapter 6, pp. 273 -286, stop at 6-4-3 Dynamic Range	Lab	Unit 3 Lab 1: VisSim: Filters, Oscilloscope, and Communication Channels	2.5%
	Assignments	Unit 3 Assignment 1: PCM Waveform Derivation	1.5%
		Unit 3 Assignment 2: Textbook Problems: Digital Transmission and Pulse Code Modulation	1%
	Quiz	Unit 3 Quiz 1	5%

Unit 4: DIGITAL TRANSMISSION (CONT.)

Out-of-class work:
10 hours

Upon completion of this unit, students are expected to:

- Explain dynamic range.
- Describe signal-to-noise quantization noise ratio.
- Explain the difference between linear and nonlinear PCM codes.
- Define digital companding.
- Define digital compression.
- Describe delta and adaptive delta modulation.
- Explain eye pattern.

READING ASSIGNMENT	GRADED ACTIVITIES / DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Tomasi, Chapter 6, pp. 286-313, start at 6-4-3	Labs	Unit 4 Lab 1: VisSim: Sample and Hold, Analog-to-Digital Conversion and Compander	1.5%
		Unit 4 Lab 2: VisSim: Pulse Transmission and	1%

Dynamic Range, stop at 6-16 Signal Power in Binary Digital Signals		Eye Diagram	
	Assignments	Unit 4 Assignment 1: Digital Compression	1.5%
		Unit 4 Assignment 2: Textbook Problems: PCM Dynamic Range and Companding	1%

Unit 5: DIGITAL T-CARRIERS

Out-of-class work:
10 hours

Upon completion of this unit, students are expected to:

- Define multiplexing.
- Describe the frame format of the T1 digital carrier system.
- Describe the format of the North American Digital Hierarchy.
- Describe the basic T-carrier system formats.
- Define line encoding.
- Explain how codecs and combo chips work.
- Describe frequency-division multiplexing.

READING ASSIGNMENT	**GRADED ACTIVITIES / DELIVERABLES**		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Tomasi, Chapter 7	Labs	Unit 5 Lab 1: VisSim: Spectrum Analyzer	1.5%
		Unit 5 Lab 2: VisSim: Multiplexing and Demultiplexing	1%
	Assignments	Unit 5 Assignment 1: Digital Carrier Line-Speed Calculation	1.5%
		Unit 5 Assignment 2: Textbook Problems: Digital T-Carriers	1%
	Quiz	Unit 5 Quiz 2	5%

Unit 6: MICROWAVE RADIO COMMUNICATIONS AND SYSTEMS GAIN

Out-of-class work:
10 hours

Upon completion of this unit, students are expected to:

- Define microwave.
- Describe microwave frequencies and microwave bands.
- Contrast the advantages and disadvantages of microwave.
- Describe the block diagram for a microwave radio system.
- Describe the different types of microwave repeaters.
- Define diversity and describe several diversity systems.

READING ASSIGNMENT	GRADED ACTIVITIES / DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Tomasi, Chapter 13, pp. 525-537, stop at 13-8 Protection Switching Arrangements	Lab	Unit 6 Lab 1: VisSim: Digital Modulation and Demodulation	2.5%
	Assignments	Unit 6 Assignment 1: Microwave Reliability	1.5%
		Unit 6 Assignment 2: Textbook Problems: Microwave Radio Communications	1%

Unit 7: MICROWAVE RADIO COMMUNICATION AND SYSTEMS GAIN (CONT.)

Out-of-class work:
10 hours

Upon completion of this unit, students are expected to:

- Describe several protection switching arrangements.
- Identify the free-space path characteristics and how they affect microwave performance.
- Explain various microwave system gain characteristics (e.g., system gain; fade margin; receiver threshold; noise factor; and noise figure).

READING ASSIGNMENT	GRADED ACTIVITIES / DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Tomasi, Chapter 13, pp. 537-558, start at 13-8 Protection Switching Arrangements	Lab	Unit 7 Lab 1: VisSim: Wireless Path With Interference	2.5%
	Assignments	Unit 7 Assignment 1: Free Space Path Loss Calculations	1.5%
		Unit 7 Assignment 2: Textbook Problems: Microwave Radio Communications	1%

Unit 8: SATELLITE COMMUNICATIONS

Out-of-class work:
10 hours

Upon completion of this unit, students are expected to:

- Explain Kepler's laws and how they relate to satellite communications.
- Define satellite orbital patterns and elevation categories.
- Describe advantages and disadvantages of geosynchronous satellite systems.
- Explain satellite look angles.

READING ASSIGNMENT	GRADED ACTIVITIES / DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Tomasi, Chapter 14, pp. 561-581, stop at 14-8 Satellite Antenna Radiation Patterns: Footprints	Lab	Unit 8 Lab 1: VisSim: BPSK Signals Generation, Multiple Access, and Recovery	2.5%
	Assignments	Unit 8 Assignment 1: Satellite Orbit Period Calculation	1.5%
		Unit 8 Assignment 2: Textbook Problems – Satellite Orbits and Antenna Look Angle	1%
	Quiz	Unit 8 Quiz 3	5%

Unit 9: SATELLITE COMMUNICATIONS (CONT.)

Out-of-class work:
10 hours

Upon completion of this unit, students are expected to:

- Describe the different types of satellite antenna radiation patterns.
- Describe satellite system up- and down-link models.
- Define satellite system parameters (e.g., back-Off loss; transmit power; bit energy; equivalent noise temperature; noise density; carrier-to-noise ratio; and gain-to-equivalent-noise-temperature ratio).
- Calculate satellite link budgets in relation to C/N and E_b/N_o ratios.

READING ASSIGNMENT	GRADED ACTIVITIES / DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Tomasi, Chapter 14, pp. 581-600, start at 14-8 Satellite Antenna Radiation Patterns:	Lab	Unit 9 Lab 1: VisSim: Satellite Earth Station Transmitter, Transponder, and Earth Station Receiver System	2.5%
	Assignments	Unit 9 Assignment 1: E_b/N_0 Calculations for a Satellite System	1.5%
		Unit 9 Assignment 2: Textbook Problems – Satellite Link Parameters	1%

Footprints			

Unit 10: SPREAD SPECTRUM TECHNIQUES

Out-of-class work:
10 hours

Upon completion of this unit, students are expected to:

- Explain the basic concept of spread spectrum.
- Describe the problem of frequency jamming.
- Describe various positive performance features of spread spectrum techniques.
- Discuss the generation of PN codes using linear feedback shift registers.
- Describe the various properties of PN codes.
- Describe the various component blocks of a generic spread spectrum communication system.
- Describe the baseband DSSS system.
- Explain time-hopping spread spectrum systems.

READING ASSIGNMENT	GRADED ACTIVITIES / DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
• Tomasi, Appendix: Spread Spectrum Techniques I • Prepare for final exam next week by using the study guide	Labs	Unit 10 Lab 1: VisSim: Baseband DSSS Transmitting and Receiving Systems	1.5%
		Unit 10 Lab 2: VisSim: BPSK DSSS Transmitting and Receiving Systems	1%
	Assignments	Unit 10 Assignment 1: PN Code Generation using SSRG LFSR	1.5%
		Unit 10 Assignment 2: Textbook Problems – Spread-Spectrum Techniques	1%
	Quiz	Unit 10 Quiz 4	5%

Unit 11: REVIEW AND FINAL EXAMINATION

Out-of-class work:
15 hours

Upon completion of this unit, students are expected to demonstrate the knowledge and understanding of the course objectives.

READING ASSIGNMENT	GRADED ACTIVITIES / DELIVERABLES		
	Grading Category	**Activity/Deliverable Title**	**Grade Allocation** (% of all graded work)
None	Exam	Final Exam	30%

Note: Your instructor may add a few learning activities that will change the grade allocation for each assignment in a category. The overall category percentages will not change.

Evaluation and Grading

Evaluation Criteria

The graded assignments will be evaluated using the following weighted categories:

Category	Weight
Assignment	25%
Lab	25%
Quiz	20%
Exam	30%
TOTAL	100%

Grade Conversion

The final grades will be calculated from the percentages earned in the course as follows:

Grade	Percentage	Credit
A	90–100%	4.0
B+	85–89%	3.5
B	80–84%	3.0
C+	75–79%	2.5
C	70–74%	2.0
D+	65–69%	1.5
D	60–64%	1.0
F	<60%	0.0

Academic Integrity

All students must comply with the policies that regulate all forms of academic dishonesty, or academic misconduct, including plagiarism, self-plagiarism, fabrication, deception, cheating, and sabotage. For more information on the academic honesty policies, refer to the Student Handbook and the Course Catalog.

(End of Syllabus)