

TCOM 551 Digital Communications

Spring 2019

1. General

Instructor: Shyam Pandula, Ph.D.
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Time and Place: Saturday 9:00am – 11:45am. Nguyen Engineering Building, Room 1110.

Office Hours: Monday 1:30pm – 2:30pm; Friday 12:00 – 1:00pm. Other times by appointment.
Nguyen Engineering Building, Room 3800.

Teaching Assistant: TBA.

Prerequisite for this course is TCOM 500. This course is required for all students who wish to take Satellite Communications (TCOM 607) and Advanced Link Design (TCOM 707). It is also useful for Mobile Communications (TCOM 552).

2. Reference Textbook

(There is no 'Required textbook' for this course)

Title: **Digital Communications** Author: Andy Bateman
Publisher: Addison Wesley Longman 1999

3. Lecture Notes & Homework

Power Point slides for the lectures will be posted to blackboard prior to each lecture. Students are encouraged to review the notes prior to class. Homework will be assigned regularly except for the week before an exam. The purpose of the homework is to reinforce what is taught in class and provide practical, in depth examples Homework solutions will be provided.

Please remember, if you miss a class, it is your responsibility to find out what information you missed.

4. Tests & Final Exam

A midterm exam and a final exam will be given (in class) during the semester. They will be closed book, closed notes tests of about 2 hours each. The first test will cover class work up to and including the lecture prior to the day of the first test. The final exam will concentrate on class work after the second test (~60%), but it will also include some questions on earlier parts of the

course. **You are allowed to bring a half page formula sheet (front only) to each exam.** This sheet must contain *only* formulas and constants. You should also bring a pen or pencil, paper, and calculator and make sure you have all the material you need available to you *before* the exam is handed out. Sharing of calculators or other materials is not permitted. No other materials are allowed, and all material, *including your formula sheet*, is to be turned in to the instructor at the end of the exam period.

5. Course Grade

Final grades will be determined by a weighted average of the two tests and final exam in the following manner: Midterm – 35% each; Final Exam – 45%; Homework 20%.

The George Mason University honor code will be strictly enforced.

6. Course Outline (Subject to Change)

Week 1: January 26

Introduction to course; Sine wave review (concepts of phase, frequency, wavelength); logarithm review (need for conversion to log values); why use dB?; review of communications concepts such as C/N, S/N, BER; difference between performance and availability; etc.,

Bateman Ch. 1

Week 2: February 2

Concept of Noise and Bandwidth, and their impact on communications systems; Boltzmann's constant = k ; System Noise Temperature = T_{sys} ; Noise Power = $k T_{\text{sys}} B$ watts, where B = bandwidth; concept of baseband and passband signals.

Bateman Sec. 1.2 (Pages 11-16), Sec. 4.3 (89-91)

Week 3: February 9

The Building Blocks of a Communications System; Transmission side: source, source coding, information signal, channel coding, modulation, multiplexing, IF, mixer, RF, transmitter, antenna; Receiving side: antenna, low noise amplifier, mixer (RF to IF), amplifier, demodulation, demultiplexing, decoding, sink.

Bateman Sec. 1.4 (Pages 25-28), 162, 172

Week 4: February 16

The Building Blocks of Networks – Digital Multiplexing: FDM and TDM concepts; multiplexing hierarchies; statistical multiplexing and Digital Speech Interpolation;

Bateman Sec. 1.3 (Pages 16-24); Class Notes

Week 5: February 23

Digitization: conversion of an analog signal into a digital signal; sampling theorem, quantization noise, aliasing, digitization (quantization, bits per sample, line codes, etc.), compression laws.

Bateman Sec. 1.4 (Pages 24-25), Sec. 3.5, 3.6 (Pages 67-70), Sec. 4.4 (Pages 91-93), Sec. 7.1 (163-168)

Week 6: March 2 **Midterm Exam**

Week 7: March 9

Link Budget I – line of sight microwave links; antenna design, gain, beamwidth; EIRP and calculation of overall System Noise Temperature; Frésnel zone; path loss; development of link budget.

Bateman Sec. 4.5 (Pages 94-102)

March 16: Spring break, no class

Week 8: March 23

Link Budget II – Amplifiers; linearity, saturation, output back-off, and input back-off; examples of other digital systems (optical fibers, satellites)

Bateman Sec. 4.2 (Pages 78-88)

Week 9: March 30

Filtering and Interference; root raised cosine filters; baseband bandwidth and pass band bandwidth; filter roll off; Inter Symbol Interference; Nyquist filtering; Sinc functions $[(\sin x)/x]$

Bateman Sec. 1.1 (Pages 8-11), Ch. 3 (Pages 50-59, 61-65)

Week 10: April 6

Digital Modulation: the concept of modulation; amplitude shift keying, frequency shift keying, phase shift keying; bits per symbol; modulation index; higher order modulations

Bateman Ch. 5, Pages 36-46, 104-135, 136-138

Week 11: April 13

Multiple Access: FDMA, ALOHA, TDMA, and CDMA

Bateman Ch. 8 (Pages 188-202)

Week 12: April 20

Channel Coding: FEC, block codes, Hamming codes, Hamming distance, convolutional codes, hard decision/soft decision decoding

Bateman Ch. 7 (Pages 173-182)

Week 13: April 27

Propagation Effects: line-of sight phenomena – multipath, rain attenuation, rain depolarization, scintillation; non-line of sight phenomena – diffraction, over-the-horizon effects; impact of atmospheric particles' (e.g. rain drops) absorption effects on system noise temperature

Bateman Sec. 4.5 (Pages 94-98)

Week 14: May 4 **Review**

Week 15: **May 11 Final Exam**

7. Acknowledgment

Much of the material used in this course is based on notes provided by Dr. Jeremy Allnutt. All material is used with permission of the author and is not to be reproduced without permission from the author.

8. Additional Information

If you are a student with a disability and you need academic accommodations, please see me and contact the Disability Resource Center (DRC) at (703) 993-2474. All academic accommodations must be arranged through the DRC.

There is a continued concern about safety and security on campus. We encourage students to sign up for the Mason Alert System, which can provide timely emergency information, by visiting the website <https://alert.gmu.edu>. Students are also reminded that an emergency poster exists in each classroom explaining what to do in the event of crises. Further information about emergency procedures exists on <http://www.gmu.edu/service/cert>.