# EECS 562: Introduction to Communication Systems

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# Course Information

- Semester: Spring 2021
- Lecture: TR 09:30 -10:45 AM LEA 3152
- Discussion: Room 3152 Lea; Monday 5:00 -07:00 PM will be used for test reviews, make up classes, and as needed homework reviews. **Will not meet every week; check class web site to find out if discussion session is meeting.**
- Required Text: Introduction to Communications Systems: An Interactive Approach Using the Wolfram Language, V. S. Frost
- Reference Texts:
  - Introduction to Analog & Digital Communications, 2nd Edition, Simon Haykin and Michael Moher
  - Digital & Analog Communication Systems, 8th Edition, Leon W. Couch
  - Introduction to Communication Systems, 3rd Edition, Ferrell G. Stremler.

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# Course Information

Class Web Page:
http://www.ittc.ku.edu/~frost/EECS_562/index_EECS_562_Spring_2021.htm

Lab
Web Site: http://people.ku.edu/~g450a858/EECS562_Spring2021/
Lab GTA: Gordon Ariho gariho@ku.edu
Labs start Week of Feb 1, 2021.
Lab schedule @ http://people.ku.edu/~g450a858/EECS562_Spring2021/

Office hours and Contact Information:

- Time: Office hours:
  - In 2054 Eaton Hall-- 8:00 - 9:00 & 11:00 - 12:00 and 2:30 - 4:00 T & R
  - Drop-ins at other times are always welcome
  - It is best to schedule via call or e-mail to insure that I am available at the time you want to meet and the there is one student at a time in my office.
- Phone:
  - Eaton 864-1028
  - Home 841-3244
- e-mail: vsfrost@ku.edu (best way to contact me)

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# Course deliverables

- Exams
- Homework: problems will be assigned & graded.
- Labs
- Grading:
  - 2 - In class tests; = 270 pts/test (45%)
    (135 points/test or 22.5%/test)
  - Lab = 120 pts 20%
  - Homework = 45 pts 7.5%
  - Review Test (Signals & Systems) = 15 pts 2.5%
  - Final = 150 pts 25%

  A test will be given near the beginning of the course to review Signals & Systems concepts from EECS 360.
- General guidelines:
  - Only under very extreme conditions will make up tests be given. I MUST be notified BEFORE you miss a test otherwise you WILL get a 0.
  - Late homework will not be accepted. No makeup quizzes will be given.

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# More on Tests

- Do not use Chegg or any other on-line question answering service.
- We are monitoring them.
- Tests will be distributed via e-mail.
- You will have 4 hours to work on the test.
  - Tests will be sent at ~8:00 AM on the day of the test.
  - Tests to be returned by noon on the day of the test.
- No class the day of the test.
- Open Book & Open Notes
- Work ALONE! Solve the test on your own, do not communicate with anyone else to get help on answers the test questions, this is an honor system, as professionals you must act ethically. It is expected that you will always act professionally and ethically.
- **By submitting your test, you will assert that you have neither provided help nor accepted help from another student or individual in completing your exam. As such, the work is yours and yours alone.**

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# More on Tests

- Make sure your name in on all submitted test pages.
- For electronic submissions of your test you must send a **pdf** file (one file) using this file naming format.
  - LastName_EECS_562_Test_1.pdf
  - For example, I would submit; Frost_EECS_562_Test_1.pdf
- Be sure your submitted pdf is readable and is clear (avoid using yellow paper) and clearly mark your final answer.
- During the testing period monitor your e-mail, if I need to make clarifications, I will do that by sending an e-mail to the class.
- If you have questions about test problems e-mail to me (vsfrost@ku.edu)
- Clearly state any assumptions.
- Where indicated provide justification for your answers.
- If you feel that a problem is unclear, contradictory, incomplete, or ambiguous, clearly state the assumptions you used to solve the problem.

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# Initial Grading Scale

- 90 - 100 % A
- 80 - 89 % B
- 70 - 79 % C
- 60 - 69 % D
- 0 - 59 % F
  - Lower limit on these ranges maybe reduced as a function of the distribution of the final scores.
  - This class will not use +/- grading

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# Homework

- Electronic submission of homework assignments is required.
- Electronic submission of homework to be sent to Gordon Ariho gariho@ku.edu and cc me at vsfrost@ku.edu.
- Homework will be returned via e-mail.
- All homework assignments will be posted on the class web page
- Solution will not be posted, problems will be worked in class or during office hours upon request.
- Electronic submissions must be in pdf format.
- Electronic submissions must use this file naming format.
  - Homework: EECS562_HW#_ yourname
  - For example, for homework # 5 I would submit; EECS562_HW5_Frost.pdf

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# Homework Format

All work containing more than one page must be stapled - no paper clips and no folded corners. In order to facilitate grading of homework problems, homework shall meet the following specifications:

1. Hand written or typed single-sided on 8.5"x11" paper.

2. If not typed then for text and equations, use an HB or No. 2 pencil (or darker), or blue or black ink. (Pencil is preferred.) No other colors please, except in diagrams or graphs.

3. All pages should be numbered i/j in top right hand corner, with your name appearing at the top of each page. It is O.K. to use your initials after the first page.

4. All work must be shown for full grade - be as thorough as possible.

5. Writing should be legible and literate - if the grader cannot read your handwriting, you will receive no credit for the problem.

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# Homework Format

6. Answers are to be boxed and right justified, with the variables, values (if any) and units (if any), included in the box. Right justified means placed on the right side of the page.

7. Leave half an inch between consecutive parts of a question, and draw a line across the page at the end of each complete question.

8. No part of a question should appear in any margin of the paper.

9. Diagrams and graphs should be of a good size (say at least 3x5 sq. inch), and may contain colors. Diagrams and graphs must be titled, labeled, and clearly drawn. Tables should also be titled.

10. Graphs should be scaled (put number on axes), labeled (put names /units on axes), and titled at the bottom of the graph. Any graph which occupies an area of less than 3x5 sq. inch and which is not titled will not be graded.

11. Where possible use conventional units such as bits/sec, Hz and km

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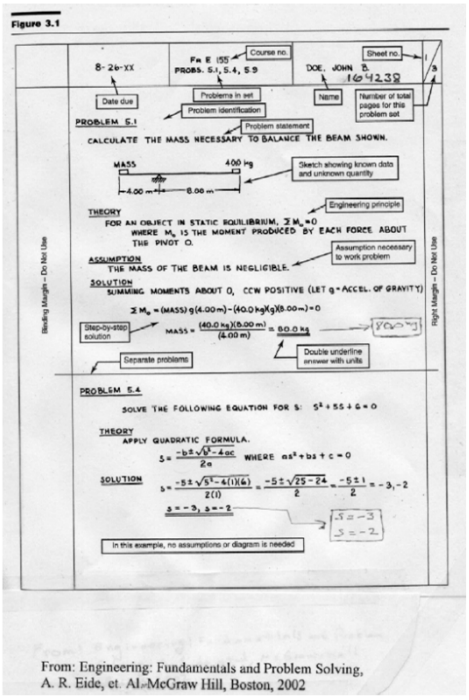


From: Engineering: Fundamentals and Problem Solving, A. R. Eide, et. Al-McGraw Hill, Boston, 2002

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# Tools Used for Required Text and Class Assignments and Demonstrations

- **REQUIRED:** Wolfram CDF Player
  - Class interactive e-book
  - Interactive documents
  - Installed on all EECS Windows computers
  - http://www.wolfram.com/products/player/
- You will need to use a software tool to create plots, e.g., matlab or excel.
- For homework you can also use WolframAlpha to solve integrals and perform other math calculations, see https://www.wolframalpha.com/

# Course Outline

- Review signals and systems ← **Signals & Systems test**
- Representation of bits as baseband signals-line coding
- M-ary baseband signals
- Intersymbol interference (ISI) and Pulse Shaping.
- Time Division Multiplexing
- Double sideband suppressed carrier modulation (DSB-SC) and binary phase shift keying (BPSK)
- Quadrature multiplexing and quadrature modulation
- Quadrature phase shift keying (QPSK) and quadrature amplitude modulation (QAM).
- Frequency division multiplexing (FDM) ← ~ Test 1

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# Course Outline

- Other analog modulation methods
  - Double sideband large carrier (DSB-LC)
  - Single sideband (SSB)
  - Vestigial sideband (VSB)
  - Frequency/phase modulation (FM/PM).
- The superheterodyne receiver.
- Characterization of noise and definition of noise figure, noise temperatures and system tradeoff exposed using link budgets.
- Noise in analog communication systems ← ~ Test 2
- Noise in digital communication systems.
- Multimegbit/sec rates over terrestrial channels using OFDM with an introduction to the modulation use in LTE/5G
- Error Control Coding

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# Course Outcomes

- Calculate and use Fourier Series and Transforms, Energy Spectral Density and Power Spectral Density of signals.
- Explain the basics of line-coding and baseband digital transmission.
- Calculate the required bandwidth for baseband digital signals.
- Explain the basics of analog modulation, DSB-SC, DSB-LC, SSB, VSB, FM and PM.
- Compare analog modulation in terms of bandwidth and power requirements.
- Explain the operation of a superheterodyne receiver.

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# Course Outcomes

- Use TDM, FDM, TDMA, FDMA, TDD, FDD to combine signals and calculate required bandwidth.
- Explain the basics of digital modulation, ASK, FSK, PSK, QPSK, MPSK, and M-QAM
- Compare digital modulation techniques in terms of bandwidth requirements and power.
- Calculate signal-to-noise ratios and perform system trade-offs using link budgets.
- Compare the noise performance of DSB-SC, DSB-LC, SSB, and FM. Understand the system trade-offs for analog modulation techniques.
- Calculate bit error rate for BPSK, QPSK, MPSK M-QAM. Explain system trade-offs for digital modulation techniques.
- Explain the operation of OFDM systems.
- Understand the basics of error control coding.

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