EECS 861
Random Signals and Noise

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Course Information

- Semester: Fall 2023
- Lecture: Room 1136 Lea; time 9:30 -11:45 PM TR
- Discussion: Room 1136 Lea; time 5:00-6:50 PM Monday will be used for test reviews, make up classes, and as needed homework reviews. **Will not meet every week; check web if discussion session is meeting.**
- Text: "Random Signals: Detection, Estimation and Data Analysis " by Shanmugan and Breiphol.
- Alternate Texts:
  - "Probability, Random Variables, and Random Signal Principles" Peebles
  - Probability and Random Processes, A. Leon-Garcia
  - Probability, Random Variables and Stochastic Processes, Papoulis and Pillai

Course Information

- Class Web Page:
- http://www.ittc.ku.edu/~frost/EECS_861/index_EECS_861_Fall_2023.htm
- Office hours and Contact Information:
  - 2054 Eaton Hall-- 8:00 - 9:00 & 1:00 - 2:00 T & R
  - Other times by appointment
    (Likely in the office MWF afternoons, e-mail me to confirm my availability)
  - Phone: 785 864 1028
  - e-mail: vsfrost@ku.edu (best way to contact me)
  - Final: Tuesday, December 12

Class Meeting Schedule	Tuesday, December 12 Final Exam Schedule
9:30 TR	7:30 – 10:00 a.m.

Course deliverables

- Exams: 2 in class tests (open book & notes)

- Final (open book & notes)

- Homework: problems will be assigned & graded.

- Grading:
  - 2 - In class tests; open book & notes = 40% (20%/test)
  - Homework & Unannounced Quizzes = 20 %
  - Class participation & attendance = 10 pts
  - Final = 30%

- General guidelines: Only under very extreme conditions will make up tests be given. No late homework will be accepted

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 course (EECS 861) will not utilize +/- grading in Fall 2023.

Homework

- All homework assignments will be posted on the class web page
- Solution will not be posted, any problem will be worked in class or during office hours upon request.
- Homework is to be submitted on paper at the beginning of the class period.
- Electronic submission of assignments is **not** permitted.

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.

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 is not titled will not be graded. Where possible use conventional units such as bits/sec, Hz and km.

   ## Graphs and plots should be done with a plotting tool.

Figure 3.1

Course no. → FR E 155
PROBS. 5.1, 5.4, 5.9

8-26-XX

Sheet no. → 1

DOE, JOHN B.
164238

Date due

Problems in set

Problem identification

Name

Number of total pages for this problem set

PROBLEM 5.1

Problem statement

CALCULATE THE MASS NECESSARY TO BALANCE THE BEAM SHOWN.

MASS   400 kg

Sketch showing known data and unknown quantity

|—4.00 m—|—8.00 m—|

Engineering principle

THEORY

FOR AN OBJECT IN STATIC EQUILIBRIUM, $\Sigma M_o = 0$
WHERE M_o IS THE MOMENT PRODUCED BY EACH FORCE ABOUT THE PIVOT O.

Assumption necessary to work problem

ASSUMPTION

THE MASS OF THE BEAM IS NEGLIGIBLE.

SOLUTION

SUMMING MOMENTS ABOUT O, CCW POSITIVE (LET g = ACCEL. OF GRAVITY)

$$\Sigma M_o = (MASS)\,g\,(4.00\,m) - (40.0\,kg)(g)(8.00\,m) = 0$$

Step-by-step solution

$$MASS = \frac{(40.0\,kg)(8.00\,m)}{(4.00\,m)} = 80.0\,kg$$

80.0 kg

Double underline answer with units

Separate problems

PROBLEM 5.4

SOLVE THE FOLLOWING EQUATION FOR S: $S^2 + 5S + 6 = 0$

THEORY

APPLY QUADRATIC FORMULA.

$$S = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \quad WHERE \quad as^2 + bs + c = 0$$

SOLUTION

$$S = \frac{-5 \pm \sqrt{5^2 - 4(1)(6)}}{2(1)} = \frac{-5 \pm \sqrt{25 - 24}}{2} = \frac{-5 \pm 1}{2} = -3, -2$$

$$s = -3, \; s = -2$$

$S = -3$
$S = -2$

In this example, no assumptions or diagram is needed

Binding Margin – Do Not Use

Right Margin – Do Not Use

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

Tools Used for Class Assignments

- Some homework assignments will require plotting, you can use Matlab or another software tool for your choice.
  - MatLab
    - For plotting in MatLab see Plotting Functions using fplot https://www.youtube.com/watch?v=Xaos1ALprCQ
    - Creating stem plots in MatLab https://www.youtube.com/watch?v=bWIzuYwwAbk)
  - Excel
  - WolframAlpha https://www.wolframalpha.com/
  - Any other plotting tool is acceptable, e.g., see Graphing Function https://mathstat.slu.edu/~may/ExcelCalculus/sec-1-4-GraphingFunctionsExcel.html
  - and Online Graph Plotter https://www.transum.org/Maths/Activity/Graph/Desmos.asp
  - The demos plotter https://www.desmos.com/calculator
- Wolfram CDF Player
  - Interactive documents
  - Installed on all EECS Windows computers
  - http://www.wolfram.com/products/player/
- Some homework assignments will require processing of .xls or .csv ("comma-separated values") files. You can use any tool for homework, e.g., matlab, excel, C, java, C++, other.

Class Attendance and Participation

- Enrolling for this class signifies that the students plan to participate in all of lectures and exams. Each student is responsible for knowing any information delivered in every class.

- Academic success in this class requires:
  - regular class attendance
  - doing the homework
  - and class participation.

Course Outline

(Sections subject to change)

- Probability (Chapter 2)
  - Axioms
  - Random Variables
    - Discrete
    - Continuous
  - Distributions
    - Marginal
    - Joint
    - Conditional
  - Expect Value
  - Characteristic and moment generating functions*
  - Random vectors and Multivariate Gaussian RVs*
  - Transformations of RVs
  - Bounds and Approximations*

  * Possible new topics

~ Test 1 →

- Random Processes (Chapter 3)
  - Definition
  - Example RPs
  - Stationarity
  - Autocorrelation function
  - Power Spectral Density
  - Ergodicity
  - Decomposition of RPs
  - Major classes of RP
    (Sections 5.2, 5.3, 5.4.1-5.4.2, 5.5)

Course Outline

- **Response of Systems to Random Inputs**

  (Sections 4.1, 4.2 4.3.1-4.3.3)

  – Discrete time systems

  ~ Test 2 ⟶

  – Continuous time systems

- **Application of Random Process Theory**

  – Detection (Chapter 6)

  – Estimation

  (Sections 7.1, 7.2, 7.7, 8.4.1, 8.4.2, 8.4.5, 8.4.6, 8.4.7, 8.5.1)

Use of EdTech Services

- Professors and instructors at the KU School of Engineering are aware that some students are actively posting homework, laboratory, and exam questions and responses to EdTech services (e.g., Chegg) even during exam time frames.
- Keep in mind that when a person signs up to participate by either uploading, and/or downloading, and/or using posted material from these sites, the "terms of service" that are agreed to do not protect the person when KU and/or the School of Engineering decide to conduct investigations related to academic misconduct (e.g., plagiarism and/or cheating).
- In fact, EdTech services, like Chegg, retain contact information of students who use their services and will release that information, which is traceable, upon request. Using these services constitutes academic misconduct, which is not tolerated in the School of Engineering. It violates Article 3r, Section 6 of its Rules & Regulations, and may lead to grades of F in compromised course(s), transcript citations of academic misconduct, and expulsion from the University of Kansas.
- If unsure about assignments, it is important that students use the allowable available resources, such as instructor office hours, graduate teaching assistants, and/or tutoring. The School of Engineering wants students to be successful; cheating is not the way to attain that success.

Use of smartphones, tablets, and laptops in class.

- Smartphones, tablets, and laptops may only be used in direct support of class activities.

- Texting, general web browsing, checking of e-mail is NOT permitted during class.

- Video and audio recording of the EECS 861 class lectures is prohibited.

Changes announced in class and the class web site supersede these written instructions.

Student with disabilities or special needs should arrange to see me for accommodations.

IEEE Code of Ethics

We, the members of the IEEE, in recognition of the importance of our technologies in affecting the quality of life throughout the world, and in accepting a personal obligation to our profession, its members and the communities we serve, do hereby commit ourselves to the highest ethical and professional conduct and agree:

I. To uphold the highest standards of integrity, responsible behavior, and ethical conduct in professional activities.

1. to hold paramount the safety, health, and welfare of the public, to strive to comply with ethical design and sustainable development practices, to protect the privacy of others, and to disclose promptly factors that might endanger the public or the environment;

2. to improve the understanding by individuals and society of the capabilities and societal implications of conventional and emerging technologies, including intelligent systems;

3. to avoid real or perceived conflicts of interest whenever possible, and to disclose them to affected parties when they do exist;

4. to avoid unlawful conduct in professional activities, and to reject bribery in all its forms;

5. to seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, to be honest and realistic in stating claims or estimates based on available data, and to credit properly the contributions of others;

6. to maintain and improve our technical competence and to undertake technological tasks for others only if qualified by training or experience, or after full disclosure of pertinent limitations;

II. To treat all persons fairly and with respect, to not engage in harassment or discrimination, and to avoid injuring others.

7. to treat all persons fairly and with respect, and to not engage in discrimination based on characteristics such as race, religion, gender, disability, age, national origin, sexual orientation, gender identity, or gender expression;

8. to not engage in harassment of any kind, including sexual harassment or bullying behavior;

9. to avoid injuring others, their property, reputation, or employment by false or malicious actions, rumors or any other verbal or physical abuses;

III. To strive to ensure this code is upheld by colleagues and co-workers.

10. to support colleagues and co-workers in following this code of ethics, to strive to ensure the code is upheld, and to not retaliate against individuals reporting a violation.