EECS 16A Designing Information Devices and Systems I
Summer 2023 Homework 1

This homework is due **Friday, June 23**, 2023 at 23:59.
Self-grades are due **Friday, June 30**, 2023 at 23:59.

This homework is meant to help you learn how to submit homework assignments and self-grades and so we can get to know you. However, it is still graded. Make sure you are comfortable with submitting homework assignments and self-grades, and remember, we are here to help you!

Submission Format
Your homework submission should consist of **one** file.
`hw1.pdf`: A single PDF file that contains all of your answers (any handwritten answers should be scanned). Submit the file to the appropriate assignment on Gradescope.

1. Background

Welcome to EECS 16A! We would love to learn a bit more about you. Please fill out this form (https://forms.gle/rwN3NG452dAxzNqH6). For this problem, filling out the Google form is sufficient. Nothing needs to be written/submitted to Gradescope for this question.
Solution: Fill out the relevant fields in the Google form.

2. Syllabus

Read the course syllabus and answer the following questions.
The syllabus can be found here: `https://eecs16a.org/policies.html`.

(a) What are the dates and times for the quest, midterm, and the final exam?
Solution:
The quest is on Monday, July 10th, 2023, from 9:30am-11am.
The midterm is on Monday, July 24th, 2023, from 5pm-7pm.
The final exam is on Wednesday, August 9th, 2023, from 6pm-9pm.

(b) If you need exam accommodation, whom do you contact and how?
Solution:
Contact the instructors via email at `eecs16a@berkeley.edu`.
You should contact the instructors as soon as possible.

(c) When is homework 2 (not this homework) due? When is homework 2's self-grade due? In general, what day of the week is the homework due and at what time? In general, what day of the week are the self-grades due and at what time? **Solution:**
Homework 2 is due Friday, June 30 at 23:59 Pacific Time. Self-grades for Homework 2 are due Friday, July 7, at 23:59 Pacific Time.
All homework assignments are due on Friday at 23:59 Pacific Time, and their respective self-grades are due the following Friday at 23:59 Pacific Time.

(d) When are homework parties? In what room are they normally held? Homework parties are where groups of students can get together to work on the homework together.

Solution:
Homework parties are on Fridays from 10am - 12pm, and are generally held in Cory 144MA.

(e) How many homework drops do you get? (Reminder: the homework drop is for extenuating circumstance such as getting sick, family emergencies etc. You should plan on completing and submitting all homework assignments and self-grades.) How do you use this drop?

Solution:
You get one homework drop.
Please reserve this for emergencies. Your lowest score is automatically dropped (you do not need to contact us).

(f) How many slip days do you receive throughout the semester? Which assignments can you use slip days on? What is the maximum number of slip days you can use on any one assignment? **Solution:** You receive 6 slip days throughout the semester. They can only be used on homework assignments, and you can only use 2 slip days maximum per homework.

(g) What is the penalty if you turn in your self-grades up to one week late?

Solution:
You only receive 75% credit on that homework.

(h) What score will you get on a homework if you do not submit your self-grades?

Solution:
You will receive a 0% on that homework.

(i) Provide a complete list of everything you must do in order to receive credit for your homework assignments. Note that we're just looking for a high-level overview (think bulleted list).

Solution:
To receive full credit, you must submit a scan of your work, including any necessary printouts and/or screenshots of your Python code (all compiled into a single pdf document) to Gradescope before the Friday submission deadline, and make sure to tag your pages to the appropriate questions. Further, once solutions are released, you must self-grade your homework using the form on the course website, and submit your self-grades to Gradescope by the next Friday deadline.

(j) Read the following guide:

`https://docs.google.com/document/d/1bTyQE6-MhExK5ZXP9nW4Zyjo1MHSzZNR-MNq7ExztoY/edit?usp=sharing`.

What are the five steps in the submission process for a PDF on Gradescope? Please note that if you do not select pages for each question/subquestion we cannot grade your homework and we will be forced to give you a 0.

Solution:

i. Find the appropriate assignment in the Gradescope portal.
ii. Select "Submit PDF".
iii. Upload your single PDF, containing both your (scanned) handwritten answers and a "printout" of your iPython code when applicable (can be concatenated with `www.pdfmerge.com`).
iv. Assign questions to pages of your submission. All of your work (including iPython pages) must be assigned to the corresponding subproblem before you click "Submit", or you will not receive credit for that work.
v. Click "Submit" in the lower right-hand corner. If you have selected pages correctly, you will not have to click through a warning message.

(k) What percentage do you need to get on a homework assignment for you to get full credit for the assignment?

Solution:
80%. (If you get x% of the homework correct, where x < 80, you will get (x/80) * 100 points on that assignment.)

(l) How many discussions do you need to attend to get full participation credit?

Solution:
You must attend 16 discussions to get full participation credit.

(m) Fill in the blanks: You should attend discussion sections on _____, _____, _____, and _____ each week.

Solution:
You should attend discussion sections on Monday, Tuesday, Wednesday, and Thursday each week.

(n) What is "Popcorn"? When is it due?

Solution:
Popcorn is a short assignment posted on Gradescope during lecture and is meant to encourage you to stay caught up with lectures and help you gauge your understanding of the material from lecture. There will be at least one per week and it is due 24 hours after the lecture during which it is posted.

(o) What are you allowed to bring to exams? What are you not allowed to bring to exams?

Solution:
You are allowed to bring one 8.5x11 sheet of paper to the quest, two 8.5x11 sheets of paper to the midterm, and three 8.5x11 sheets of paper to the final, each with handwritten notes on the front and back. You should also bring your student ID and pencils/pens. You are not allowed to bring calculators, smartwatches, or other electronics. All exams will be in-person.

(p) Fill in the blank:
If you miss ___ or more labs, you will fail the class.

Solution:
If you miss 4 or more labs, you will fail the class.

(q) Fill in the blank:
During buffer lab periods, you may get checked off for at most _____ missed lab that occurred during that lab module by attending a buffer section.

Solution:
During buffer lab periods, you may get checked off for at most **one** missed lab that occurred during that lab module by attending a buffer section.

(r) As a student in this course, what online forum should you check regularly?

Solution:
Ed.

3. Academic Honesty

For each scenario described below, indicate whether or not it constitutes academic dishonesty according to course policies. Provide a brief justification for your answer.
Course policies on collaboration can be found here: `https://eecs16a.org/policies.html#collaboration`.

(a) John downloaded homework solutions off of the Spring 2021 website before they were taken down. When he gets really stuck and can't figure out the next step of a problem, he checks these solutions for a hint.

Solution:
This is against course policy, as it gives students who got ahold of the solutions an unfair advantage. From the syllabus, "Using previous EECS 16A homework, exam, and lab solutions is strictly prohibited, and will be considered academic dishonesty."

(b) Esmeralda and Joseph are working on the homework together with their study group. When Joseph gets stuck on a problem, he explains his logic to Esmeralda and she asks questions to help him figure out where he went wrong. Once they agree on the approach, they both write up their solutions independently.

Solution:
This type of collaboration is allowed, and encouraged, per course policy: both students learn from the interaction, but nobody is unfairly advantaged.

(c) Lily has all of her homework finished except for one block of iPython code. At 11:55pm on Friday, she can't get rid of a pesky syntax error, so she has her roommate Michelle send her working code. She pastes this code into her iPython notebook and submits it, citing Michelle as a collaborator.

Solution:
This is against course policy, as Michelle shares her exact solution with Lily.

4. Homework resources

If you need help on a homework problem or have a question about the material, what are some of the resources you might be able to use?

(i) Homework party
(ii) TA office hours
(iii) Professor office hours
(iv) Asking a friend taking 16A
(v) Posting on Ed
(vi) Going to discussion
(vii) All of the above

Solution:

vii.

5. Reading Assignment

For this homework, please read Note 0 and Note 1A. These will provide an overview of linear equations and augmented matrices. You are always welcome and encouraged to read ahead as well. How does the content you read in these notes relate to what you've learned before? What content is unfamiliar or new?

Solution: Give yourself credit for any reasonable answer.

6. Magic Square

In an $n \times n$ "magic square," all of the sums across each of the n rows, n columns, and 2 diagonals equal magic constant k. For example, in the below magic square, each row, column, and diagonal sums to 34.

4	14	15	1
9	7	6	12
5	11	10	8
16	2	3	13

The magic square is a classic math puzzle, and some of you may have solved these as children by guessing. However, it turns out they can be solved systematically by setting up a system of linear equations!

(a) How many linear equations can you write for an $n \times n$ magic square?

Solution:

$2n+2$, since there is one equation for each of the n rows, n columns, and 2 diagonals.

(b) For the generalized magic square below, write out a system of linear equations.
Hint: Set the sum of entries in each row, column, and diagonal equal to k.

x_{11}	x_{12}	x_{13}
x_{21}	x_{22}	x_{23}
x_{31}	x_{32}	x_{33}

Solution:

$$
\begin{aligned}
x_{11}+x_{12}+x_{13} &= k \\
x_{21}+x_{22}+x_{23} &= k \\
x_{31}+x_{32}+x_{33} &= k \\
x_{11}+x_{21}+x_{31} &= k \\
x_{12}+x_{22}+x_{32} &= k \\
x_{13}+x_{23}+x_{33} &= k \\
x_{11}+x_{22}+x_{33} &= k \\
x_{31}+x_{22}+x_{13} &= k
\end{aligned}
$$

(c) Now consider the following square, with some entries filled in. Substitute the known entries into the linear equations you wrote in part (b) to solve for the missing entries x_{11}, x_{12}, x_{32}. Please show the equations you use to solve; credit will not be given for solving by inspection.

2	x_{12}	6
9	5	1
x_{31}	x_{32}	8

Solution:

$$x_{31}+x_{32}+8=k \tag{1}$$
$$9+5+1=k \tag{2}$$
$$2+x_{12}+6=k \tag{3}$$
$$x_{31}+9+2=k \tag{4}$$
$$x_{32}+5+x_{12}=k \tag{5}$$
$$8+1+6=k \tag{6}$$
$$x_{31}+5+6=k \tag{7}$$
$$2+5+8=k \tag{8}$$

From Eq. 2, $k=15$.
Substituting $k=15$ back into Eq. 3, $x_{12}=7$.
Similarly, substituting $k=15$ back into Eq. 8, $x_{31}=4$.
Finally, substituting $k=15, x_{12}=7$ into Eq. 5, we find $x_{32}=3$.

(d) Suppose you now have a 'tomographic' magic square. This square is special in that the *product* of the *exponentials* of the elements sum to a constant. So, the equation for the first row might look like:

$$e^{x_{11}} \times e^{x_{12}} \times e^{x_{13}} = k$$

where k is the constant value of the magic square. Can you write out a system of linear equations for this new magic square? If so, write out the new system. If not, explain why.
Hint: Think about what you did in the previous part. In combination with properties of e, can you transform this new system into a linear form? Remember that $\ln(e^x) = x\ln(e) = x$.

Solution:
Let's consider the first row, with the equation:

$$e^{x_{11}} \times e^{x_{12}} \times e^{x_{13}} = k$$

Noting that the product of exponentials allows you to sum the exponents, this is equivalent to:

$$e^{x_{11}+x_{12}+x_{13}} = k$$

Applying the natural log results in the following linear equation:

$$x_{11}+x_{12}+x_{13} = ln(k)$$

$$x_{11}+x_{12}+x_{13}=ln(k)$$
$$x_{21}+x_{22}+x_{23}=ln(k)$$
$$x_{31}+x_{32}+x_{33}=ln(k)$$
$$x_{11}+x_{21}+x_{31}=ln(k)$$
$$x_{12}+x_{22}+x_{32}=ln(k)$$
$$x_{13}+x_{23}+x_{33}=ln(k)$$
$$x_{11}+x_{22}+x_{33}=ln(k)$$
$$x_{31}+x_{22}+x_{13}=ln(k)$$

7. Recognizing Linear Equations

Your instructor, Anvitha, started taking EECS C106A (Robotics), and wanted to brush up on her physics knowledge. She remembered the following formula describing the position of an object with respect to time:

$$x = v_0 t + \frac{at^2}{2}$$

Here, we assume a starting position of 0 meters, where v_0 represents the initial velocity, and a represents the acceleration (assumed to be constant).

(a) A lot of robotics involves understanding system parameters based on measurements. You consider thinking about them from a 16A lens, and first want to see if the equation is linear. Is the equation linear with respect to t? In other words, is the function $x(t)$ linear? How about with respect to v_0 AND a (i.e is $x(v_0, a)$ linear)? If it is linear, show the properties of homogeneity and superposition hold for those variables. If not, explain which property it violates.

Solution: This is NOT linear with respect to t, as we have a squared term. Notice, however, that it IS linear with respect to a and v_0. Once the t and x values are set, we end up with an equation that looks like this:

$$c_1 = c_2 v_0 + c_3 a$$

which follows all the linear properties, for c_i that are constant, real numbers.
Homogeneity:

$$f(\alpha v_0, \alpha a) = \alpha(c_2 v_0 + c_3 a) = \alpha f(v_0, a)$$

Superposition:

$$f(v_{0,1}+v_{0,2}, a_1+a_2) = c_2(v_{0,1}+v_{0,2}) + c_3(a_1+a_2) = f(v_{0,1}, a_1) + f(v_{0,2}, a_2)$$

(b) You decide to test your theory of linearity by taking measurements of a projectile thrown by the robot arm. You record the following measurements:

- At t = 1 second, the position, x, is measured to be 1 meter.
- At t = 2 seconds, the position, x, is measured to be -7.8 meters.

Can you set this up as a system of linear equations and calculate the value of v_0 and a?

Solution: The equations are as follows:

$$1v_0 + 0.5a = 1$$

$$2v_0 + 2a = -7.8$$

Solving this system yields:

$$v_0 = 5.9m/s$$

$$a = -9.8m/s^2$$

8. Homework Process and Study Group

Who did you work with on this homework? List names and student IDs. (In case you met people at homework party or in office hours, you can also just describe the group.) How did you work on this homework?

Please remember to submit both your homework as well as the self-grade assignment following the release of the solutions. A full description of the submission process is listed on the class website (eecs16a.org).

Solution:

I first worked by myself for 2 hours, but got stuck on problem 5. Then I went to office hours, where I worked with X (SID:0000000),Y (SID:1111111), and Z (SID: 2222222), but we were still stuck on the problem, so we discussed it with a TA...Then I went to homework party for a few hours, where I finished the homework.

