1) **Course Learning Objectives.**

Write one sentence each explaining how (if at all) this class has helped you with making progress in the four main learning objectives:

a) **to learn how the engineering design process works,**

The class taught design principles, such as decomposition into parts, testing, verification, and it also demonstrated these principles in three projects.

b) **to learn to become a good team member in an engineering team,**

The three projects were team projects, and the students were confronted with having to work under the constraints imposed by the team, rely on their colleagues, and learn to honor the trust (reliance) of their colleagues by living up to their expectations.
c) to commit to a major of study, and
The open houses as well as talks by industry were designed to show the students engineering reality, and allow them to judge for themselves, what they like and what doesn't interest them.

d) to improve your personal learning and management skills necessary to complete successfully an engineering education.

Project 4 taught techniques for good time management and objectivation (quantification) of goals, schedules, and milestones.

2) Explain in a sentence, how you can manage your time, such that assignments are always turned in on time.

Mark in your calendar not only due dates, but also when you need to start on your projects. Monitor progress relative to schedule.
3) Explain why the capability to communicate your engineering knowledge to non-engineers in both verbal and written form is important.

Communication is salesmanship. Unless you can communicate (sell) your ideas, you'll never get money to realize them.

4) Explain the difference between ethical and legal conduct.

**Legal**: in accordance with the law.

**Ethical**: acting responsibly, in accordance with the conscience.

→ Provide an example of a conduct that is legal but unethical.

Dumping prices at a big corporation to get rid of the competition by selling under price for some time, then once the competition is bankrupt, returning to high profit margins.
Provide an example of a conduct that is ethical but not legal.

Using drugs (you only harm yourself, thus this is not unethical — but it is certainly illegal).

5) Explain why it is important for engineers to provide a mathematical description of engineering/science phenomena.

In today's world, systems almost always are multifaceted. No single individual is an expert on every facet. Mathematics is the way to communicate knowledge to your colleagues on the team who are not expert in your own field.
Given the following bridge:

Show in a free-body diagram how the hanging stud with the two cables that pull with a force $F$ each helps reduce the sag of the bridge.

(Note: The AME Bldg. has such bridges to connect the North with the South parts.)

The $x$-components of the forces cancel out, the $y$-components add up to a resulting force up that supports the bridge.
7) Statistics:

a) Explain why it is necessary to control the mean value of an outcome of an experiment.

Controlling the mean value means to be able to reproduce the same results in a bias-free manner.

b) Explain why it is necessary to control the variance of an outcome of an experiment.

Controlling the variance means to not only hit your target in a statistical sense (i.e., on average), but in reality, and each time.
8) Given three students answering a question. The correct answer is 10, but the students don't know this. They shall answer either 9, 10, or 11 with equal probability.

Assume that the answers are statistically independent, thus the probability of all three students answering 9 is only

\[
\frac{1}{3} \cdot \frac{1}{3} \cdot \frac{1}{3} = \frac{1}{27}
\]

However, the probability of two students answering 9 and one answering 10 is three times as large

\[
\begin{array}{c|ccc}
A & B & C \\
\hline
9 & 9 & 10 & \frac{1}{27} \\
9 & 10 & 9 & \frac{1}{27} \\
10 & 9 & 9 & \frac{1}{27}
\end{array}
\]

\[
\frac{1}{9}
\]
Calculate the probabilities for:

$3 \times 9 \rightarrow \frac{1}{27}$

$2 \times 9 + 1 \times 1 \Phi \rightarrow \frac{3}{27} = \frac{1}{9}$

$2 \times 9 + 1 \times 11 \rightarrow \frac{3}{27} = \frac{1}{9}$

$1 \times 9 + 2 \times 1 \Phi \rightarrow \frac{2}{27} = \frac{1}{9}$

$1 \times 9 + 2 \times 11 \rightarrow \frac{2}{27} = \frac{1}{9}$

$1 \times 9 + 1 \times 1 \Phi + 1 \times 11 \rightarrow \frac{6}{27} = \frac{2}{9}$

$2 \times 1 \Phi + 1 \times 11 \rightarrow \frac{3}{27} = \frac{1}{9}$

$1 \times 1 \Phi + 2 \times 1 \rightarrow \frac{3}{27} = \frac{1}{9}$

$3 \times 11 \rightarrow \frac{1}{27}$

$3 \times 1 \Phi \rightarrow \frac{1}{27}$

Class

(I hope I caught all possibilities).

(see next page!)
Students: A, B, C
Answers: 9, 10, 11

<table>
<thead>
<tr>
<th>Student answers</th>
<th>class</th>
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<tbody>
<tr>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>q</td>
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<td>q</td>
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</tbody>
</table>
Now round to the next integer and add the probabilities of rounding to the same integer. What are the probabilities now to obtain:

<table>
<thead>
<tr>
<th></th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>( \frac{1}{27} + \frac{3}{27} = \frac{4}{27} )</td>
</tr>
<tr>
<td>10</td>
<td>( \text{rest} = \frac{19}{27} )</td>
</tr>
<tr>
<td>11</td>
<td>( \frac{1}{27} + \frac{5}{27} = \frac{4}{27} )</td>
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</table>

Did the averaging of the answers of the three team members increase the chances of a correct answer? **Yes**

<table>
<thead>
<tr>
<th>Classes</th>
<th>Average</th>
<th>New Class</th>
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<tbody>
<tr>
<td>9.0</td>
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<td>9.9</td>
</tr>
<tr>
<td>9.67</td>
<td>9.67</td>
<td>9.9</td>
</tr>
<tr>
<td>10.33</td>
<td>10.60</td>
<td>10.9</td>
</tr>
<tr>
<td>10.33</td>
<td>10.67</td>
<td>10.9</td>
</tr>
</tbody>
</table>

**Note:** If the correct answer would have been 9 or 11, it would not have helped. Averaging helped with controlling the variance.