Please complete this worksheet by **September 17th, 2021** by **11:59pm**.
Once you upload a picture of your work (here), the solutions will become available so you can study for the weekly quizlet, which may draw one problem from this week's worksheets.

Problem 1

The following sets are described in set builder notation. Describe each of them in roster notation instead. The following symbols are used: $\mathbb{Z}$ denotes the set of integers; $\mathbb{R}$ denotes the set of real numbers; $\mathbb{N}$ denotes the set of natural numbers $\{1, 2, 3, \dots\}$.

(a) $\{z \mid z \in \mathbb{Z} \text{ and } 3 < z < 6\}$.

(b) $\{z \mid z \in \{a, c, e\} \text{ and } z \neq c\}$.

(c) $\{A \mid A \subseteq \{a, c, e\} \text{ and } |A| \neq 2\}$.

(d) $\{r \mid r \in \mathbb{R} \text{ and } r = r^2\}$.

(e) $\{n \mid n \in \mathbb{N} \text{ and } n > n^2\}$.

(f) $\{x \mid x \text{ is a letter in the word accommodate }\}$.

(g) $\{z^2 \mid z \in \mathbb{Z} \text{ and } 6 < z^3 < 160\}$.

(h) $\{S \subseteq \{2, 4, 6, 8\} \mid S \cap \{2, 4\} \neq \emptyset \text{ and } |S| \text{ is even }\}$.

(i) $\{S \subseteq \{a, b, c\} \mid S \cap \{b, d\} \neq \emptyset\}$.

Problem 2

Simplify the following expressions, where A and B are arbitrary sets, $\emptyset$ is the empty set and U is the universal set. Hint: each answer to (a)-(h) is one of A, U or $\emptyset$. Please simply write the answer (no proof or steps are needed).

(a) $A \cap U$

(b) $A \cap \emptyset$

(c) $A \cup U$

(d) $A \cup \emptyset$

(e) $A \cup A$

(f) $A \cap A$

(g) $A \cup \overline{A}$

(h) $A \cap \overline{A}$

(i) $A \cap (A \cup B)$

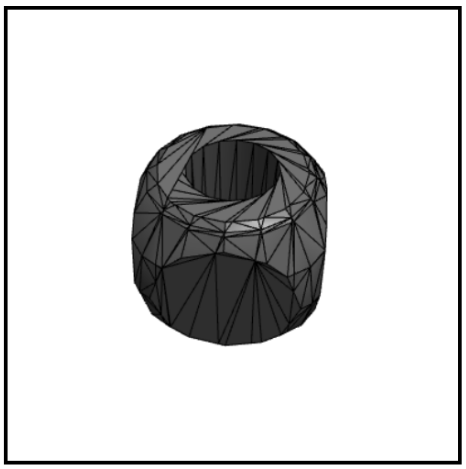
Problem 3 (optional)

Constructive Solid Geometry (CSG) allows you to create complicated shapes from simpler ones using Boolean operators, which is really useful when creating computer graphics models, or in engineering design. These operations are related to operations on sets, such as the difference, union and intersection.

The following demo allows you to investigate concepts in CSG (I suggest using Google Chrome):

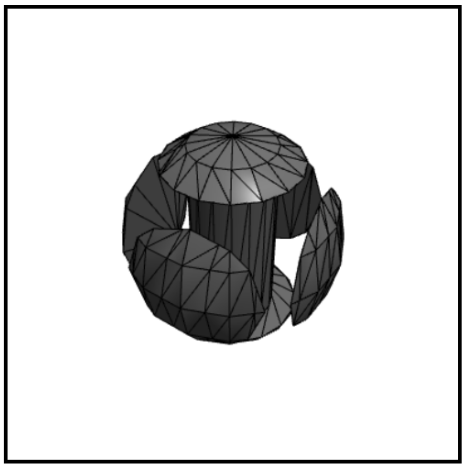
https://philipclaude.gitlab.io/cs200f21/tools/triangulations.html

Here are some sample shapes created with the accompanying code on the right:



Functions

```
1  makeGeometry = function()
2  {
3      var cube = CSG.cube({radius:1.0});
4      var sphere = CSG.sphere({radius:1.3});
5      var cylinder = CSG.cylinder( {radius:0.5} );
6      return sphere.intersect(cube).subtract(cylinder).toMesh();
7  }
```



Functions

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4      var sphere = CSG.sphere({radius:1.3});
5      var cylinder = CSG.cylinder( {radius:0.5} );
6      return cylinder.union( sphere.subtract(cube) ).toMesh();
7  }
```

You can use the following functions between two shapes A and B, which you can think of as sets:

- `A.subtract(B)`: performs the set difference $A - B$
- `A.union(B)`: computes the set union $A \cup B$
- `A.intersect(B)`: computes the set intersection $A \cap B$.

The basic shapes you can create are: `CSG.cube` (with a `radius` and `center`), `CSG.sphere` (with a `radius` and `center`) and a `cylinder` (with a `radius`, `start` and `end`). Note that the `center`, `start` and `end` variables are $3d$ point coordinates and should be an array of 3 values. For more information on using the `CSG` library, please see here. What kinds of shapes can you create with these functions?