This homework is due on gradescope Friday October 12th at 11:59pm. Remember to justify your work even if the problem does not explicitly say so. Writing your solutions in \LaTeX is recommended though not required.

**Question 1** (Time Maze, 30 points). Sheldon is trying to traverse a maze. The maze is only open for 12 hours (noon until midnight). Sheldon has a map of the maze, but unfortunately some of the walls will change locations over time. Additionally, some locations in the maze contain time machines that Sheldon can use to transport himself to a specified hour in the same location. More formally, the maze is represented by an undirected graph $G$. Sheldon starts at a node $s$ and is trying to reach a node $t$. Each edge of the maze is only passible during certain hours (between 1 and 12) that are known. Some vertices of $G$ contain time machines with a specified end time, and Sheldon can also use this machine to transport himself to that time. In traversing the maze, Sheldon can either travel to adjacent vertices if the edge is available at the time (this takes effectively no time), wait around for the next hour to come, or use a time machine in his current location.

Give an algorithm to determine whether or not it is possible for Sheldon to complete the maze. For full credit your algorithm should run in time $O(|V| + |E|)$ or better.

**Question 2** (Edge Activation Maze, 40 points). Penny is trying to escape a mad scientist’s lair. Unfortunately for her, some of the doorways are blocked by security doors. These can be deactivated if she can reach the security panel located somewhere else in the lair. Fortunately, once a security door has been deactivated, it will stay that way indefinitely. Formally, the lair is given by a graph $G$ where Penny starts at vertex $s$. Each edge has an associated control vertex, and Penny cannot traverse the edge until she has reached the associated control vertex.

Provide an algorithm that given $G$, $s$ and the control vertices for each edge, returns the list of vertices that Penny can escape to. For full credit your algorithm should run in linear time.

**Question 3** (Pre- and Post-Order Computations, 30 points). Given the set of vertices of an undirected graph $G$ and the pre- and post-order numbers of depth first traversal of $G$, show how to compute the following properties of $G$:

(a) The number of connected components of $G$. [20 points]

(b) The number of leaves in the depth first search tree (that is the number of nodes from which DFS discovered no new nodes). [10 points]

**Question 4** (Extra credit, 1 point). Approximately how much time did you spend on this homework?