You're expected to work on the discussion problems before coming to the lab. Discussion session is not meant to be a lecture. TA will guide the discussion and correct your solutions if needed. We will not release 'official' solutions. If you're better prepared for discussion, you will learn more. TAs will record names of the students who actively engage in discussion and report them to the instructor; they are also allowed to give some extra points to those students at their discretion. The instructor will factor in participation in final grade.

1. (Basic) Run the Floyd-Warshall algorithm on the weighted, directed graph of Figure 25.2 (CLRS). Show the matrix $D^{(k)}$ that results for each iteration of the outer loop.

2. (Intermediate) The Floyd-Warshall algorithm requires $O(n^3)$ space, since we compute $d_ij^{(k)}$ for $i, j, k = 1, 2, \ldots, n$. Show that the following procedure, which simply drops all the superscripts, is correct, and thus only $O(n^2)$ space is required.

```
FLOYD-WARSHALL'(W)
1  n = W.rows
2  D = W
3  for k = 1 to n
4    for i = 1 to n
5      for j = 1 to n
6        d_ij = min(d_ij, d_ik + d_kj)
7  return D
```

3. (Intermediate) How can we use the output of the Floyd-Warshall algorithm to detect the presence of a negative-weight cycle?

4. (Advanced) Suppose that we can compute the *transitive closure* (see CLRS page 697-699 for more details) of a directed acyclic graph in $f(|V|, |E|)$ time, where f is a monotonically increasing function of $|V|$ and $|E|$. Show that the time to compute the transitive closure $G^* = (V, E^*)$ of a general directed graph $G = (V, E)$ is then $f(|V|, |E|) + O(V + E^*)$.