Please print out this form (two-sided, if you can) and write your answers *legibly* in the spaces provided. If you can't write legibly, type.

1. Draw a flow graph with at least 8 vertices and 12 edges. Assign a positive capacity and cost to each edge. Add flow along three augmenting paths from the source to the sink (you may choose any augmenting paths). Compute the total cost of your flow. Does the residual graph for your flow contain any negative cycles? If so identify one. If not, what does that tell you about your flow?

2. Draw a directed graph with at least five vertices and eight edges. Assign lengths to all the edges, including a few negative lengths. Be careful not to introduce any negative length cycles. Now, use the breadth-first scanning algorithm to find a shortest path tree from vertex *a*. Are there any vertices that are placed on the queue more than once? If so, name at least one.

3. In your example from question 2, how many *passes* are completed during the execution of the algorithm (using the definition of pass given on the top of page 4). List the vertices on the queue at the start of each pass.