1. Consider the adjacency list of a digraph G below:

   0: 1 2

   1: 2

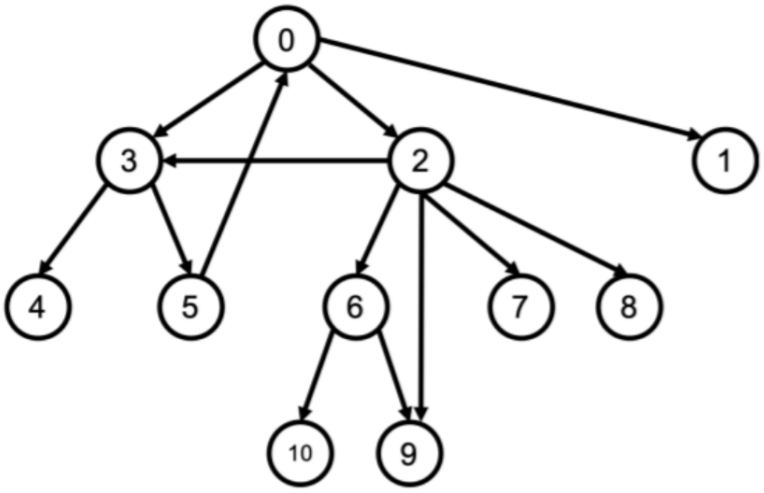
   2: 1 3 4

   3: 4

   4:

   1. Draw the digraph G.
   2. If the search forest F contains exactly the following arcs $(0, 1), (1, 2), (3, 4)$, what is the order of nodes visited?

2. Consider the directed graph G below:



Perform the general traversal algorithm define in the coursebook/lecture slides. Using the convention that nodes are chosen in ascending numeric order when there is a choice of nodes. Show the resulting pred array and the search forest.

3. Is priority first search a generalisation of depth first and breadth first search? Explain why.

4. Carry out BFS and DFS on the digraph with adjacency list given below. Show the state of the queue/stack after each change in its state.

   0 : 2

   1 : 0

   2 : 0 1

   3 : 4 5 6

   4 : 5

   5 : 3 4 6

   6 : 1 2

5. Consider the grid graph defined as follows. It has a node at each point (x, y) in the plane such that x and y are both integers, and $0 \leq x \leq 19, 0 \leq y \leq 19$. There is an edge between any two nodes at distance 1 in the plane. Suppose that we use depth-first search, starting at $(0, 0)$ and terminating when we reach $(19, 19)$. We must choose the order in which we process the neighbours of each node. Which ordering will cause the DFS to visit the fewest nodes before terminating?

   A. right, down, up, left

   B. up, down, left, right

   C. left, right, down, up

   D. right, down, left, up

   E. right, left, down, up

6. Come up with an algorithm using BFS to calculate the minimum number of throws to win at a snakes and ladders game. In a snake and ladders game, the player will throw two dices and move forward on a game board with n squares according to the sum of the two dice. Whenever the player encounters the foot of a ladder, he/she can climb up to the top of the ladder. Sometimes, the player may stop at a snake's head, then the player will be pulled down to lower levels. The player starts at square 1, and wins if he/she reaches the last square n.

7. Do the graphs below have a topological sorting if so give one, if not why not?

   0 : 1 2

   1 : 3 5

   2 : 4

   3 : 4

   4 : 5

   5 :

   0 : 4 5

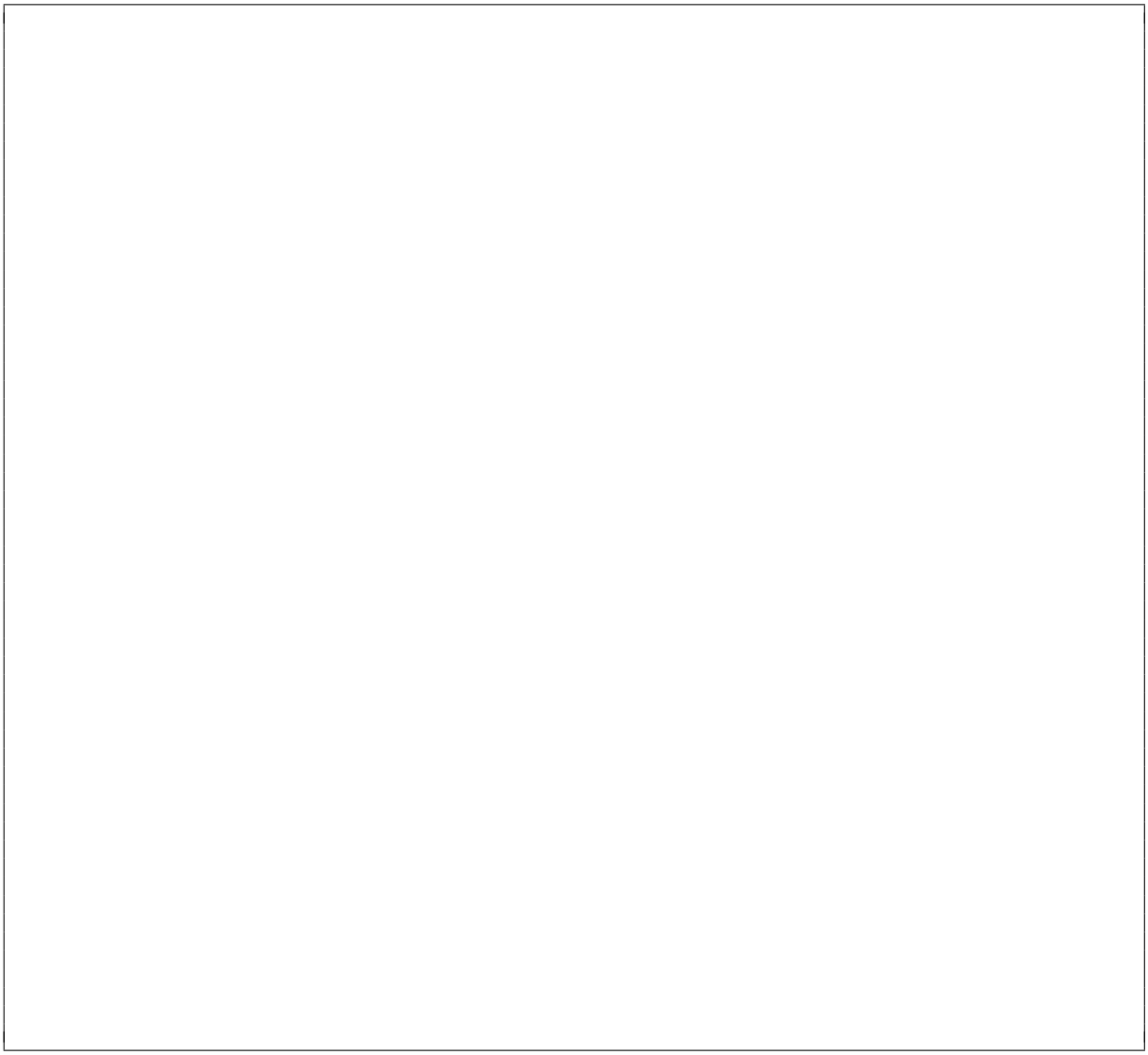
   1 :

   2 : 4 0

   3 : 1 2

   4 : 5 0

   5 : 1



8. We have mentioned an algorithm for finding the directed girth:

   1. For all nodes $v \in V(G)$ do:
      (a) Run BFSVISIT from node v.
      (b) As soon as the algorithm finds a back arc of the form (x, v), terminate, recording the length of such a cycle c, which will be $h + 1$, where h is the depth of node x in the given search tree.
   2. Return smallest such c.

   Answer the following two questions:

   1. Why is there no need to continue to the end of the level before halting the traversal?
   2. What is the running time for doing so?