1. Suppose you work for a lab which is studying butterflies. It has a sample of \( n \) butterflies, \( b_1, b_2, \ldots, b_n \). The researchers have made a series of \( r \) determinations determining whether two butterflies belong to different species. A determination is of the form \((i, j)\), and it means that \( b_i \) and \( b_j \) belong to different species. Your job is to give an \( O(n + r) \) time algorithm to decide whether the determinations are consistent with the butterflies belonging to just two species. (Note: it is possible that they could belong to three or more species, but that is a separate question.) [5 points]

2. (exercise 22.3-2, from CLRS text, but on slightly different graph than text) Show how depth-first search works on the graph of figure 1 below. Assume that the for loop of lines 5-7 of the DFS procedure considers the vertices in alphabetical order, and assume that each adjacency list is ordered alphabetically. Show the discovery and finishing times for each vertex, and show the classification of each edge. [8 points]

![Figure 1: for question 2](image)

3. (exercise 22.4-1, from CLRS text, also on different graph) Show the ordering of vertices produced by \textsc{Topological-Sort} when it is run on the dag of figure 2 below, under the assumption of the previous exercise. [7 points]

4. Not for credit here, but take a look at exercise 22.4-2 from CLRS. This will form the basis of assignment 2, which will involve programming. [0 points]

Total: 20 points