Assignment: Holiday Scheduling

Hand in with using a single pdf file. Clearly specify the flow networks in your two drawings with the nodes clearly labeled by what they represent and the edges by their capacities. You may hand draw the diagrams and scan them in, place in a word processor and create a pdf but if it is not neat and easily read it will not be graded. Upload your assignment to PolyLearn.

IT department holiday scheduling

Congratulations! You have been promoted to be manager of IT organization of your favorite company. However every position has its headaches. Since it is imperative that the companies systems be available every day of the year, you must ensure that there is a (exactly one) supervisor at the data center every day of the year including all the holidays. Holidays are single days including days like Thursday, Friday, Saturday, and Sunday of Thanksgiving week, every day during Christmas week, etc.

Some holidays occur during holiday periods. For example the Thanksgiving holiday period might be Thursday, Friday, Saturday, and Sunday of Thanksgiving week for your company. For the purposes of this problem we will assume there are **k** holiday periods. Some of these will have a single holiday but many will have more than one day, e.g. Thanksgiving holiday period has 4 days. Let $\mathbf{D_j}$ be the number of holidays in period **j**.

Luckily, there are sufficient supervisors to cover all these days even with the following constraints.

1. There are exactly **n** supervisors, each supervisor offers to work exactly **i** of the holidays. Each supervisor has submitted a list of the holidays they would be willing to work
2. No supervisor should be assigned to cover more than **C** holiday days in a year. (i>C)
3. No supervisor should work more than one holiday in each of the holiday periods

So to try to make everyone happy you ask each supervisor to provide you with a list of the "holidays" that they would be willing to work.

You think to yourself, I could write an algorithm to **determine if** there is a 1-1 assignment of supervisors to holidays that satisfies the above constraints where the supervisors only work on the days from their list - BUT I don't have time. **So you cleverly remember that the maximum flow algorithm your learned at Cal Poly is good at solving matching problems.** Thus you decide to try to model the problem as a maximum flow problem. Then you can just use the shortest augmenting path algorithm to solve the problem!

A. First do the problem without constraint #3. That is the supervisors may work more than one day in a holiday period. Determine a flow network that models the problem. G = (V, E, u) and draw a picture of it. **Use labels that represent the different things you are trying to model, namely**
Supervisors = { S_1 , S_2 , …. , S_n }
Holidays = { H_1 , H_2 , …. , H_m } where m is the total number of holidays that must be worked
Holiday Periods = {VP_1 , VP_2 , …. , VP_k } (note that the sum of the D_j is m)
Any symbols you use must be clearly defined before the diagram.

B. Then develop the model to solve the problem with all three constraints. Again determine a flow network that models the problem. G = (V, E, u) and draw a picture of it. Any symbols you use must be clearly defined before the diagram.

You should explain why each diagram solves the problem in a short paragraph. Namely why does the maximum flow obtained represent a solution to the problem. Satisfies the contraints etc. Also how would you be able to tell if there is no solution to the problem given the list of holidays that each supervisor is willing to work.