It is certainly preferable for you to solve the questions without consulting a published source. However, if you are using a published source then you must specify the source and you should try to improve upon the presentation of the result.

If you would like to discuss any questions with someone else that is fine BUT at the end of any collaboration you must spend at least one hour playing video games or watching two periods of Maple Leaf hockey or maybe even start reading a good novel before writing anything down.

If you do not know how to answer a question, state “I do not know how to answer this (sub) question” and you will receive 20% (i.e. 2 of 10 points) for doing so. You can receive partial credit for any reasonable attempt to answer a question BUT no credit or arguments that make no sense.

In class I can clarify any questions you may have about this assignment.
1. Consider the following makespan problem in the restricted machines model. The input is a set of unit processing time jobs $\{J_1, \ldots, J_n\}$ where each job $J_i$ can be scheduled on some subset $S_j \subseteq \{M_1, \ldots, M_m\}$ of the $m$ identical machines.

- Show that the online greedy algorithm will not be better than a $\Omega(\log m)$ approximation. The online greedy algorithm schedules jobs on the least loaded machine and breaks ties in favour of the machine with the smallest index. Can you achieve this inapproximation for arbitrarily large $n >> m$?

- Show how to optimally solve this makespan problem by reducing the problem to optimal flows.

2. Suppose we have a maximum flow $f$ with $val(f) \geq 1$ in an flow network $\mathcal{F} = (G, s, t, c)$ with integral capacities.

- Does there always exist an edge $e$ such that by decreasing the capacity $c(e)$ of $e$ by one unit to $c(e) - 1$, the value of the maximum flow is decreased by exactly one unit? Does your answer depend on the network having integral capacities? Briefly justify your answer.

- Assuming again integral capacities, we want to increase the flow value by two units and want to do so by increasing the capacity of some edges by one unit. Can this always be done? When it can be done, explain how you could efficiently determine the fewest number of edges needed to do this.