CSC2421f25 **Assignment 2** **Fall, 2025**

Due: Tuesday, December 2, noon

This assignment is worth 35% of the final grade. Each question is worth a multiple of 5 points. If you have no idea how to answer a question (or part of a question), you will receive 20% of the credit for that question (or subquestion) by leaving the question (or subquestion) blank. If your answer makes no sense, you will not receive any credit. Any answer that shows some understanding of the question will receive some credit.
NOTE: Some of these questions will not be solved easily. Do NOT worry if you cannot answer every question. Do what you can and manage your time so that the course work for CSC2421 does not impact your other courses(s).

Q1: 10 points The proof that the double coverage algorithm is k-competitive for the k-server problem on the line is by a potential argument. The proof follows from Table 5.1. Verify table 5.1.

Q2: 5 points Show that if there is a ROM algorithm (either deterministic or randomized) achieving competitive ratio ρ for the unweighted bipartite matching problem (BMM), then there is a *greedy* ROM algorithm (respectively, deterministic or randomized) achieving competitive ratio at least ρ. That is, a ROM algorithm for the BMM problem can always match an online vertex if one of its neighbours is not yet matched.

Q3: 5 points Prove that no deterministic algorithm for the Display Ads problem (as defined in Section 7.6.1) can have an asymptotic competitive ratio better than $\frac{1}{2}$.

Q4: 5 points Prove Lemma 8.2.20. That is, for the RSIC problem, prove that $OPT(\mathbf{x}) \geq \max(span(\mathbf{x}), util(\mathbf{x})$.