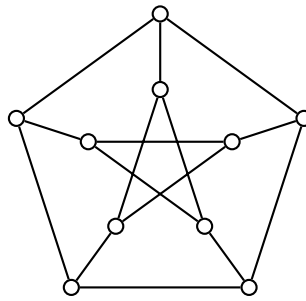


2020F Math589 Midterm1

5 questions, 25 total points

Note: Use other papers to answer the problems. Remember to write down your **name** and your **student ID #**.

1. [5pt] Draw a K_5 on a torus.
2. [5pt] Find a $K_{3,3}$ or a K_5 as a minor of the graph below.



3. [5pt] Let $\alpha(G)$ be the independence number of G , that is, the largest k such that there are k vertices in G that are not adjacent to each other. (For example, $\alpha(K_{3,3}) = 3$.) Define

$$[\alpha](G) = \max\{\alpha(H) : H \text{ is a minor of } G\}.$$

Find $[\alpha](G)$ for each G .

4. [5pt] Prove that K_5 and $K_{3,3}$ are not planar using Euler's formula $V - E + F = 2$.
5. [5pt] Prove that if X is a graph with $\Delta(X) \leq 3$, then any IX contains an TX as a subgraph.