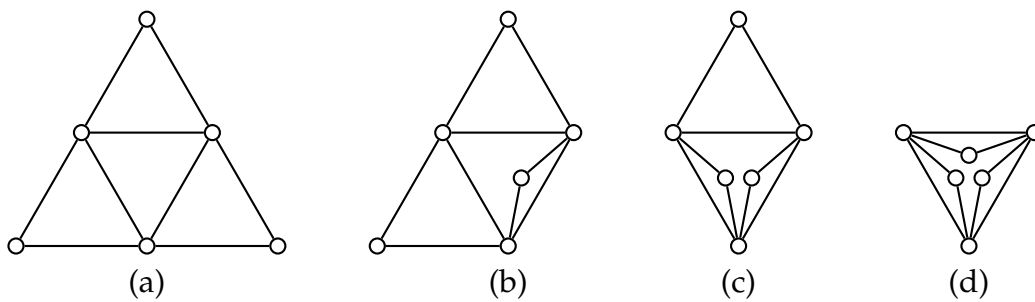


2020F Math589 Midterm2

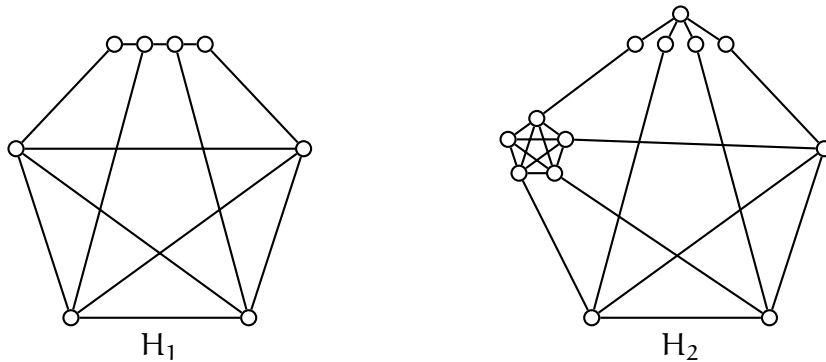
5 questions, 25 total points

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

1. [5pt] Consider the following four drawings and determine whether they are topologically isomorphic to each other. (E.g., (a)~(b), (c)~(d), but (a)~(c).)



2. [5pt] It is known that every graph $H \in \text{IK}_5$ is also in TK_5 or in $\text{TK}_{3,3}$. For the following $H_1, H_2 \in \text{IK}_5$, show that they contain K_5 or $K_{3,3}$ as a topological minor.



3. [5pt] Find a graph G and an edge $e \in E(G)$ such that G is not planar but G/e (contraction of G on e) is planar.

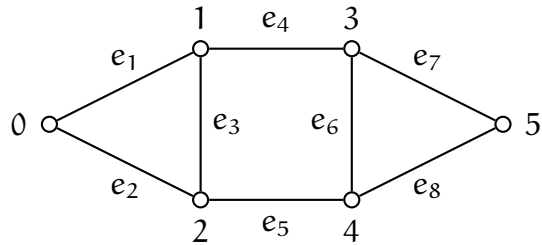
[Two more problems on the back.]

4. [5pt] Let G be the graph below and $\mathcal{C}(G)$ its cycle space. Answer the following questions:

(a) How many elements are in $\mathcal{C}(G)$?

(b) What is the dimension of $\mathcal{C}(G)$?

(c) Find a basis of $\mathcal{C}(G)$.



5. [5pt] Consider the matrix below over \mathbb{Z}_2 , the field of two elements.

$$A = \begin{bmatrix} 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 1 & 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 \end{bmatrix}$$

Find a basis of the row space of A .