Last name _____

First name _____

LARSON—MATH 756–SAGE PROJECT
CONJECTURING for Independent Sets Research

You will each be sent a specific topic to investigate. You should largely be able to imitate our Sage/CoCalc investigations from class.

The **goal** of the investigation is to generate *new theorems*, or at least well-tested unresolved (open) conjectures.

The **point** of the investigation is to practice doing a computer-assisted investigation, and to develop a new tool that you can use in your own research.

1. Login to your Sage/Cocalc account.
   (a) Start the Chrome browser.
   (b) Go to `http://cocalc.com`
   (c) Login. You created a new Project for our class. Click on that.
   (d) Click "New", then "Worksheets", then call it **My_Research_Log**.
   (e) Also click "New", then "File", then call it **research.sage**. This will be a file where you keep all relevant definitions—that you can load every time you work on the **My_Research_Log** worksheet.
   (f) Run `load("research.sage")` and `load("conjecturing.py")` every time you come back to your investigation—definitions lose their state when you leave your project.
2. Keep a track of your conjecture runs in **My_Research_Log**. Every time you make a new run, you should add a useful *comment* (starting with a hashtag "#') and what you are doing in that cell as you are trying to move forward your investigation. This worksheet will be something like a lab scientist's log. At any point you can click "make pdf" and you will have a printable copy of your investigation.
3. Here are steps you can take in investigating your topic.
   (a) Switch between investigating upper and lower bounds (or necessary and sufficient conditions if you are researching a graph property).
   (b) Add graphs to your `objects` list, either because they are counterexamples, or because they existing theory is tight for the current input graphs.
   (c) Add more invariants (or properties) to add to your input `invariants` list (or input `properties` list). You might code these yourself, or find built-in ones.
   (d) Search for a counterexample, either systematically for small graphs using `nauty_geng`, or by generating larger random graphs using `graphs.RandonGNP`, and then add it to your `objects` list.
   (e) Add theorems to `theory`, either ones that you've proved or ones you know from the literature.

(f) See me to discuss your progress, when you get stuck, when you need a new idea, etc.

4. Dates

   (a) Wed., Nov. 27. **Progress Report** due. Send a pdf of your **My_Research_Log** CoCalc worksheet.

   (b) Mon., Dec. 1, I will email comments and suggestions.

   (c) Mon., Dec. 8. **Lab Report** due. Your Lab Report should be LaTeX'ed, it should include definitions of all terms used, and include a *Results* section. Your results include any new graphs (not in the literature, not standard graph classes) that you found that were counterexamples—include a picture and g6 string. Include any theorems that you discovered—and their proofs. Include any open conjectures you generated—and how you tested them.

   (d) When you send me your Lab Report at that time also send me a pdf of the latest version of your **My_Research_Log** CoCalc worksheet.