For answering this class's quizzes, the following programs may be useful:

- GCP Model with `K_max`:
  - Model gcp.mod.
  - Data gcp.dat.
  - AMPL run file gcp.run.
  - Python program gcp.py.

- GCP Model with fixed `k`:
  - Model gcp_fixed_k.mod.
  - AMPL run file gcp_fixed_k.run.
  - Python program gcp_fixed_k.py.

- Maximum stable set files:
  - Model ssp.mod.
  - AMPL run file ssp.run.
  - Python program ssp.py.

1. Consider the coloring problem in the following graph:
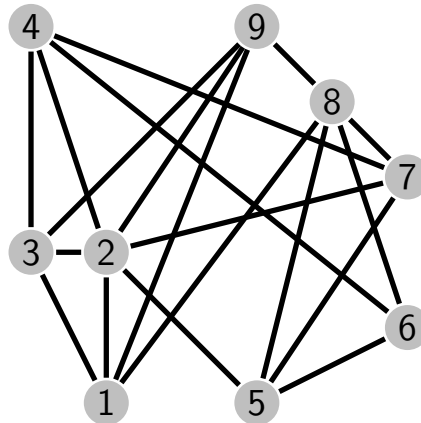
   (a) Determine a solution of using the "standard" formulation, with an upper bound for the number of colors equal to the number of vertices (i.e., $K_{\max} = |V|$).

   (b) Using the model with a fixed number of colors $K = 2$, determine the minimum number of "bad edges" (edges whose end nodes have the same color).

   (c) Solve the problem using the *fixed-k formulation* and the bisection method in a "manual" way, using initially 2 as the lower bound and $|V|$ as the upper found for the chromatic number.

2. Consider the following graphs:
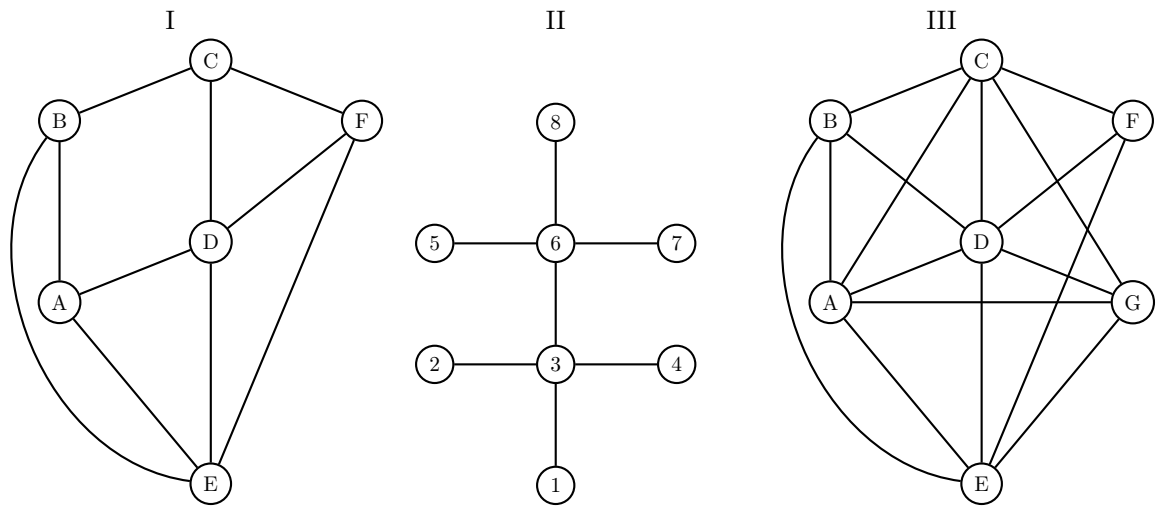
For each of the graphs, instantiate a model and identify the solution to the following problems:

(a) Graph partitioning;
(b) Maximum stable set;
(c) Maximum clique;
(d) Graph coloring.