Problem 1. The state of California is evil and limits the number of permits they will issue to ice cream truck vendors to 400 permits. The inverse demand for ice cream truck permits is $P = 10,000 - 10Q$, and the marginal cost of a permit is $\text{MC} = 1,000$ because California's bureaucracy is out of control.

(a) What would be the welfare-maximizing quantity of permits to issue?

(b) If the state of California wanted to sell the permits and maximize revenue, how many permits would they sell?

(c) Suppose the state of California auctions 400 permits. Calculate consumer surplus, government revenue, and deadweight loss.

(d) As an alternative, the state of California considers a lottery in which all interested ice cream vendors—those who would have purchased a permit without the government limitation—would apply for a permit. The 400 permits would be randomly allocated to ice cream vendors, which cannot be traded. Relative to part (c), how would consumer surplus and welfare change?

Problem 2. Two firms compete in a Bertrand market to produce a good. Inverse demand is given by $P = 120 - Q$, and the marginal cost of each firm is given by $\text{MC} = 40$.

(a) How much of the good is produced by each firm in (unregulated) equilibrium?

(b) The production of the good generates an externality that depends on the amount produced. The marginal external costs (i.e. the externality) is given by $\text{MEC} = Q$, so the marginal social costs for the industry are $\text{MSC} = \text{MC} + \text{MEC} = 40 + Q$. What is the socially optimal price and quantity?

(c) Given your answers to part (b), what is the deadweight loss in the unregulated market of part (a)?

(d) What is the optimal Pigouvian tax to charge the two Bertrand competitors?

(e) Would your answer to part (d) change if the two firms were instead a monopoly? If not, briefly explain why not. If so, what is the optimal tax?

Problem 3. Energy companies deliver natural gas to residential consumers.

(a) The federal government decides to tax air pollution created when natural gas is burned. Assume that the marginal cost of abatement and the marginal benefit of abatement curves are respectively given by $\text{MBA} = 200 - 2A$ and $\text{MCA} = 20 + A$, where A is abatement measured in tons. What tax should the government set?

(b) Suppose that instead of the tax you just calculated, the government sets a tax rate of \$100/ton. Draw a diagram illustrating the deadweight loss and calculate the size of deadweight loss.

(c) Suppose the company emits 200 tons of pollution before any policy is put into place. How many tons of pollution should be permitted to maximize social welfare? What will be the market price of a permit to emit one ton of pollution? Which energy companies will buy the permits?