Name:

Student Number:

Final Exam (100 Points Total)

- The space provided below each question should be sufficient for your answer. If you need additional space, ask for additional paper.
- You are allowed to use a calculator, but only the basic functions. Use of advanced formulas (e.g., if your calculator does present value) or of material that you have programmed into your calculator is not allowed and will be considered cheating.
- You are encouraged to show your work for partial credit. It is very difficult to give partial credit if the only thing on your page is "$x = 3$".
- **Expected value** is given by summing likelihood times value over all possible outcomes:

$$\text{Expected Value} \quad = \sum_{\text{Outcomes } i} \text{Probability}(i) \cdot \text{Value}(i).$$

- A **fair bet** is a bet with an expected value of zero.
- The **future value of a lump sum payment** of $\$x$ invested for n years at interest rate r is $\text{FV} = x(1+r)^n$. The **present value of a lump sum payment** of $\$x$ after n years at interest rate r is $\text{PV} = \dfrac{x}{(1+r)^n}$.
- The present value of an **annuity** paying $\$x$ at the end of each year for n year at interest rate r is

$$\text{PV} = x \left[\frac{1 - \dfrac{1}{(1+r)^n}}{r} \right].$$

  The present value of the related **perpetuity** (with annual payments forever) is

$$\text{PV} = \frac{x}{r}.$$

- The **inflation rate**, i, is the rate at which prices rise. The **nominal interest rate**, n, is the interest rate in terms of dollars. The **real interest rate**, r, is the interest rate in terms of purchasing power. These are related by

$$1 + r = \frac{1+n}{1+i}.$$

  When the inflation rate is small, we can approximate this as

$$r \approx n - i.$$

- A **Pareto efficient** (or **Pareto optimal**) allocation or outcome is one in which it is not possible find a different allocation or outcome in which nobody is worse off and at least one person is better off. An allocation or outcome B is a **Pareto improvement over A** if nobody is worse off with B than with A and at least one person is better off.

- A (strictly) **dominant strategy** is a strategy which yields higher payoffs than any other strategy regardless of the other players' strategies. A (strictly) **dominated strategy** is a strategy that yields lower payoffs than some other strategy regardless of the other player's strategy.

- A **Nash equilibrium** occurs when the strategies of the various players are best responses to each other. Equivalently but in other words: given the strategies of the other players, you are acting optimally; and given your strategy, your opponents are acting optimally. Equivalently again: No player can gain by deviating alone, i.e., by changing his or her strategy single-handedly.

- In an **ascending price auction**, the price starts out at a low value and the bidders raise each other's bids until nobody else wants to bid. In a **descending price auction**, the price starts out at a high value and the auctioneer lowers it until somebody calls out, "Mine." In a **first-price sealed-bid auction**, the bidders submit bids in sealed envelopes; the bidder with the highest bid wins, and pays an amount equal to his or her bid (i.e., the highest bid). In a **second-price sealed-bid auction**, the bidders submit bids in sealed envelopes; the bidder with the highest bid wins, but pays an amount equal to the *second-highest* bid.

- **Total revenue** is price times quantity: $TR = pq$.

- The **price elasticity of demand at point A** measures the percentage change in quantity demanded (relative to the quantity demanded at point A) resulting from a 1% increase in the price (relative to the price at point A). The formula is

$$\varepsilon(A) = \frac{\%\text{ change in } q}{\%\text{ change in } p} = \frac{\dfrac{\Delta q}{q_A}}{\dfrac{\Delta p}{p_A}} = \frac{\Delta q}{\Delta p} \cdot \frac{p_A}{q_A} = \frac{q_B - q_A}{p_B - p_A} \cdot \frac{p_A}{q_A}.$$

  In English If, at point A, a small change in price causes the quantity demanded to increase by a lot, demand at point A is elastic; if quantity demanded only changes by a little then demand at point A is inelastic; and if quantity demanded changes by a proportional amount then demand at point A has unit elasticity.

  In math If, at point A, the price elasticity of demand is less than -1 (e.g., -2), then demand at point A is elastic; if the elasticity is greater than -1 (e.g., $-\frac{1}{2}$), then demand at point A is inelastic; if the elasticity is equal to -1 then demand at point A has unit elasticity.