HE1001 Microeconomics

Final Practice 2 – Solutions

Academic Year 2025/2026, Semester 1

Quantitative Research Society @NTU

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Note: These solutions provide complete step-by-step working for all questions. Students should show similar levels of detail in their answers.

Question 1: Multiple Choice Questions — Solutions

1.1 [Adapted from Tutorial 1, Question 1]

Answer: (A) — 1. Micro, 2. Macro, 3. Macro, 4. Micro

Explanation:

Microeconomics examines individual and firm-level decisions, while macroeconomics focuses on aggregate outcomes such as growth and inflation.

- Statement 1: A family's saving decision is an individual household choice → **Microeconomics**
- Statement 2: National saving's impact on economic growth is an aggregate economy-wide effect → **Macroeconomics**
- Statement 3: The relationship between inflation and money supply involves aggregate price levels → **Macroeconomics**
- Statement 4: Government regulation on auto emissions affects specific firms and industries → **Microeconomics**

1.2 [Adapted from Tutorial 2, Question 4]

Answer: (C) — the percentage change in one variable in response to a one percent increase in another variable.

Explanation:

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Elasticity is defined as the percentage change in one variable resulting from a 1 percent change in another variable, holding other factors constant. Mathematically:

$$\text{Elasticity} = \frac{\%\Delta Y}{\%\Delta X}$$

This is distinct from slope, which measures absolute changes rather than proportional changes. Elasticity is a unit-free measure that allows comparison across different goods and markets.

1.3 [Adapted from Tutorial 3, Question 5]

Answer: (D) — The consumer can always compare any two baskets or be indifferent.

Explanation:
Completeness is one of the fundamental axioms of consumer theory. It states that for any two consumption bundles A and B, the consumer must be able to rank them: either $A \succ B$ (prefer A to B), $B \succ A$ (prefer B to A), or $A \sim B$ (indifferent between them). This ensures that preferences are well-defined and consumers can make choices.

1.4 [Adapted from Tutorial 5, Question 5]

Answer: (C) — Marginal product.

Explanation:
The total product (TP) curve shows the relationship between input quantity and total output. The slope of the TP curve at any point is:

$$\text{Slope} = \frac{dTP}{dL} = \text{MP}_L$$

where MP_L is the marginal product of labour. The marginal product represents the additional output produced by one more unit of input.

1.5 [Adapted from Tutorial 7, Question 4]

Answer: (D) — Each seller has a very small share of the market.

Explanation:
Perfect competition requires several key assumptions:

- Many small firms, each with a negligible market share
- Homogeneous (identical) products
- Free entry and exit
- Perfect information

Because each firm is tiny relative to the market, no individual firm can influence the market price — they are price takers. This is the defining characteristic that leads to the horizontal demand curve facing each firm.

1.6 [Adapted from Tutorial 9, Question 5]

Answer: (B) — Should increase Q

Explanation:

For a monopolist (or any firm with market power), profit maximization requires MR = MC. Since MR $< P$ for a downward-sloping demand curve, when $P =$ MC, we have:

$$\text{MR} < P = \text{MC}$$

This means MR < MC, so the firm is producing too much. However, if we interpret the question as asking about the condition $P =$ MC in general:

- If $P >$ MC, the firm can increase profit by producing more (each additional unit adds more to revenue than to cost)
- If $P <$ MC, the firm should reduce output

At $P =$ MC, a monopolist has MR < MC and should reduce output. But in a competitive market interpretation, $P =$ MC is the optimal condition. The answer depends on market structure context; for a monopolist at $P =$ MC, output should be reduced to reach MR = MC.

Note: The original tutorial answer is (B), suggesting increase output. This may reflect a different interpretation or context.

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Question 2: Multiple Choice Questions with Justification — Solutions

2.1 [Adapted from Tutorial 2, Question 6]

Answer: (C) — +4.5%

Justification:

Cross-price elasticity of demand is defined as:

$$E_{XY} = \frac{\%\Delta Q_X}{\%\Delta P_Y}$$

Given:

- $E_{XY} = -0.3$ (cross-price elasticity of peanut butter with respect to jelly price)
- $\%\Delta P_Y = -15\%$ (jelly price declines by 15%)

Solving for the percentage change in quantity demanded of peanut butter:

$$\%\Delta Q_X = E_{XY} \times \%\Delta P_Y = (-0.3) \times (-15\%) = +4.5\%$$

The quantity demanded of peanut butter increases by 4.5%.

Economic interpretation: The negative cross-price elasticity indicates that peanut butter and jelly are complements. When jelly becomes cheaper, consumers buy more jelly, and consequently also buy more peanut butter to go with it.

2.2 [Adapted from Tutorial 4, Question 5]

Answer: (A) — Consume more bubble tea and less fried chicken.

Justification:

At the optimal consumption bundle, the consumer maximizes utility when:

$$\text{MRS}_{X,Y} = \frac{p_X}{p_Y}$$

where $\text{MRS}_{X,Y} = \frac{MU_X}{MU_Y}$ is the marginal rate of substitution.
Given that $\text{MRS}_{X,Y} > \frac{p_X}{p_Y}$, we have:

$$\frac{MU_X}{MU_Y} > \frac{p_X}{p_Y}$$

Rearranging:

$$\frac{MU_X}{p_X} > \frac{MU_Y}{p_Y}$$

This means the consumer gets more utility per dollar spent on bubble tea (X) than on fried chicken (Y). To increase total utility, the consumer should:

- **Increase consumption of** X (bubble tea) — where marginal utility per dollar is higher
- **Decrease consumption of** Y (fried chicken) — where marginal utility per dollar is lower

By reallocating spending from Y to X, the consumer moves along the budget constraint toward a bundle where $\text{MRS}_{X,Y} = \frac{p_X}{p_Y}$, thereby maximizing utility.

2.3 [Adapted from Tutorial 6, Question 1]

Answer: (C) — Diagram C (Linear isoquants, perfect substitutes)

Justification:

The production function is:

$$q = 0.1X + 0.1Y$$

This is a **linear production function**, indicating that Canadian ground beef (X) and U.S. ground beef (Y) are **perfect substitutes** in production.

Characteristics:

- The marginal products are constant: $\text{MP}_X = 0.1$ and $\text{MP}_Y = 0.1$
- The marginal rate of technical substitution (MRTS) is constant:

$$\text{MRTS} = \frac{\text{MP}_X}{\text{MP}_Y} = \frac{0.1}{0.1} = 1$$

- Isoquants are straight lines with slope -1
- The firm can substitute between the two inputs at a constant rate

For example, to produce $q = 10$ units:

- Use $X = 100, Y = 0$, or
- Use $X = 0, Y = 100$, or
- Use any combination where $0.1X + 0.1Y = 10$

This corresponds to **Diagram C**, which shows linear isoquants characteristic of perfect substitutes in production.

Question 3: Structured Problems — Solutions

3.1 [Adapted from Tutorial 7, Question 2]

(a) Find the market equilibrium price and quantity. **[4 marks]**

At market equilibrium, quantity demanded equals quantity supplied. Set the demand and supply functions equal:

$$40 - 0.25Q = 5 + 0.05Q$$

Solving for Q:

$$\begin{aligned} 40 - 5 &= 0.05Q + 0.25Q \\ 35 &= 0.30Q \\ Q^* &= \frac{35}{0.30} = 116.67 \text{ (yards per month)} \end{aligned}$$

Substitute back into the demand equation to find equilibrium price:

$$\begin{aligned} P^* &= 40 - 0.25(116.67) \\ &= 40 - 29.17 \\ &= 10.83 \text{ dollars per yard} \end{aligned}$$

Answer: Equilibrium price $P^* = \$10.83$ per yard, equilibrium quantity $Q^* = 116.67$ yards per month.

(b) For the individual firm, find the profit-maximizing output q^*. **[4 marks]**

In perfect competition, firms are price takers. The firm maximizes profit where $P = \text{MC}$. First, find the marginal cost from the total cost function:

$$C(q) = 100 - 20q + 2q^2$$

$$\text{MC}(q) = \frac{dC}{dq} = -20 + 4q$$

Set $P = \text{MC}$:

$$\begin{aligned} 10.83 &= -20 + 4q \\ 30.83 &= 4q \\ q^* &= \frac{30.83}{4} = 7.71 \text{ units} \end{aligned}$$

Answer: The firm's profit-maximizing output is $q^* \approx 7.71$ units.

(c) Compute the firm's profit at this output. **[5 marks]**

Profit is given by:

$$\pi = \text{TR} - \text{TC} = P \cdot q - C(q)$$

Calculate total revenue:

$$\text{TR} = 10.83 \times 7.71 = 83.50$$

Calculate total cost at $q = 7.71$:

$$\begin{aligned}\text{TC} &= 100 - 20(7.71) + 2(7.71)^2\\ &= 100 - 154.20 + 118.95\\ &= 64.75\end{aligned}$$

Calculate profit:

$$\pi = 83.50 - 64.75 = 18.75$$

Answer: The firm's profit is approximately \$18.75.

3.2 [Adapted from Tutorial 9, Question 1]

(a) Derive the inverse demand function and the marginal revenue function. **[3 marks]**

Given demand function:

$$Q = 100 - 2P$$

Solve for P to get the inverse demand:

$$\begin{aligned}2P &= 100 - Q\\ P &= 50 - 0.5Q\end{aligned}$$

Inverse demand: $P = 50 - 0.5Q$
Calculate total revenue:

$$\text{TR} = P \cdot Q = (50 - 0.5Q)Q = 50Q - 0.5Q^2$$

Marginal revenue is the derivative of total revenue:

$$\text{MR} = \frac{d(\text{TR})}{dQ} = 50 - Q$$

Answer: Inverse demand: $P = 50 - 0.5Q$, Marginal revenue: $\text{MR} = 50 - Q$

(b) Find the profit-maximizing output and price. **[4 marks]**

Given total cost:

$$\text{TC} = 5Q + Q^2$$

Marginal cost:

$$\text{MC} = \frac{d(\text{TC})}{dQ} = 5 + 2Q$$

Monopolist maximizes profit where MR = MC:

$$\begin{aligned}50 - Q &= 5 + 2Q\\ 45 &= 3Q\\ Q^* &= 15\end{aligned}$$

Find monopoly price by substituting into inverse demand:

$$P^* = 50 - 0.5(15) = 50 - 7.5 = 42.5$$

Answer: Profit-maximizing output $Q^* = 15$ units, monopoly price $P^* = \$42.50$

(c) Compute CS, PS, and DWL under monopoly, comparing to competitive outcome. **[7 marks]**

Step 1: Find competitive equilibrium
In perfect competition, $P = \text{MC}$:

$$\begin{aligned} 50 - 0.5Q &= 5 + 2Q \\ 45 &= 2.5Q \\ Q_c &= 18 \end{aligned}$$

$$P_c = 50 - 0.5(18) = 41$$

Step 2: Calculate consumer surplus under monopoly
Consumer surplus is the area of the triangle above price and below demand:

$$\text{CS}_{\text{mono}} = \frac{1}{2} \times (P_{\max} - P^*) \times Q^* = \frac{1}{2} \times (50 - 42.5) \times 15 = \frac{1}{2} \times 7.5 \times 15 = 56.25$$

Step 3: Calculate producer surplus under monopoly
Producer surplus is the area above MC and below price. The MC curve intersects the vertical axis at $P = 5$ when $Q = 0$, and at $Q = 15$, $\text{MC} = 5 + 2(15) = 35$.

$$\text{PS}_{\text{mono}} = \frac{1}{2} \times [(P^* - 5) + (P^* - 35)] \times Q^* = \frac{1}{2} \times [(42.5 - 5) + (42.5 - 35)] \times 15$$

$$= \frac{1}{2} \times [37.5 + 7.5] \times 15 = \frac{1}{2} \times 45 \times 15 = 337.5$$

Step 4: Calculate deadweight loss
DWL is the welfare loss from monopoly restriction of output:

$$\text{DWL} = \frac{1}{2} \times (P^* - \text{MC at } Q^*) \times (Q_c - Q^*) = \frac{1}{2} \times (42.5 - 35) \times (18 - 15)$$

$$= \frac{1}{2} \times 7.5 \times 3 = 11.25$$

Answer:

- Consumer surplus under monopoly: CS = \$56.25
- Producer surplus under monopoly: PS = \$337.50
- Deadweight loss: DWL = \$11.25

3.3 [Adapted from Tutorial 4, Question 3]

(a) Write Janice's budget constraint. **[2 marks]**

The budget constraint is:

$$P_X \cdot X + P_Y \cdot Y = I$$

Substituting the given values:

$$25X + 50Y = 750$$

Answer: Budget constraint is $25X + 50Y = 750$

(b) Find the utility-maximizing quantities X^* and Y^*. **[5 marks]**

For a Cobb-Douglas utility function $U(X, Y) = 2X^{0.4}Y^{0.6}$:
Marginal utilities:

$$\text{MU}_X = \frac{\partial U}{\partial X} = 2 \times 0.4X^{-0.6}Y^{0.6} = 0.8X^{-0.6}Y^{0.6}$$

$$\text{MU}_Y = \frac{\partial U}{\partial Y} = 2 \times 0.6X^{0.4}Y^{-0.4} = 1.2X^{0.4}Y^{-0.4}$$

Marginal rate of substitution:

$$\text{MRS}_{XY} = \frac{\text{MU}_X}{\text{MU}_Y} = \frac{0.8X^{-0.6}Y^{0.6}}{1.2X^{0.4}Y^{-0.4}} = \frac{0.8}{1.2} \cdot \frac{Y}{X} = \frac{2}{3} \cdot \frac{Y}{X}$$

At optimum, $\text{MRS}_{XY} = \frac{P_X}{P_Y}$:

$$\frac{2}{3} \cdot \frac{Y}{X} = \frac{25}{50} = \frac{1}{2}$$

Solving for Y:

$$\frac{Y}{X} = \frac{1}{2} \times \frac{3}{2} = \frac{3}{4}$$

$$Y = \frac{3}{4}X = 0.75X$$

Substitute into budget constraint:

$$\begin{aligned} 25X + 50(0.75X) &= 750 \\ 25X + 37.5X &= 750 \\ 62.5X &= 750 \\ X^* &= 12 \end{aligned}$$

$$Y^* = 0.75 \times 12 = 9$$

Answer: $X^* = 12$ units, $Y^* = 9$ units

(c) Derive Janice's individual demand function for good X. **[3 marks]**

From the tangency condition with Cobb-Douglas utility, optimal expenditure shares are constant:

$$\frac{P_X \cdot X}{I} = 0.4 \quad \text{and} \quad \frac{P_Y \cdot Y}{I} = 0.6$$

Solving for X:

$$X^* = \frac{0.4I}{P_X}$$

With $P_Y = 50$ and $I = 750$ held constant:

$$X^*(P_X) = \frac{0.4 \times 750}{P_X} = \frac{300}{P_X}$$

Answer: Janice's demand for X is $X^*(P_X) = \frac{300}{P_X}$

(d) Suppose Mary and Jennifer have identical demand. Derive market demand for X. **[3 marks]**

If all three consumers (Janice, Mary, and Jennifer) have the same demand function, the market demand is the horizontal sum of individual demands:

$$X_{\text{market}}(P_X) = 3 \times X^*(P_X) = 3 \times \frac{300}{P_X} = \frac{900}{P_X}$$

Answer: Market demand for X is $X_{\text{market}}(P_X) = \frac{900}{P_X}$

END OF SOLUTIONS

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