HE1001 Microeconomics

Final Practice 4 – 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 4]

Answer: (D) — $P = 200$

Explanation:

Given $I = 50$, substitute into the demand function:

$$Q_D = 300 - 2P + 4(50) = 300 - 2P + 200 = 500 - 2P$$

At equilibrium, $Q_D = Q_S$:

$$\begin{aligned} 500 - 2P &= -100 + P \\ 600 &= 3P \\ P^* &= 200 \end{aligned}$$

1.2 [Adapted from Tutorial 2, Question 3]

Answer: (B) — \$250

Explanation:

Average cost is defined as:

$$AC = \frac{TC}{Q}$$

Given:

- $TC = \$20{,}000$
- $Q = 80$ hoods

Calculate:

$$AC = \frac{20{,}000}{80} = 250$$

Answer: Average cost per hood is \$250.

1.3 [Adapted from Tutorial 3, Question 2]

Answer: (B) — The budget line rotates outward, pivoting at the Y-intercept.

Explanation:

The budget constraint is:

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

Initially: $10X + 20Y = 600$
When P_X decreases to 5: $5X + 20Y = 600$
The Y-intercept (when $X = 0$) remains at:

$$Y = \frac{600}{20} = 30$$

The X-intercept (when $Y = 0$) changes from:

$$X = \frac{600}{10} = 60 \quad \text{to} \quad X = \frac{600}{5} = 120$$

Since the Y-intercept stays fixed and the X-intercept increases, the budget line rotates outward, pivoting at the Y-intercept.

1.4 [Adapted from Tutorial 5, Question 3] **[5 marks]**

A chair manufacturer has the following short-run production function (labour is the only variable input):

$$q = 20L^2 - L^3,$$

where q is output (chairs) and L is labour input (workers).

At what level of labour input does the average product of labour reach its maximum?

(A) $L = 5$

(B) $L = 10$

(C) $L = 15$

(D) $L = 20$

Answer: (B) — $L = 10$

Explanation:

The average product of labour is

$$AP_L = \frac{q}{L} = \frac{20L^2 - L^3}{L} = 20L - L^2.$$

To find the labour input that maximizes AP_L, differentiate with respect to L and set equal to zero:

$$\frac{d(AP_L)}{dL} = 20 - 2L = 0 \quad \Rightarrow \quad L = 10.$$

The second derivative is

$$\frac{d^2(AP_L)}{dL^2} = -2 < 0,$$

so $L = 10$ gives a maximum.

Therefore, the average product of labour reaches its maximum at $\boxed{L = 10}$, corresponding to option **(B)**.

1.5 [Adapted from Tutorial 7, Question 3]

Answer: (A) — \$525

Explanation:

For a competitive firm, profit maximization occurs at $P = MC$.
Given $TC = 100 + q^2$:

$$MC = \frac{dTC}{dq} = 2q$$

Set $P = MC$:

$$\begin{aligned} 50 &= 2q \\ q^* &= 25 \end{aligned}$$

Calculate profit:

$$\begin{aligned} \text{TR} &= P \times q = 50 \times 25 = 1{,}250 \\ \text{TC} &= 100 + (25)^2 = 100 + 625 = 725 \\ \pi &= \text{TR} - \text{TC} = 1{,}250 - 725 = 525 \end{aligned}$$

1.6 [Adapted from Tutorial 8, Question 1]

Answer: (B) — $q = 6$

Explanation:

Given $TC = q^3 - 12q^2 + 60q$:
Average cost:

$$AC = \frac{TC}{q} = q^2 - 12q + 60$$

To minimize AC, take the derivative and set to zero:

$$\frac{dAC}{dq} = 2q - 12 = 0$$
$$q^* = 6$$

Verify it's a minimum (second derivative test):

$$\frac{d^2AC}{dq^2} = 2 > 0$$

Therefore, AC is minimized at $q = 6$.

Question 2: Multiple Choice Questions with Justification — Solutions

2.1 [Adapted from Tutorial 3, Question 8]

Answer: (B) — The additional satisfaction from consuming one more unit of a good.

Justification:

Marginal utility (MU) measures the change in total utility from consuming one additional unit of a good:

$$MU_X = \frac{\partial U}{\partial X}$$

At the optimal consumption bundle, the consumer maximizes utility subject to the budget constraint. The optimality condition is:

$$\frac{MU_X}{P_X} = \frac{MU_Y}{P_Y}$$

This means the marginal utility per dollar spent is equal across all goods. Equivalently:

$$\frac{MU_X}{MU_Y} = \frac{P_X}{P_Y}$$

The left side is the marginal rate of substitution (MRS), which equals the price ratio at the optimal bundle.

2.2 [Adapted from Tutorial 6, Question 5]

Answer: (B) — Marginal cost is constant at \$55 per unit.

Justification:

Given $TC = 200 + 55q$:
Breaking down the cost function:

- Fixed Cost: $FC = 200$
- Variable Cost: $VC = 55q$

Marginal cost:

$$MC = \frac{dTC}{dq} = 55$$

Since the variable cost is linear in q, marginal cost is constant at \$55 per unit.
Other statements:

- (A) False: $AFC = \frac{200}{q}$ decreases as q increases
- (C) False: $ATC = \frac{200}{q} + 55$ decreases as q increases
- (D) False: $AVC = 55$ is constant

2.3 [Adapted from Tutorial 9, Question 4]

Answer: (B) — West Coast

Justification:

Under third-degree price discrimination, the monopolist sets a higher price in the market with less elastic (more inelastic) demand.

Demand elasticities:

- East Coast: $P_1 = 15 - Q_1$, so $Q_1 = 15 - P_1$, $\frac{dQ_1}{dP_1} = -1$
- West Coast: $P_2 = 25 - 2Q_2$, so $Q_2 = \frac{25-P_2}{2}$, $\frac{dQ_2}{dP_2} = -\frac{1}{2}$

At any given price, the West Coast demand is less responsive to price changes (smaller $|\frac{dQ}{dP}|$), indicating less elastic demand.

The monopolist charges a higher price in the less elastic market (West Coast) because consumers there are less sensitive to price increases.

Question 3: Structured Problems — Solutions

3.1 [Adapted from Tutorial 3, Question 3]

(a) Sketch Molly's indifference curves. **[4 marks]**

Molly loves hamburgers (positive utility) but dislikes soft drinks (negative utility).
Indifference curve shape: Upward sloping

- To maintain the same utility level, if Molly consumes more soft drinks (which she dislikes), she must be compensated with more hamburgers
- Higher indifference curves are to the right (more hamburgers, fewer soft drinks)
- The curves slope upward from left to right

Diagram description: Indifference curves slope upward, with higher utility curves further to the right and lower on the vertical axis.

(b) Sketch Mary's indifference curves. **[4 marks]**

Mary views hamburgers and soft drinks as perfect complements (1:1 ratio).
Indifference curve shape: L-shaped (right angles)

- Mary gets utility only from the minimum of the two goods
- Each indifference curve has a kink at the 45-degree line where $H = S$
- Additional hamburgers without soft drinks (or vice versa) provide no additional utility
- Higher indifference curves are further from the origin

Diagram description: L-shaped indifference curves with kinks along the 45-degree line.

(c) Find optimal consumption bundles. **[5 marks]**

Budget constraint: $2H + S = 20$
Molly's optimal bundle:
Since Molly dislikes soft drinks, she maximizes utility by consuming zero soft drinks (if possible) and spending all income on hamburgers:

$$2H = 20 \implies H^* = 10, \quad S^* = 0$$

Mary's optimal bundle:
Mary consumes hamburgers and soft drinks in a 1:1 ratio: $H = S$.
Substitute into budget constraint:

$$\begin{aligned} 2H + H &= 20 \\ 3H &= 20 \\ H^* &= \frac{20}{3} \approx 6.67 \end{aligned}$$

Therefore: $H^* = \frac{20}{3}$, $S^* = \frac{20}{3}$

3.2 [Adapted from Tutorial 7, Question 9]

(a) Find MC function. **[2 marks]**

Given $TVC = 0.5q^2$:

$$MC = \frac{d(TVC)}{dq} = q$$

Answer: $MC = q$

(b) Find profit-maximizing output. **[3 marks]**

Set $P = MC$:

$$5 = q$$
$$q^* = 5$$

Answer: $q^* = 5$ meals

(c) Calculate TR, TC, and profit. **[4 marks]**

$$\text{TR} = P \times q = 5 \times 5 = 25$$
$$\text{TC} = TFC + TVC = 100 + 0.5(5)^2 = 100 + 12.5 = 112.5$$
$$\pi = \text{TR} - \text{TC} = 25 - 112.5 = -87.5$$

Answer: TR = \$25, TC = \$112.50, Profit = −\$87.50 (loss)

(d) Find shutdown price and decision. **[5 marks]**

Average variable cost:

$$AVC = \frac{TVC}{q} = \frac{0.5q^2}{q} = 0.5q$$

Minimum AVC occurs at $q = 0$, which isn't economically meaningful. Since AVC is increasing, the minimum over positive q approaches 0 as $q \to 0$.

However, at the operating level $q = 5$:

$$AVC = 0.5(5) = 2.5$$

Since $P = 5 > AVC = 2.5$, the firm covers its variable costs and should continue operating in the short run, even though it's making a loss.

Shutdown condition: The firm shuts down if $P < \min(AVC)$.

At $q = 5$, $P = 5 > AVC = 2.5$, so the firm should continue operating.

3.3 [Adapted from Tutorial 10, Question 1]

(a) Dominant strategies. **[4 marks]**

Firm A's strategy:

- If Firm B plays High: A gets 50 from High, 60 from Low $\implies$ Low is better
- If Firm B plays Low: A gets 20 from High, 30 from Low $\implies$ Low is better

Firm A has a **dominant strategy: Low**
Firm B's strategy:

- If Firm A plays High: B gets 50 from High, 60 from Low $\implies$ Low is better
- If Firm A plays Low: B gets 20 from High, 30 from Low $\implies$ Low is better

Firm B has a **dominant strategy: Low**

(b) Nash equilibria. **[5 marks]**

Since both firms have dominant strategies (Low, Low), the unique Nash equilibrium is:
Nash Equilibrium: (Low, Low) with payoffs (30, 30)
Verification:

- Given Firm B plays Low, Firm A's best response is Low (30 ¿ 20)
- Given Firm A plays Low, Firm B's best response is Low (30 ¿ 20)
- Neither firm can improve by deviating unilaterally

(c) Prisoner's Dilemma? **[4 marks]**

Yes, this is a Prisoner's Dilemma.
Characteristics of Prisoner's Dilemma:

1. Each player has a dominant strategy
2. The dominant strategy equilibrium is Pareto inefficient
3. There exists a mutually beneficial outcome that players cannot reach without cooperation

In this game:

- Both firms choose Low (dominant strategy)
- Outcome: (30, 30)
- If both chose High: (50, 50) — both better off
- But each firm has an incentive to deviate to Low

This is the classic Prisoner's Dilemma structure: individually rational behavior leads to a collectively suboptimal outcome.

END OF SOLUTIONS