General Guidelines

- You may use a calculator;
- You may **not** use a programmable calculator;
- You may **not** use notes or books;
- You may have some food and beverages on your desk;
- All other belongings, including phones, must be on the floor;
- You can only leave the room after 30 minutes into the exam and up unto 15 minutes before the exam ends;
- Write all your answers on the blank answer sheets brought by you;
- Write your name and student number on every answer sheet;
- Number all your answer sheets and hand them in in chronological order;
- If a question does not ask for an explanation, there is no need to give one;
- This exam is to be handed in together with your answer sheets;
- Any form of fraud will, at least, imply an invalid grade for this course.

1. Production (3 points)

Let $y = \beta x_1 + \gamma x_2$ be a production function, where y is the output and x_1 and x_2 are the two inputs.

1.1 Find the Technical Rate of Substitution (TRS) for the production above.

Consider for the following two questions that $\beta = 4$ and $\gamma = 2$.

1.2. Carefully sketch the input requirement set for producing at least 16 units of output:

$$\{ (x_1, x_2) \ in \ R_+^2 \ | \ 4x_1 + 2x_2 \geq 16 \}$$

1.3. Consider that in the short run x_2 is fixed at a value of 4. Carefully sketch the short-run production possibilities set:

$$\{ (y, x_1) \ in \ R_+^2 \ | \ 4x_1 + 2x_2 \geq y, x_2 = 4 \}$$

2. Profit and costs (4 points)

Consider a firm that produces output y while using input x. The price for output y is denoted by p and the price for input x is denoted by w. Imagine that you observe the following data of the firm across two months:

Month	p	w	y	x
1	2	1	5	5
2	4	2	10	10

2.1. Does the Weak Axiom of Profit Maximization (WAPM) hold for this firm?

Consider for the following three questions that the firm starts using two inputs x_1 and x_2 to produce output y via the following production function: $y = \min(x_1, x_2)$. Consider that the price for inputs x_1 and x_2 are $w_1 = w_2 = 1$.

2.2. Carefully sketch the isoquant that allows the firm to produce exactly 4 units of output:

$$\{ (x_1, x_2) \ in \ R_+^2 \ | \ \min(x_1, x_2) = 4 \}$$

Carefully sketch into the same graph the isocost line that corresponds to the minimum costs $\underline{c}$ that allows the firm to produce those 4 units of output:

$$\{ (x_1, x_2) \ in \ R_+^2 \ | \ x_1 + x_2 = \underline{c} \}$$

Conclude from your graph what are the conditional factor demands for input 1 and 2 and what are the minimum costs $\underline{c}$ to produce 4 units of output.

2.3. Consider that the price for input 1 increases to 2, so that $w_1 = 2$. What are the new conditional factor demands for input 1 and 2 and what are the new minimum costs $\underline{c}$ to produce 4 units of output?

2.4. From your answers to question 2.2 and 2.3, what do you conclude about the substitution effect in a *consumer choice* problem when the utility function is equal to $u = \min(x_1, x_2)$? Provide a brief explanation for your answer.

3. Consumer choice (5 points)

Consider a consumer with a utility function equal to $u = x_1^\alpha x_2^\beta$. The consumer has income m, and the price for good x_1 and x_2 are denoted by p_1 and p_2 respectively.

3.1. Find the Marshallian demand functions for both good 1 and 2.

3.2. Take the derivative of the Marshallian demand functions derived in question 3.1 towards m. Use these derivatives to discuss under which restrictions on α and β the Marshallian demand functions for good 1 and 2 are less steep (with price on the vertical axis and quantity on the horizontal axis) than the Hicksian demand functions for good 1 and 2 respectively.

Consider for the following three questions that $u = x_1^{0.5} x_2^{0.5}$.

3.3. Briefly explain what the Marginal Rate of Substitution (MRS) is. Find the MRS for the utility function above.

3.4. The consumer wants to reach a certain utility level $\bar{u}$. Find the expenditure function as a function of $\bar{u}$, p_1, and p_2. Briefly discuss what the expenditure function represents.

3.5. To find the Lagrange multiplier lambda one can take the derivative of the expenditure function towards an exogenous variable. Which exogenous variable is this? Find lambda via this route. Provide a brief economic interpretation for lambda while assuming that $p_1 = p_2 = 1$ and $\bar{u} = 5$.

4. Welfare (4 points)

Consider a consumer with a utility function equal to $u = \sqrt{x_1} + x_2$. The consumer has income $m = 50$, and the price for good x_1 and x_2 are denoted by p_1 and p_2 respectively.

4.1. Find both the Marshallian and the Hicksian demand function for good x_1.

4.2. Use the derived demand functions in question 4.1 to argue that the change in consumer surplus can be used as an exact measure of welfare.

4.3. Consider that $p_2 = 4$. Find either the change in consumer surplus, equivalent variation, or compensating variation for a change in p_1 from 1 to 2.

5. Perfect competition (2 points)

Consider a perfect competitive market. Let the total cost function of *a single* firm be equal to:

$$c(y) = 0.5y^2 + 2$$

Where *y* is the output. Let the *market* demand be given by:

$$X(p) = 40 - 2p$$

Where *p* is the price. Suppose that in the long run there is free entry into, and exit out of, this market, and that all potential firms have the same cost function $c(y)$ as above.

5.1. How many firms will there be active in this perfect competitive market in the long run?

6. Monopoly (2 points)

Two economists (A and B) discuss the difference between a perfect competitive market and a monopoly.

Economist A argues the following: "In a perfect competitive market, firms will enter and exit until profits are zero. In contrast, a monopolist does not face entry and exit, and so a monopolist will be able to ask a mark-up and make a profit. Hence, the difference between these markets is that firms in a perfect competitive market will not make profits whereas a monopolist will."

Imagine you are economist B. Answer the following two questions.

6.1. Does the argument of economist A hold in the short run, long run, or both?

6.2. Does the argument of economist A that "a monopolist will be able to ask a mark-up" always hold?