**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 (6 points)

Let $y = 2x_1 + 4x_2$ be a production function, where $y$ is the output and $x_1$ and $x_2$ are the two inputs.

**1.1** Briefly explain what the Technical Rate of Substitution (TRS) is. Calculate the TRS for the production function above.

**1.2.** Carefully sketch the input requirement set for producing at least 20 units of output:

$$V(y) = \{ (x_1, x_2) \ in \ R_+^2 \ | \ 2x_1 + 4x_2 >= 20 \}$$

**1.3.** Consider that in the short run $x_2$ is fixed at a value of 1. Carefully sketch the following short-run production possibilities set:

$$Y(x_2 = 1) = \{ (y, x_1) \ in \ R_+^2 \ | \ 2x_1 + 4x_2 >= y, x_2 = 1 \}$$


## 2. Profit (8 points)

Consider a firm that uses one input $x$ against price $w$. With that input it produces one output $y$ via the production function $y = f(x)$ that it sells at price $p$. Hence, the profit of the firm is:

$$\pi(x, p, w) = pf(x) - wx$$

The firms' factor demand function is $x(p, w)$.

**2.1.** Substitute $x = x(p, w)$ into $\pi(x, p, w)$ and subsequently take the derivative towards $w$. Rewrite this derivative into a "direct" and "indirect" effect of $w$. Briefly interpret this direct and indirect effect.

**2.2.** Briefly explain why the indirect effect is equal to zero.

**2.3.** The CEO of this firm wants to test the Weak Axiom of Profit Maximization (WAPM). Which data does the CEO need to collect? Write down the formula that the CEO should calculate with those data, *or* briefly explain the formula in words.


## 3. Costs (6 points)

The firm from question 2 starts to use a second input, so it now uses $x_1$ and $x_2$ to produce $y$. Imagine that the prices for $x_1$ and $x_2$ are $w_1 = 1$ and $w_2 = 4$ respectively. The production function is given by $y = x_1^{1/4} x_2^{1/4}$.

**3.1** Calculate the minimum costs to produce $y = 10$.