**Examination in the Bachelor of Science**
**Course title: Markets, Incentives and Ethical Management**
**Part: Markets and Incentives**
**Semester: 3**
**Lecturers: Prof. Dr. Heiko Karle, Prof. Dr. Markus Reisinger, Prof. Dr. Frederik Schwerter**
**Examination date: 22nd October 2021**

**Aids: pocket calculator Casio FX-82 solar,**
**German-English Dictionary, English-English Dictionary**

Please enter your student ID (matriculation number) and your group!

| Student ID | Group |
|---|---|
| | |

Please note:

The exam consists of 4 questions of which you will have to answer **all** questions. You have **90** minutes to complete the examination. The maximum of points to be reached is **90**. Please use the enclosed answer sheet to answer your questions and add your student ID on its cover.

We wish you all the best for your examination!

Internal use only!

| Question | 1 | 2 | 3 | 4 | **Total** |
|---|---|---|---|---|---|
| Possible points: | 16 | 27 | 27 | 20 | **90** |
| Points achieved: | | | | | |

Signature of corrector

## Question 1 – General Equilibrium (16 points)

(a) State the definition of competitive equilibrium in a market economy with two goods. (4 points)

(b) State the definition of the First Welfare Theorem. (2 points)

Suppose that there are two consumers A and B and two products *X* and *Y*. The initial endowment is such that consumer A is endowed with $(X_A, Y_A) = (5, 3)$ and consumer B is endowed with $(X_B, Y_B) = (7, 2)$. Both consumers have standard preferences and their utility functions are

$$U_A(X_A, Y_A) = X_A Y_A \quad \text{and} \quad U_B(X_B, Y_B) = X_B Y_B.$$

(c) Determine the utilities of consumers A and B at their respective initial endowment. (2 points)

(d) Determine consumer A's and B's utility when consumer A gives 1 unit of good Y to consumer B. (2 point)

(e) State whether the allocation in d) or in e) is preferred by a Rawlsian social welfare function. Explain your answer. (3 point)

(f) State whether the allocation in d) or e) is preferred by a Utilitarian social welfare function. Explain your answer. (3 point)

## Question 2 – Oligopoly (27 points)

Consider price competition between two firms (firm 1 and 2). The firms sell a homogeneous product at constant marginal costs of c=5 for each firm. (There are no fixed costs). Prices are set simultaneously (**Bertrand competition**). The demand function is D(p)=10-p for a firm setting the lowest price alone, D(p)/2 for a firm setting the lowest price together with the other firm, and 0 for a firm not setting the lowest price. Assume that price differences can be infinitesimally small. Use the notation "$p - \varepsilon$" for slightly undercutting a price p of a rival firm.

**(a)** Determine the equilibrium prices and explain briefly why they constitute a Nash equilibrium. (4 points).

**(b)** Determine the corresponding profit of firm 1 and 2. (1 point)

**(c)** Explain briefly why the Nash equilibrium in Bertrand competition cannot be determined by deriving the first-order conditions of the profit-maximizing firms. (3 points)

Suppose now that only firm 1 is active in this market.

**(d)** Determine the profit function of firm 1. (1 point)

**(e)** What is the monopoly price that firm 1 will set? (2 points)

Suppose next that both firms are active in the market but firm 2 has higher marginal costs of 6, i.e., $c_1$=5<$c_2$=6.

**(f)** Determine the equilibrium prices and explain briefly why they constitute a Nash equilibrium. (4 points)

**(g)** Determine the corresponding profit of firm 1 and 2 when $\varepsilon$ is approximately zero. (2 point)

**(h)** Explain how the equilibrium prices in (f) are changing if firm 2's marginal costs increase further to 8, i.e., $c_1$=5<$c_2$=8. (3 points)

Assume that the demand functions of firm 1 and 2 have changed such that

$D_1(p_1, p_2) = 10 - p_1 - \frac{1}{2}p_2$ and $D_2(p_1, p_2) = 10 - p_2 - \frac{1}{2}p_1$.

**(i)** Do the two firms sell substitutes or complements now? Briefly explain your result. (3 points)

**(j)** Solve the game for the Nash equilibrium prices when the marginal costs of both firms are equal to 5, i.e., $c_1$=$c_2$=5. (4 points)

## Question 3 – Tacit Collusion (27 points)

Consider a situation with two firms, firm 1 and firm 2, which produce a homogenous product. The inverse demand function is D(p) = 10 – 2p. Production cost functions are $2q_i$, i=1,2, for each firm, that is, $C_1(q_1) = 2q_1$ and $C_2(q_2) = 2q_2$.

(a) Suppose that firm 1 is a monopolist (that is, firm 2 does not participate in the market). Determine the monopoly price and firm 1's profit. (3 points)

(b) Instead of firm 1 being a monopolist, firm 1 now competes with firm 2. Competition occurs in prices (**Bertrand competition**). What are the equilibrium prices and equilibrium profits of this game? (3 points)

(c) Suppose that instead of competing only for one period, the two firms compete in prices repeatedly for 50 periods. Explain why the Subgame Perfect Nash equilibrium in this repeated interaction is the same as the one in one-shot (single period) competition. (4 points)

Suppose now that the two firms compete for an infinite number of periods. Both firms have a common discount factor $\delta$, which is between 0 and 1. Each firm follows a grim-trigger strategy.

(d) Formulate a reasonable grim-trigger strategy that allows the firms to sustain collusion if the discount factor $\delta$ is large enough. (5 points)

(e) To determine the best deviation from a grim-trigger strategy, state the optimal one-period best-response of a firm, given that the competitor sets its price at the monopoly level. What is the resulting profit? (3 points).

(f) Determine now the critical discount factor above which firms can sustain tacit collusion when following a grim trigger strategy. (5 points)

Suppose that firms would compete in quantities instead of prices. They still follow a grim-trigger strategy to sustain a collusive outcome in which each firm produces half of the monopoly quantity.

(g) Explain verbally how the deviation profit of a firm differs when firms collude by setting quantities as compared to the price setting case. (4 points)

## Question 4 – Asymmetric Information (20 points)

Consider the following signaling situation:

There are two types of cars: one has high quality and is worth 50 to a buyer, and one has low quality and is worth 20 to a buyer. Both types are equally likely (that is, they each have a probability of 0.5).

The owner of each type of car can go to a car repair shop to implement “cosmetic” changes to the car, which do not affect the quality. However, implementing a level K of cosmetic changes is less expensive for the owner of a high-quality car than for the owner of a low-quality car. Specifically, implementing one unit of cosmetic changes costs 2 for the owner of a high-quality car but 5 for the owner of a low-quality car.

(a) Suppose that implementing cosmetic changes was not possible, what is the expected value of a car to a buyer? (2 points)

Consider the following constellation: Low-quality owners choose K=0, high-quality owners choose K= K*>0, and buyers pay 50 when seeing a level K= K* but only 20 when seeing a car with K=0.

(b) Determine for which values of K* neither the owner of low-quality car nor the owner off a high-quality car have an incentive to deviate from the constellation describec above. (5 points)

(c) Out of these levels, which level of K* is the most-efficient one for social surplus? Give a short explanation. (3 points)

(d) Explain verbally why signaling allows a buyer to disentangle the quality types although cosmetic changes do not improve the quality of a car. (4 points)

Hidden action occurs in several economic situations.

(e) State and briefly explain a situation of hidden action. (2 points)

(f) Consider a situation of hidden action in which both parties (i.e., the principal and the agent) are risk neutral. Describe a contract that can avoid inefficiencies in such a situation and briefly explain your result. (4 points)