SØK1011 - EXAM

Total points = 25 points.

## Question 1 (4 points)

In a perfectly competitive market, each firm has the following production costs:

| Firm supply | Firm total costs |
|---|---|
| 1 | 10 |
| 2 | 18 |
| 3 | 24 |
| 4 | 28 |
| 5 | 30 |
| 6 | 42 |
| 7 | 56 |
| 8 | 72 |
| 9 | 90 |
| 10 | 110 |

The market demand is given by: $X = 80 - 5p$ (where $X$ denotes the market quantity of the good).

a) (2 points) What is the market price in the long-run equilibrium?

In the long run equilibrium, the price is equal to the minimum average cost.
To find the average costs, divide the total costs by the supply:

| Firm supply | Firm total costs | Average costs |
|---|---|---|
| 1 | 10 | 10 |
| 2 | 18 | 9 |
| 3 | 24 | 8 |
| 4 | 28 | 7 |
| 5 | 30 | 6 |
| 6 | 42 | 7 |
| 7 | 56 | 8 |
| 8 | 72 | 9 |
| 9 | 90 | 10 |
| 10 | 110 | 11 |

The minimum average cost is 6. So, $p = 6$.

b) (1 point) What is the market quantity of the good in the long-run equilibrium?

To find the market quantity we use the market demand:

$$X = 80 - 5p = 80 - 5 \times 6 = 80 - 30 = 50$$

c) (1 point) How many firms will operate in the market in the long-run equilibrium?

To find the number of firms divide the total market quantity by the quantity supplied by an individual firm. The quantity supplied by a firm is the quantity that results in the minimum average cost for the firm, which is 5 units.

$$number\ of\ firms = \frac{50}{5} = 10$$

Question 2 (6 points)

In the market for videos on demand, there are two types of consumers whose marginal willingness to pay is described by the following demand curves:
Type 1: $p = 20 - 4x$
Type 2: $p = 20 - 2x$
where $x$ is the number of videos watched in a month.
The only supplier is a firm whose marginal cost of streaming a video is zero. The firm offers two plans. Plan 1 allows the customer to watch $x_1$ videos per month at a monthly fee of $F_1$. Plan 2 allows the customer to watch $x_2$ videos per month at a monthly fee of $F_2$. In both plans, the price per video is 0.

a) (4 points) Assume the firm knows the type of each customer and can offer the correct plan to each customer. Find the values of $x_1, F_1, x_2, F_2$ that maximize profits.

Solve for plan 1 first. As stated in the question, the price per video is 0. The profit-maximizing plan involves letting the (type 1) customer buy as many videos per month as they are willing to at that price and setting a fee equal to the (type 1) consumer surplus. We can use the type 1 demand curve to find how many videos per month will be purchased at a price of 0:

$$p = 20 - 4x; 0 = 20 - 4x \Rightarrow x = \frac{20}{4} = 5$$

Then calculate the consumer surplus:

$$CS = \frac{20 \times 5}{2} = 50$$

So, plan 1 is: $(x_1 = 5; F_1 = 50)$. Proceeding similarly for plan 2, we find: $(x_2 = 10; F_2 = 100)$.

b) (2 points) Assume the firm does not know the type of each customer and lets customers choose the plan they want. Keeping $x_1$ and $x_2$ equal to what you found earlier, find the values of $F_1$ and $F_2$ that maximize profits.

Plan 1's monthly fee does not need to be changed, so we still have: $F_1 = 50$.
However, to ensure that type 2 customers choose plan 2, the firm must lower plan 2's monthly fee. The highest $F_2$ is such that it leaves a type 2 customer indifferent between plan 1 and plan 2. A type 2 customer's net consumer surplus from choosing plan 1 is:

$$gross\ CS\ from\ plan\ 1 - F_1 = \frac{(20 + 10) \times 5}{2} - 50 = 25$$

A type 2 customer's net consumer surplus from choosing plan 2 is:

$$gross\ CS\ from\ plan\ 2 - F_2 = \frac{20 \times 10}{2} - F_2 = 100 - F_2$$

This customer is indifferent if:

$$25 = 100 - F_2$$

So the optimal plan 2 fee is: $F_2 = 75$

Question 3 (4 points)

Consider a market where two firms, A and B, compete by choosing how much to supply, as in the Cournot oligopoly model. The market demand curve is:

$$p = 30 - 2X$$

where $X$ is the total market quantity.
Firm A has a constant marginal cost $c_A = 4$. Firm B has a constant marginal cost $c_B = 4$.

a) (3 points) Find the equilibrium supply of firm A and firm B.

First find the best response of firm A. Firm A's revenues are:

$$px_A = [30 - 2(x_A + x_B)]x_A = 30x_A - 2x_A^2 - 2x_A x_B$$

The optimal supply is such that marginal revenue equals marginal cost:

$$30 - 4x_A - 2x_B = 4 \Rightarrow x_A = \frac{26 - 2x_B}{4}$$

Proceeding similarly the best response function of firm B is:

$$x_B = \frac{26 - 2x_A}{4}$$

To find the equilibrium we use both best response functions and solve for the two supply levels. The equilibrium supplies are $x_A = \frac{13}{3} \approx 4.333$ and $x_B = \frac{13}{3} \approx 4.333$.

b) (1 point) Find the equilibrium price.

The total supply is $X = x_A + x_B = \frac{26}{3}$. The price is given by the demand curve:

$$p = 30 - 2X = \frac{38}{3} \approx 12{,}667$$

Question 4 (3 points)

Two firms compete in a market. Each firm can set either a high price (strategy H) or a low price (strategy L).
If firm 1 chooses H and firm 2 chooses H, each of them earns a profit of 120.
If firm 1 chooses L and firm 2 chooses L, each of them earns a profit of 30.
If firm 1 chooses H and firm 2 chooses L, firm 1 earns a profit of 10 and firm 2 earns a profit of 150.
If firm 1 chooses L and firm 2 chooses H, firm 1 earns a profit of 150 and firm 2 earns a profit of 10.

a) (1 point) Assuming this game is played only once, what is the Nash equilibrium?

Both firms will choose strategy L.
The payoff table is the following:

| Firm 1 \ Firm 2 | H | L |
|---|---|---|
| H | 120, 120 | 10, 150 |
| L | 150, 10 | 30, 30 |

Assume that firm 2 chooses H: then the best response of firm 1 is to choose L (L gives 150, while H yields 120). Assume that firm 2 chooses L: then the best response of firm 1 is to choose L (L gives 30, while H yields 10). So, L is always a best response for firm 1. The same is true for firm 2.

b) (2 points) If this game is repeated for an infinite number of periods and the discount factor is 0.4, can the two firms cooperate (choosing H in each period)? Answer yes or no, and briefly explain why.

Yes.
If a firm cooperates by choosing H in each period, it gets a profit of 120 in each period forever. This yields a total discounted payoff of: $\frac{120}{1-0.4} = 200$. If the firm cheats, by choosing strategy L, then it will get a profit of 150 in the first period, but then it will only get a payoff of 30 in each following period (since the other firm will also switch to L in response). This gives a total discounted payoff of: $150 + 0.4 \times \frac{30}{1-0.4} = 170$. Since 200 is bigger than 170, cooperating is optimal for both firms. Noting that the threshold discount factor for cooperation (0.25) is lower than 0.4 is also a valid answer.

Question 5 (4 points)

A good is sold under perfect competition. Let $x$ denote the total amount of the good. The market marginal willingness to pay (or marginal benefit) is: $130 - 25x$. The market marginal private cost is: $10 + 5x$. Production of the good creates a total externality cost equal to $5x^2$.
a) (1 point) Find the competitive market equilibrium level of $x$.

To find the competitive market equilibrium level of $x$, set the marginal benefit equal to the marginal private cost:

$$130 - 25x = 10 + 5x \Rightarrow x = 4$$

b) (2 points) Find the socially efficient level of $x$.

To find the socially efficient level of $x$, set the marginal benefit equal to the marginal private cost + marginal externality. The marginal externality is the derivative of the total externality, which is equal to $10x$.

$$130 - 25x = 10 + 5x + 10x \Rightarrow x = 3$$

c) (1 point) What level of per-unit tax should the government charge on the production of the good to achieve the socially efficient outcome?

The efficient tax is equal to the marginal externality at the socially efficient level of $x$:

$$tax = 10 \times 3 = 30$$

Question 6 (4 points)

What are two important characteristics of public goods? Briefly explain what they mean.

1) Non-rivalrous: many users can use it at the same time.
2) Non-excludable: it is difficult to prevent someone from using the good.