Part A (15 points). Write an essay (1-1.5 pages) on the following topic. Be concise. You do not need to provide lots of detail. Just make sure to state the main points.

A.1. What were the two main approaches governments used to deal with externalities prior to Coase? Explain briefly how one of these approaches can handle externalities and what its drawbacks are as an anti-externality tool. State the two major insights that Coase made with respect to externalities. Formulate the Coase Theorem for the case of zero transaction costs of negotiations and for the case when the transaction costs of negotiations are high.

Part B (10 points). Short answers (0.5-1 page long). Answer one of the following two questions.

B.1. Describe the rule of first possession and the rule of tied ownership. To what type (or types) of property do these rules apply? Provide an example of each rule in the law. Explain the relative advantages and disadvantages of each rule.

B.2. A common law doctrine of “coming to the nuisance” is an example of a rule that helps allocate property rights in the presence of externalities. For instance, if person A builds a house next to a pig farm owned by person B, then B might not be liable to A for the smell emanating from the pig farm, because A “came to the nuisance” that had already existed. What is the economic justification for this doctrine? What major insight by Coase with respect to the nature of externalities does it illustrate? Can you think of any inefficient incentives that this doctrine might produce?

Part C (10 points). Short answers (0.5-1 page long). Answer one of the following two questions.

C.1. Consider cumulative potential inventions with the 2nd invention based on the 1st invention in the sense that the 2nd invention would not have been possible without the first one. Suppose both of these inventions cannot be made by the same inventor and the 2nd invention infringes on the 1st. Is there a legal rule that could provide socially efficient incentives for both inventors? If yes, what is that rule? If no, why not? An intuitive explanation is sufficient. Ideally, you would explain your answer in general. But you can also explain your answer by referring to prior agreement and to licensing as the two candidates for solving cumulative invention problem.

C.2. Describe the “fair use” exception. What is it an exception from? What are the economic justifications for this exception?
Part D (60 points). Solve all of the following four problems. In order to get full credit, you need to show your work or explain how you obtained the answers. Wherever relevant, assume that all agents are risk-neutral.

D.1. (10 points) Mike likes having loud parties till midnight while his neighbor Jim prefers to go to bed early (by 10 pm). Mike values his ability to party till midnight at 200. Jim values quietness after 10 pm at 150. Each party’s alternative is zero (i.e., if Mike parties, Jim’s payoff is zero; if Mike doesn’t party, Mike’s payoff is zero).

(i) (3 points) What is the socially efficient outcome?

Answer: Mike has loud parties till midnight.

(ii) (3 points) What is the minimum transaction costs of negotiations that would preclude socially efficient outcome if Jim has the right to noise-free environment?

Answer: 50.

(iii) (4 points) Suppose now that the allocation of property rights is unclear and Jim plans to take Mike to court to enjoin him from making noise after 10 pm. Both parties think that Jim would win the case with probability 0.7 while Mike would win with probability 0.3. Also, each party would have to spend 20 on court costs. There are no other transaction costs. What are the parties’ threat values?

Answer: Jim’s threat point is $0.7 \times 150 - 0.3 \times 0 - 20 = 85$. Mike’s threat point is $0.3 \times 200 - 20 = 40$.

D.2. (20 points) A farmer and a cattle-raiser are operating on neighboring properties. Without any fencing between the properties, an increase in the size of the cattle-raiser’s herd increases the total damage to the farmer’s crops. The relation between the number of cattle in the herd and the annual crop loss is as follows:

<table>
<thead>
<tr>
<th>Number in Herd (Steers)</th>
<th>Total Annual Crop Loss (Tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
</tr>
</tbody>
</table>

A ton of crops brings $100 of profit to the farmer and each steer brings in $250 of profit to cattle-raiser (these numbers also represent social values of crops and steers). The farmer has the right to have his crops free from damage by steers. The cattle-raiser’s and the farmer’s payoffs when there is no cattle are normalized to zero. Both parties’ utilities are linear in payoffs.

(i) What is the socially efficient number of steers in the herd?

Answer: 2, because social surplus is maximized at this number of steers (surplus is $500 - 300 = 200$).

(ii) Suppose that the farmer’s right is protected by injunction and the transaction costs of negotiations are zero. What would be the outcome in this situation? (Indicate who would pay whom and how much. Derive the “how much” number explicitly using Nash bargaining model.)
**Answer:** Given zero transaction costs, the parties would negotiate a socially efficient solution, i.e., the cattle-raiser would have 2 steers. Both parties’ threat points are zero. The cooperative solution results in the cattle-raiser getting $500 - P$ and the farmer getting $P - 300$, where $P$ is the payment from the cattle-raiser to the farmer (this produces a surplus of $500 - 300 = 200$). Therefore, Nash bargaining would maximize $(500 - P - 0) \times (P - 300 - 0)$. The FOC for this problem is $800 - 2P = 0$ or $P = 400$, implying that the cattle-raiser pays the farmer 400 for the right to have 2 steers (i.e., the cattle-raiser’s net payoff is $500 - 400 = 100$ and the farmer’s payoff is $400 - 300 = 100$).

(iii) Suppose now that the farmer’s right is protected by double damages (i.e., the cattle-raiser would have to pay double the amount of actual damage to the farmer’s crops). How many steers would the cattle-raiser have in this case?

**Answer:** Same as in (i). The potential for double damages affects neither the threat values nor the surplus due to negotiations.

(iv) Suppose now that cattle-raiser could build a fence around his ranch that would completely protect the farmer’s field. The cost of the fence is $950. What would be the outcome in this situation? (Indicate who is going to pay whom and how much. Derive the “how much” number explicitly using Nash bargaining model.)

**Answer:** Now the cattle-raiser’s threat point is $1000 - 950 = 50$. The farmer’s threat point is still 0. The socially efficient outcome is still for the cattle-raiser to have 2 steers and build no fence. The surplus from negotiations is now $200 - 50 = 150$. Therefore, Nash bargaining solution would be to maximize $((500 - P - 50) \times (P - 300 - 0))$ with respect to $P$. The solution is found from FOC: $750 - 2P = 0$ or $P = 375$, implying that the cattle-raiser pays the farmer 375 for the right to have 2 steers (i.e., the cattle-raiser’s payoff is 125 and the farmer’s payoff is $375 - 300 = 75$, i.e., the surplus is split 50/50).

D.3. (20 points) Baby carriages are produced at time $t = 1$ by a competitive industry. Each baby carriage requires permission (license) from the holder of a design patent and a holder of a patent for the suspension mechanism. (Both the design and the suspension were invented at time $t = 0$.) The (constant) marginal cost of baby carriages not counting the license fees is $MC = 200$. The demand curve for the baby carriages is $D = 2000 - P$, where $P$ is the price of each baby carriage.

(i) (4 points) What is the socially efficient license fee for the patents at time $t = 1$?

**Answer:** The socially efficient fee is 0, because the inventions have been made already.

(ii) (8 points) If both patents needed for baby carriages belong to the same party, what fee $F$ would the patent holder charge for the license (per baby carriage) and how many baby carriages will be produced? (Assume that patent holder’s costs of granting a license is zero.)
Answer: The competitive price of baby carriages is going to be \( MC + F = 200 + F \). Therefore, the patent holder’s problem is \( \max_F (2000 - 200 - F) \times F \). FOC for this problem is \( 1800 - 2F = 0 \), implying that \( F = 900 \). The number of baby carriages produced would be \( 2000 - 200 - 900 = 900 \).

(iii) (8 points) If the design patent and the suspension patent are owned by different independent parties, what would each of them charge for their respective licenses (per baby carriage) and how many baby carriages would be produced? (Assume that each patent holder’s costs of granting a license is zero.)

Answer: The total license fee is now \( F_1 + F_2 \). Each patent holder solves essentially the same problem. For example, patent holder 1 solves \( \max_{F_1} (2000 - 200 - F_1 - F_2) \times F_1 \). FOC is \( 1800 - 2F_1 - F_2 = 0 \). Because patent holders solve the same problem, \( F_1 = F_2 \). Therefore, FOC is \( 1800 - 3F = 0 \), implying that \( F = 600 \), and the combined license fee is 1200. Therefore, the number of carriages produced would be \( 2000 - 200 - 1200 = 600 \).

D.4. (10 points) Any firm that invests 100 can develop a particular kind of a safety device for cars within a reasonable period of time. The expected present value of profit from the patent on this device is 500. Firms can invest extra resources worth \( e \) to speed up the development and thus increase the probability of getting the patent. In particular, firm \( i \) that invests \( e_i \) has the probability
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p = \frac{e_i}{\sum e_j} \quad \text{to become patent holder (here } n \text{ is the number of competing firms). Assume that all firms that could potentially compete for the patent are identical and risk-neutral.}
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(i) What extra investment would firms undertake to develop the device?

Answer: Each firm’s problem is \( \max_{e_i} \{500e_i / (\sum e_j) - 100 - e_i \} \). The FOC for this problem is \( \frac{500e(n-1)}{(ne)^2} - 1 = 0 \). Since firms are identical, this reduces to \( \frac{500e(n-1)}{(ne)^2} - 1 = 0 \), and thus \( e = 500(n-1)/n \).

(ii) How many firms would participate in this patent race?

Answer: The number of firms could be found from \( 100 + 500(n-1)/n \leq 500 \), implying that \( 100n - 500 \leq 0 \), i.e., \( n \leq 5 \).

Potentially helpful notes:

Given that the second order conditions for maximization hold (you can assume this for this exam), the values of \( x \) that maximize \( f(x) \) can be found by solving the equation \( \frac{\partial f(x)}{\partial x} = 0 \) for \( x \).

The relevant derivatives are: \( \frac{\partial \alpha x}{\partial x} = \alpha; \frac{\partial x^b}{\partial x} = bx^{b-1}; \frac{\partial y}{\partial x} = \frac{\partial y}{\partial x} \frac{\partial z}{\partial x} \), where \( \alpha \) and \( b \) are constants.