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**Department of Economics**

**Examination paper for SØK3524 Environmental and Resource Economics**

**Examination date: 07.06.2024**

**Examination time (from-to): 09:00 – 14:00**

**Permitted examination support material: C**

Mathematical manuals:

Knut Sydsæter, Arne Strøm og Peter Berck (2006) Matematisk formelsamling for økonomer, 4utg. Gyldendal akademiske.

Knut Sydsæter, Arne Strøm, og Peter Berck(2005): Economists' mathematical manual, Berlin.

Approved calculator:

- Casio FX-82CW, Casio FC100 V2, Casio fx-82ES PLUS og Casio fx-82EX
- Citizen SR-270X og Citizen SR-270X College
- Hewlett Packard HP30S

**Academic contact during examination: Irmelin Slettemoen Helgesen**  
**Phone: 92250647**

**Academic contact present at the exam location: NO**

### **OTHER INFORMATION**

**Get an overview of the question set** before you start answering the questions.

**Read the questions carefully** and make your own assumptions. If a question is unclear/vague, make your own assumptions and specify them in your answer. The academic person is only contacted in case of errors or insufficiencies in the question set. Address an invigilator if you suspect errors or insufficiencies. Write down the question in advance.

**Hand drawings:** The questions can be answered directly in Inspera and/or on handwritten sheets or tablet.

At the bottom of the question you will find a seven-digit code. Fill in this code in the top left corner of the sheets you wish to submit. We recommend that you do this during the exam. If you require access to the codes after the examination time ends, click "Show submission".

**Weighting:** The questions are weighted. This is to let you know how much each question count towards your final grade, the weights should also give you an indication on what is expected, and how to manage your time during the exam.

**Notifications:** If there is a need to send a message to the candidates during the exam (e.g. if there is an error in the question set), this will be done by sending a notification in Inspera. A dialogue box

will appear. You can re-read the notification by clicking the bell icon in the top right-hand corner of the screen.

**Withdrawing from the exam:** If you become ill or wish to submit a blank test/withdraw from the exam for another reason, go to the menu in the top right-hand corner and click “Submit blank”. This cannot be undone, even if the test is still open.

**Access to your answers:** After the exam, you can find your answers in the archive in Inspira. Be aware that it may take a working day until any hand-written material is available in the archive.

## 1 Question 1 (45%)

Fill in your answer here

Format | **B** | *I* | U |  $x_2$  |  $x^2$  |  $I_x$  | | | | | | | | |

| | | |  $\Omega$  | | |  $\Sigma$  | |










Words: 0










Maximum marks: 45

## 2 Question 2 (15%)

- a) What is Hotelling's rule? Explain briefly.  
b) What is the Hartwick rule? Explain briefly.

Fill in your answer here

Format | **B** | *I* | U |  $x_2$  |  $x^2$  |  $I_x$  |  |  |  |  |  |  |  |  |  |

 |  |  |  |  |  |  |  |  |

Words: 0

Maximum marks: 15

### 3 Question 3 (40%)

Fill in your answer here

Format | **B** | *I* | U |  $x_2$  |  $x^2$  |  $I_x$  | | | | | | | | |

| | | | | | | | |

Words: 0

Maximum marks: 40

**Question 1**  
Attached



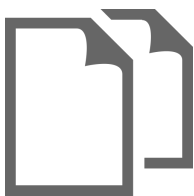
### Question 1 (45%)

The biomass of a stand of trees grows according to  $V(t)$ . The price of timber  $p(t)$  also vary over time.

- a) What may the growth function  $V(t)$  look like? Suggest an explicit formulation and explain your choice. Illustrate the function graphically and describe the graph.
- b) Find the optimal cutting time when the land has no opportunity value. Interpret the optimality condition.
- c) Find the second order condition of the problem and show how the discount rent influences the optimal cutting time.
- d) Formulate and solve the optimal cutting problem when the land has a fixed opportunity value  $W$  after cutting.
- e) Discuss the statement “paying Norwegian forest owners for carbon storage (where carbon storage at time  $t$  is equal to forest biomass growth at time  $t$ ) will reduce global net carbon emissions and maintain old growth forest”.

### Question 3

Attached



### Question 3 (40%)

$N$  identical countries consider entering into a binding agreement on reduction of CO2 emissions. Let  $q_i$  denote country  $i$ 's abatement (reduction in emissions), and let  $Q$  denote aggregate abatement,  $Q = \sum_{i=1}^N q_i$ . Country  $i$ 's payoff is given by  $\pi_i = bQ - \frac{cq_i^2}{2}$ , where  $b$  and  $c$  are positive constants.

Assume that  $n \in (1, N)$  countries sign the international agreement on abatement, entailing an individual reduction of  $q_i^c$  for each of the cooperating countries (superscript  $c$  for cooperation). The remaining  $(N - n)$  countries choose their individual emission reduction levels  $q_i^{nc}$  independently (superscript  $nc$  for non-cooperation).

- a) Give a brief interpretation of the payoff function.
- b) Formulate the decision problem of the two types of countries and solve for the optimal abatement for both types of countries. Calculate the payoff for the two country types.
- c) Briefly discuss the conditions for *internal* and *external* stability of the game in b).