# NTNU
Det skapende universitet

Institutt for samfunnsøkonomi

# Eksamensoppgave i SØK3524 – Miljø- og ressursøkonomi

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**Question 1**

A landowner controls a wildlife stock which grows according to $dX_t / dt = F(X_t) - q_t$.
Suppose that the value per unit animal hunted is $p$ and that the hunting cost depends only on
the harvest, $C_t = C(q_t)$, such that $C'(q_t) > 0$, $C''(q_t) > 0$ and $C(0) = 0$. The landowner profit
per unit of time is thus $\pi_t = pq_t - C(q_t)$.

a) Formulate the optimal management strategy of the landowner. Find the optimality
conditions. Substitute away the shadow price, and find the differential equations of the system
in the variables $q_t$ and $X_t$. Find next the isoclines and analyze the dynamics using phase
plane diagram. (hint: The marginal profit must be positive all the time; $\pi'_t = p - C'(q_t) > 0$)

b) Characterize the steady-state, and show how the price $p$ and the discount rent $\delta$ influence
the optimal steady-state stock and hunting.

c) Assume that natural growth is governed by $F(X_t) = rX_t(1 - X_t / K)$. Interpret the
parameters of this function, and find how these parameters influence the above optimal
steady-state.

d) The wildlife causes a negative externality due to crop and grazing damages for the farmers
living in the area. Assume that the damage function may be written as $D_t = D(X_t)$ with
$D'(X_t) > 0$, $D''(X_t) \geq 0$ and $D(0) = 0$. Formulate the social planner problem, and characterize
the steady state. Compare with the landowner optimization problem.

**Question 2**

a) Explain your understanding of a tradable emission permit system ('cap and trade').

b) Explain and discuss the Environmental Kuznets Curve (EKC) concept.

c) What is your understanding of the so-called IPAT identity? Discuss briefly the prospects of
'decoupling' economic growth and environmental degradation.

**Question 3**

a) Consider a hydropower project. $I$ is the investment cost and $D_t > 0$ is the operating profit
(electricity sale minus operating costs), assumed to be fixed through time, $D_t = D$. With $\delta$ as
the discount rate and when investment takes place instantaneously, the present-value of the
project is defined by $PV = -I + \int_0^T De^{-\delta t} dt$ when. Calculate $PV$.

Next, calculate $PV$ when the operating time of the project is infinite such that $T = \infty$. Will
the company carry out the project?

The construction causes a negative externality ('destroying pristine land') .These costs are also assumed to be fixed through time, $P_t = P$. Find the present-value social net benefit, and discuss the solution of this problem compared to the above problem of the firm.

b) Consider an even aged stand of trees planted at a piece of land at $t = 0$. The biomass at time $t \geq 0$ is given as $V_t$. How may the time profile of $V_t$ look like?

The planting cost is $c_0$ and the net sale price (net of logging costs) of the biomass is given by $p_t$. Characterize and interprete the optimal logging time when the land has no opportunity value after logging. What is the effect of the discount rate?

Assume now instead that the land after logging has an opportunity value $Q_t$ at every point of time. Characterize the optimal logging time when this opportunity value is included. Compare with what you found without this value.