NTNU – Trondheim
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Department of Economics

Examination paper for SØK3524 / SØK8624

Environmental and Resource Economics

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Permitted examination support material:	C / Formelsamling: 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. Calculator: Casio fx-82ES PLUS, Citizen SR-270x, SR-270X College or HP 30S.

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Question 1

a) Discuss briefly some main elements that should be included in an age-structured (demographic) fishery model. Discuss also briefly what an age-structured model tries to answer compared to a biomass model.

b) Consider now a biomass model where a fish stock grows according to $dX(t)/dt = F(X(t)) - h(t)$. The current utility of the fish stock is described by the function $U(h(t))$ with $U' > 0$ and $U'' < 0$. The fish stock is assumed to be optimally managed, and where the social planner maximizes the present-value utility with the discount rent $\delta > 0$. Formulate and solve the planning problem. Find next the isoclines and analyze the dynamics using phase plane diagram.

c) Find and characterize the steady state. Show that a higher discount rent will reduce the steady state stock, and explain why.

d) Assume now that a positive stock value $Q(X(t))$ ('intrinsic value') is included so that the current benefit reads $U(h(t)) + Q(X(t))$. Find the steady state of the planning problem also in this case, and compare to the above solution in c). Assume the logarithmic utility function $U(h(t)) = a \ln h(t)$ with $a > 0$, and the linear stock value function $Q(X(t)) = qX(t)$ with $q > 0$. Demonstrate how the fixed marginal stock value q affects the steady state fish stock and harvest.

Question 2

a) Consider a flow pollution problem with several emitting firms. Assume that this pollution problem is managed through a quota market for emission permits (cap- and trade system). Discuss the main elements of such a system. Formulate a simple abatement model, and demonstrate factors that may influence the quota price.

b) Consider an economy where the welfare depends on the consumption of a single commodity $q(t)$ and a jointly generated residual whose accumulated mass is denoted by $A(t)$. The residual is assumed to accumulate according to:

(1) $dA(t)/dt = \beta q(t) - G(A(t))$

where $G(A(t))$ is the natural decay function. The current welfare is defined by:

(2) $W(t) = B(q(t)) - D(A(t))$.

i) Discuss and interpret Eqs. (1) and (2).
ii) Assume now zero accumulation growth such that Eq. (2) reads $\beta q(t) - G(A(t)) = 0$.

Formulate, solve and interpret the welfare maximization problem under this equilibrium condition.

Question 3

a) The growth of a stand of trees is given by $V(t)$. Find the time when the stand reaches its maximum average value. Find also the optimal economic logging time when the planting cost is c and the net timber price (net of cutting costs) is fixed and equal to p. Compare and illustrate these two cases with a figure. Show also how the discount rent influences the economic optimal logging time.

b) Assume now instead that the timber price changes over time $p(t)$, with $dp(t)/dt = p' > 0$. Characterize the optimal economic logging time in this case, and compare with the above fixed price situation.

c) Now use the functional forms $V(t) = 0.1t^2 - 0.005t^3$ and $p(t) = p(0)e^{\beta t}$ with $\beta > 0$, and find the optimal economic logging time. How does β influence the optimal logging time?

d) The land-value after logging in not included in the above problem. Use again the general growth function $V(t)$, and characterize the optimal logging time when the land has a fixed value $H > 0$ per unit of time after logging.