2580031

THE UNIVERSITY of York

Degree Examination 2004

ENVIRONMENT DEPARTMENT

MSc in Environmental Economics
MSc in Environmental Economics and Environmental Management

RESOURCE ECONOMICS

Time allowed: **two hours**

Answer **TWO** questions out of **FOUR**
Each question is worth 50 marks.
Answer all parts of each question selected, and show how you arrived at your answers.

University calculators will be provided

Pay adequate attention to mathematical notation, spelling, punctuation and grammar, so that your answers can be readily understood.

1 Consider the following system of equations describing the dynamics of an open access fishery

$$\begin{cases} \dot{s} = rs\left(1 - \frac{s}{k}\right) - aes \\ \dot{e} = v(pas - w)e \end{cases}$$

where

- $v > 0$ is the *reaction coefficient* of the industry to profits,
- $p > 0$ is the *price* per unit of fish,
- $w > 0$ is the *wage* to a unit of effort,
- $a > 0$ is the *technological efficiency* of the harvest function,
- $0 < r < 1$ is the *instantaneous growth rate* of the fish biomass,
- $e > 0$ is an index of effort,
- $s > 0$ is the *stock* of fish, and
- k represents the *carrying capacity.*

Answer the following questions.

(a) Draw the phase diagram of the system.

(10 marks)

(b) Consider a fall in fish price. Show the resulting new equilibrium.

(10 marks)

(d) Show the possible dynamics paths from the old to the new equilibrium.

(10 marks)

(e) Interpret economically (and biologically) the *possible* paths toward equilibrium.

(20 marks)

2 Consider the following dynamic optimization problem

$$\begin{aligned} \max & \int_0^{\infty} U\left(h(t)\right) e^{-\delta t}\, dt \\ \text{s.t.} \quad & \dot{x} = F(x) - h(t) \\ & x(0) \quad \text{given} \end{aligned}$$

where $h(\cdot)$ denotes the rate of harvest (control), $F(\cdot)$ defines the natural growth rate of the resource, and $U(\cdot)$ its a (social) utility function. Assume $U' > 0$ and $U'' < 0$.

(a) Find the first order necessary conditions.

(10 marks)

(b) Interpret the first order necessary conditions in economic terms.

(15 marks)

(c) Draw the phase diagram of the resulting system.

(15 marks)

(d) Draw and interpret the optimal path to the equilibrium.

(10 marks)

3 Consider a fishery with a population dynamics given by the equation:

$$X_{t+1} - X_t = F(X_t) - Y_t$$

where we use conventional notation as in Conrad (1999).

Suppose in periods $t \geq T+1$ we required sustainability in the harvest of the renewable resource, in terms of harvest to be set equal to net growth henceforth.

a) Use conventional notation to derive a formula for the present value of such a sustainable fishing regime.

(10 marks)

b) Suppose a resource manager were told to maximize the present value of net benefits over the *finite* horizon, $t = 0, 1, 2, 3, \ldots T$. Suppose, also that:
the final function is :

$$\rho^T \bar{\pi}(X_{T+1} F(X_{T+1}))\delta^{-1}$$

the net benefit function is:

$$\pi(Y_t) = aY_t - (b/2)Y_t^2$$

the net growth function is:

$$F(X) = rX(1 - X/K)$$

where all the notation is conventional.

Solve for X^*, that is, the optimal stock, and interpret this equality.

(10 marks)

c) Solve for Y^*, that is, the optimal harvest, and interpret this equality.

(15 marks)

d) Solve for λ^*, that is, the optimal Lagrange multiplier, and interpret this equality.

(15 marks)

4 Set-up a simple model of non-renewable resource extraction.

a) Derive Hoteling's Rule and briefly discuss its implications.

(10 marks)

b) Consider the linear demand function $p_t = a\text{-}bq_t$ and the constant elasticity demand function $p_t = a - q_t^{-b}$. For the moment ignore reserve-dependent costs. How would you derive the extraction and time path in a *competitive industry*?

(10 marks)

c) Ignoring reserve-dependent costs, how would you derive the extraction and time path in a *monopoly*? Discuss and compare this result with the previous one.

(15 marks)

d) Expand on the above by introducing reserve-dependent costs.

(15 marks)

End of paper