AFRICAN ECONOMIC RESEARCH CONSORTIUM

Collaborative MA Programme in Economics for Anglophone Africa (Except Nigeria)

JOINT FACILITY FOR ELECTIVES (JFE)

JULY – OCTOBER 2006

ENVIRONMENTAL ECONOMICS I

First Semester: Final Examination

Duration: 3 Hours **Date: Thursday, August 17, 2006**

INSTRUCTIONS:

1. There are **FOUR** questions in this exam. Attempt **ANY THREE** questions of your choice.
2. All questions carry equal marks **(20 marks each).**
3. Precision and legibility of writing results in favourable outcomes.
4. The exam carries 60% of the total results.

Question 1: Answer Question 1 A and Question 1 B.

***Question 1 A*:** The simplest model of optimal resource depletion is where welfare (W) is defined as a discounted integral of utility $\int_{t=0}^{t=\infty} U(\cdot)e^{-\delta t}dt$; utility is a function of consumption, $U(C(t))$ which is strictly concave; and consumption is equal to the amount of the (non-renewable) resource extracted $R(t)$. The resource stock ($S(t)$) at the initial period is fixed and given as a constant which is always non-negative.

(a) Identify the state and instrument variables in the question. (**2 points**)

(b) Formulate the dynamic optimisation problem for this situation. **(1 point**)

(c) Obtain the present and current value Hamiltonian, and the necessary first-order conditions associated with each version for a welfare maximum; interpret their first order conditions and relate them. (**6 points**)

(d) What happens to consumption along the optimal path? (*a proof is not necessary, but logical arguments are recommended*) (**3 points**)

(e) What is the effect of an increase in the discount rate? (**3 points**)

***Question 1 B*:** Discuss the arguments for and against the exclusion (or deduction) of defensive or preventive environmental expenditure from GDP. Identify other components of GDP which, it could be argued, should be excluded for identical or similar reasons. **(5 points**)

Question 2: answer Question 2 A and Question 2 B.

Question 2 A: Suppose you have been given the responsibility of managing a goldmine with initial stock of 20 units. The owner of the mine intends to shut it at period T = 2, the market price of gold is fixed at p = 1 for all periods, the discount rate is zero, and the cost of extraction is given by:

$$C_t = \frac{y_t^2}{x_t}; \forall t = 0,1,2$$

Where x_t = stock and y_t = amount extracted at period *t*, respectively.

a) Set up the intertemporal optimisation problem that you face. (**2 points**)

b) Formulate the Lagrangean and obtain the first order conditions. (**3 points**)

c) Write the Hamiltonian and obtain the 'maximum principle'. (**3 points**)

d) Obtain the solution for the problem. (**2 points**).

***Question 2 B*:** What is the difference, if any, between the consumption discount rate and utility discount rate (pure time preference) and derive their relationship. Are there any conditions that equate the two? (**10 points)**

Question 3: Answer Question 3 A and Question 3 B.

***Question 3 A*:** The physical carrying capacity of a lake is reported to be 1750 thousand tons. Moreover, assuming a logistic population growth function, the maximum sustainable yield is 350 thousand tons per month. Yield, $Y(t)$, is proportional to effort, $E(t)$, and given as:

$$Y(t) = bE(t)Y(t)$$

a) Obtain the parameters for the specified growth function, i.e,

$$F(X(t)) = rX(t)(1 - X(t)/K)$$ (**4 points**)

b) Assume that b = 0.01, using the parameters obtained in a) above determine the effort associated with the maximum sustainable yield and the extinction of the fish population (**6 points**).

***Question 3 B*:** While 'the absence of enforceable private property rights does not *necessarily* imply that renewable resources will fail to be harvested in a rational or conservationist manner … [i]t is possible that any resource stock could be harvested to exhaustion, or a species driven to extinction, under open access.' Perman et. al., 2003. Discuss. (**10 points**)

Question 4: Answer Question 4 A and Question 4 B.

***Question 4 A*:** At the start of 1998 oil reserves in country X were 504 units. During 1998 country X produced 8 units, and there were no new discoveries of oil there. The world price of oil was constant at 3.125 units of currency per unit of output throughout 1998, and the interest rate in X was also constant, at 5%. Total oil production costs in X, including a normal return on capital employed were 20 units of currency per unit of output.

(**Note: $(1/1.05)^{62}$ = 0.048558298; $(1/1.05)^{63}$ = 0.046246; $(1/1.05)^{64}$ = 0.044043808; and $(1/1.1)^{63}$ = 0.00246752**)

a) Calculate the depreciation of country X's oil stock using the net present value method (**3 points**)

b) Repeat a using an interest rate of 10% (**2 points**)

c) Repeat the calculation for a 5% interest rate, but with the world price of oil being 3.00 at the start of the year and 5.00 at the end of the year. (**5 points**)

***Question 4 B*:** Suppose that a specific renewable resource is being used as factor in the production of other goods. Let the production technology be given by

$Q\left(K\left(t\right),R\left(t\right)\right)$

Where Q = output

$K(t)$ = manmade capital used in production

$R(t)$= renewable resource used in production,

The marginal products of both inputs increase at a decreasing rate.

Harvesting of the renewable resource is costly and given by the function

$G\left(R\left(t\right),X\left(t\right)\right)$ where $G_R > 0$ and $G_X < 0$, and

Where $R(t)$ = amount of the resource harvested

$X(t)$ = the renewable natural resource stock

Assume that utility depends on $C(t)$ only; namely the harvested renewable natural resource is not an argument in the utility function.

Show that if the resource is harvested in a sustainable manner; that is, $R\left(t\right)=F\left(X\left(t\right)\right)$, where $F\left(X\left(t\right)\right)$ is the intrinsic growth rate of the renewable resource, then there is no need for adjusting the conventional national income figures to obtain environmentally adjusted national income. (**10 points**)