AFRICAN ECONOMIC RESEARCH CONSORTIUM

Collaborative PhD Programme in Economics for Sub-Saharan Africa

COMPREHENSIVE EXAMINATIONS IN CORE AND ELECTIVE FIELDS
FEBRUARY 11 – MARCH 3, 2014

ENVIRONMENTAL ECONOMICS

Time: 08:00 – 11:00 GMT   **Date: Friday, February 21, 2014**

INSTRUCTIONS:

Answer a total of FOUR questions: ONE question from Section A, ONE question from Section B, and TWO questions from Section C. The sections are weighted as indicated on the paper.

SECTION A (15%)

Answer only ONE Question from this Section

Question 1

Welfare economics theory gives us a set of conditions such that a system of free markets would sustain an efficient allocation of resources.

  (a) State these set of these conditions.   **[5 marks]**

  (b) State and *explain*   the type of market failure that can arise from any four of the conditions stated in (a) and give an example for each case.   **[10 marks]**

Question 2

Suppose that a mining company operating on the banks of a river in Kisumu County has the right to dump untreated waste into the river. Let the marginal benefit (*MB*) to the community of each tonne of the mineral produced be given by:

$$MB = 25 - 0.5q$$

where q is the tonnes of the mineral produced. Furthermore, let the private marginal cost (MC_p) of producing the mineral (in $ per tonne) be given by:

$$MC = 10 + 0.5q$$

Assume that each tonne of mineral produced dumps effluent into the river that causes damage valued at $10.

(a) Find the profit-maximizing output of the mineral if the company ignores the *MEC*.
[5 marks]

(b) Find the level of mineral output that would be socially efficient.   **[5 marks]**

(c) Explain why the socially efficient output of the mineral is lower than the private profit-maximizing level of output.   **[5 marks]**

SECTION B (25%)
Answer only ONE Question from this Section

Question 3

(a) Assume a uniformly mixed pollutant and let z_i represent the uncontrolled level of emission for an individual firm, $i,$ and let x_i be the firm's level of abatement. Assume there are n firms. The Environmental Protection Agency (EPA) wishes to hold total emissions at the efficient level.

   (i) Derive (mathematically) the least cost condition for abatement and explain it.
[5 marks]

   (ii) Assuming the EPA knows the damage and abatement cost functions, explain how it can use a marketable emissions permit system to achieve the required level of abatement.   **[5 marks]**

   (iii) If the number of permits is set at the level you established in (ii) above, derive (mathematically) the condition required for the efficient level of abatement to be achieved.   **[5 marks]**

(b) Discuss the distributional implications of initially allocating permits by competitive auction compared to when permits are initially issued freely.   **[5 marks]**

(c) A politician was once quoted to the effect that "We don't want pollution. We want to *eliminate* it." Do you agree or disagree and why?   **[5 marks]**

Question 4

Assume that an individual has a well-behaved utility function $U = U(x_1, x_2)$, where x_1 is an environmental good and x_2 is a market good. Assume that due to some environmental improvement, the price of x_1 decreases from p'_1 to p''_1. Let good x_2 be the numeraire. Thus, $p'_2 = 1$.

(a) Define the following alternative measures of welfare using appropriate graphical aides: consumer's surplus (S), compensating variation (CV), equivalent variation (EV), compensating surplus (CS), and equivalent surplus (ES).   **[12 marks]**

(b) Is consumer's surplus a suitable measure of welfare change? Explain your answer.

[4 marks]

(c) Under what conditions could CV and EV be the same?   **[3 marks]**

(d) What are the rights implied by CV compared to EV?   **[2 marks]**

(e) Define CV and EV in terms of willingness-to-pay (WTP) or willingness to accept (WTA) for a price fall.   **[4 marks]**

SECTION C (60%)

Answer TWO Questions from this Section

Question 5

One major result that emerges from theories on optimal extraction of both renewable and non-renewable resources is how price of the extracted resource, extraction costs, and the discount rate affect the incentive to conserve or deplete the resource. Consider each of the following problems:

   i.   A fishery exploitation problem with harvest *(q)* and stock *(x)* dependent cost function $C = C(q_t, x_t)$

   ii.   mineral extraction problem with extraction costs dependent on the rate of extraction, q_t, and the stock of remaining reserves, x_t, i.e., $C = C(q_t, x_t)$.

Assume the discount rate is r.

   (a) For each problem derive the condition required for optimal harvesting/extraction in continuous time.   **[10 marks]**

   (b) For each of your results discuss the effect of changes in price, marginal harvesting (or extraction costs), as well as the discount rate on the incentive to conserve or deplete the resource.   **[10 marks]**

   (c) Private property optimal resource harvesting programmes cannot lead to extinction of renewable resources. Discuss.   **[10 marks]**

Question 6

The transactions table in millions of dollars for an economy is given by:

	Agriculture	Manufacturing	Final Demand Household demand	Exports
Agriculture	120	210	400	100
Manufacturing	210	520	500	300
Primary inputs	500	800		

It is given that the agriculture industry purchased 50 petajoules (PJ) of energy S and the manufacturing sector 30 PJ.

(a) If the use of 1 PJ of energy releases 73,200 tonnes of CO_2, determine the CO_2 emissions intensity for each industry. Use that information to calculate total CO_2 emissions and allocate them to deliveries of final demand by the agriculture and manufacturing industries. **[12 marks]**

(b) Suppose that due to a particular government policy, household expenditure increases by 20% across the board. Calculate the resulting change in CO_2 emissions in each industry. **[4 marks]**

(c) State and explain the assumptions of the Input-Output (IO) model. **[7 marks]**

(d) Discuss the similarities and differences between IO models and Computable General Equilibrium (CGE) models. **[7 marks]**

Question 7

In December 2007 the United Nations Climate Change Conference (UNCCC) took place on the island of Bali in Indonesia. The conference encompassed a number of bodies, including the 13th Conference of the Parties to the United Nations Framework Convention on Climate Change (COP 13) and the 3rd Meeting of the Parties to the Kyoto Protocol. The conference adopted the *Bali Road Map*, which charted a path to finalise a binding global agreement to replace the Kyoto Protocol at the COP 15 meeting in Copenhagen in 2009. Since then COP meetings have been held in Cancun, Durban, Doha and Warsaw, but all have failed to reach an agreement.

(a) During the Kyoto Protocol negotiations, the policy options were narrowed down to a choice between emissions charges and emissions trading. Eventually, the emissions trading scheme (ETS) was selected over the former.

Suppose a firm's objective is to maximize profit after taking into account abatement costs, emissions charges or the price of a permit.

charge; a = abatement level; e_{i0} = initial allocation of permits; e = emissions level; and w = price of a permit.

(i) State the firm's decision problem for both the emissions charge and the ETS.
[2 marks]

(ii) In each case derive the first order conditions from the Lagrangean. **[4 marks]**

(iii) Interpret the first order conditions in each case and explain why the optimality conditions are similar for the two policy instruments. **[4 marks]**

(iv) Does the ETS have any advantages over emissions charges? What do you consider to be the limitations of the ETS? **[5 marks]**

(b) Discuss appropriate criteria that could be used to evaluate any post-Kyoto climate change policy instrument. **[6 marks]**

(c) One of the outcomes of the COP 15 meeting in Copenhagen was the *Copenhagen Accord*, which, among other things, agreed that the "developed countries shall provide adequate, predictable and sustainable financial resources, technology and capacity building to support the implementation of adaptation action in developing countries".

To determine the appropriate level of financial resources that the developing countries would require, it would be necessary for them to know their costs of adapting to climate change. To do this, developing country governments would need to decide how much to adapt.

(i) Explain what is meant by adaptation cost from the viewpoint of the Intergovernmental Panel on Climate Change (IPCC). **[2 marks]**

(ii) What is the cost of adaptation if: (1) a country wants to adapt fully to climate change, and (2) if the country wants to choose an optimal level of adaptation instead. **[3 marks]**

(iii) Describe the process by which the adaptation cost of the country could be estimated. **[4 Marks]**

Question 8

Suppose that the Government in your country is considering a proposal in which a forest that is currently used for logging would become a national park. Ecologists have determined that the area has significant benefits that include biodiversity and recreational values. A survey is to be

undertaken to estimate these values using the Contingent Valuation Method (CVM) or a Choice Experiment (CE).

(a) Let U_i be the individual's utility function where subscript $i=0$ represents the status quo (using the forest for logging) and $i=1$ represents the policy change (i.e. conservation of the forest). Explain the conditions under which an individual would accept an offered bid under the CVM. State any assumptions required. **[4 marks]**

(b) Describe how a double-bounded dichotomous choice CVM survey could be used to value the community's preference for the policy change. Include in your response how the data would be collected and analyzed to obtain the community's preservation value for this forest. **[8 marks]**

(c) Describe how the CE approach would be used to obtain the preservation value of the forest. Use appropriate examples. **[8 marks]**

(d) What limitations, if any, are shared by both the CVM and CE? Does the CE offer any advantages over CVM? Explain your answer. **[10 marks]**