Resource Economics
Final Exam – Fall 2020

1. Discuss these statements. (8 points, each question 4 points)

i) Comprehensively discuss the following statement: "The price of a fossil-fuel resource has to increase at the rate of interest". If you think there are limitations, please list and discuss them.

ii) Discuss the following statement about renewable resource use:
"The dynamic system characterizing the use of a renewable resource always converges to a unique steady state independent of initial conditions".

2. Fishery Economics - Part I (18 points, each question 3 points)
The constant price per unit of harvest of a fishery is p and the total cost of harvest, y, given stock x, is $c(x, y) = x^{\beta} y^{\alpha}$, so the profit flow is

$$\pi = py - x^{\beta} y^{\alpha}.$$

In the absence of harvest, the fish stock evolves according to

$$\dot{x} = \gamma x \left(1 - \frac{x}{K}\right).$$

The sole owner has the constant discount rate $r > 0$ and an infinite time horizon.

i) Interpret the parameters α and β and state reasonable restrictions for these parameters.

ii) What is the biological interpretation of the parameters γ and K?

iii) Write down the current value Hamiltonian. What is the interpretation of the shadow value?

iv) Spell out the necessary first order conditions of the sole owner's optimization problem.

v) Derive the Euler equation.

vi) Take a step back, think about the Euler equation in general terms, and give an interpretation of the Euler equation you derived.

3. Fishery Economics - Part II (18 points, each question 3 points)
Continuation of Problem 2 on Fishery Economics. From now on, assume that $\gamma = K = p = 1$ and that $\alpha = 2$ and $\beta = -1$.

i) In the Euler equation for this special case, substitute the harvest amount y by the harvest rate $z = \frac{y}{x}$.
"Hint": You can always double-check your result starting with the FOCs.

ii) Draw a phase diagram, part I. Draw the $\dot{x} = 0$-line into a phase diagram and mark with arrows how the stock evolves in the different areas of the diagram. Mark clearly what you put onto the axes and mark all the characteristic points that you can numerically identify.

iii) Draw a phase diagram, part II. Draw the $\dot{y} = \dot{z} = 0$-line into the phase diagram and mark with arrows how the control evolves in the different quadrants of the diagram.

iv) Interpret the arrows in your diagram, what information do they convey? Draw the separatrix into the diagram. Assume the current biomass is at half of the carrying capacity. Explain qualitatively how the optimal harvest trajectory evolves over time.

v) What happens in the model if we swap the sole owner fishery for an open access setting?
Note: Look at the problem from the aggregate perspective, do not worry about modeling individual fishermen.

vi) Now let's add a given demand function $D(y)$ to the model. You have to re-introduce one of the original parameters to consistently model this scenario (which one?). State the conditions for biomass extinction and/or a long-run open access equilibrium with finite biomass.