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- (ii) Derive an index for measuring the weak sustainability of any open economy by considering the following two-country trade flows and the production input-output model :

Country	1	2	Consumption	Saving	Total Output
1	0	$X_{12}$	$C_1$	$S_1$	$Y_1$
2	$X_{21}$	0	$C_2$	$S_2$	$Y_2$
Capital	$r_1 K_1$	$r_2 K_2$			
Resource	$p_1 R_1$	$p_2 R_2$			
Labour	$w_1 L_1$	$w_2 L_2$			
Total Input	$Y_1$	$Y_2$			

Where,

$X_{ij}$  - Value of exports from country  $i$  to country  $j$ ;  $C_i$  - Value of consumption by country  $i$ ;

$S_i$  - Value of savings/investment by country  $i$ ;  $Y_i$  - Gross value of income/product by country  $i$

$K_i$  - Quantity of capital used in country  $i$ ;  $R_i$ -Gross rate of return on capital in country  $i$ ;

$R_i$ -Quantity of natural resource used in country  $i$ ;  $p_i$ -Price of natural resource in country  $i$ ;

$L_i$ -Quantity of labour used in country  $i$ ;  $w_i$ -Wage rate of labour in country  $i$

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Ex/PG/ECO 309/2024

MASTER OF ARTS EXAMINATION, 2024

(2nd Year, 1st Semester)

ECONOMICS

PAPER : PG/ECO/309

[ Resource and Environmental Economics-I (Local Issues) ]

Time : 2 Hours

Full Marks : 30

1. Answer any two questions.

5×2=10

- (a) (i) Consider the following “skewed” logistic function

$$F(x) = rx \left( 1 - \frac{x}{k} \right)^\alpha \quad (0 < \alpha < 1)$$

(with known explanations for  $x$ ,  $r$ , and  $k$ )

Find the MSY solution and sustained yield curve.

- (ii) What do you mean by the bionomic equilibrium of the common property? 3+2=5

- (b) Is the tradable emission permit system better than the emission charge system? Give reasons for your answer.

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- (c) Specify the optimal rotation problem that maximizes the net present value of forestry in a single stand one rotation problem. 5

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2. Answer any two questions.

10×2=20

- (a) (i) Derive the optimal conditions for the extraction of exhaustible resources by a competitive firm. Assume that there is no extraction cost.
- (ii) Suppose that the cost of mining depends only on the rate of extraction and cost function is  $C(q) = a + bq^2$ , where  $q$  is the quantity of extracted mine, the unit price ( $p$ ) is exogenous and known in advance to the mine owner, and the initial reserve is  $R$ . Then the mine owner would want to

$$\text{Maximize } \int_0^T [p(t)q(t) - C(q(t))]e^{-\delta t} dt$$

subject to  $\dot{R}(t) = -q(t)$   $R(0)$  given  $R(t) \geq 0$

Find the condition required for a unique solution of  $T > 0$  (complete exhaustion time). Also show graphically the possible value of  $T$ . 5+5

- (b) (i) Consider optimal growth in an economy in which  $\int_0^\infty U(C)e^{-\rho t} dt$  is being maximized subject to  $\dot{K} = F(K, L, R) - C - f(R, S) - g(D, S)$  and  $\dot{S} = R + D$ , where  $C$  is aggregate consumption,  $U(\cdot)$  is the aggregate utility function,  $\rho$  is the social discount rate,  $K$  is the stock of produced capital,  $L$  is the current labour force ( $L(t) = L_0 e^{nt}$ , where  $n$  is the rate of growth of the labour force),  $R$  is the

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current flow from stock  $S$  of an exhaustible resource,  $F(K, L, R)$  is the aggregate production function for 'manufactured' output,  $f(\cdot)$  is the current cost of exhaustible resource extraction, defined in terms of the composite produced good, and  $g(D, S)$  is current costs of exploration also defined in terms of the composite produced good, and  $g(D, S)$  is current costs of exploration also defined in units of the composite produced good.  $f_R$  is the marginal cost of producing  $R$  from the stock  $S$ , and  $g$  is the marginal cost of discovering new stock  $D$  given  $S$ .

Solve this dynamic optimisation problem and show that the ratio of the current value Hamiltonian and marginal utility of composite goods is equal to NNP. 5

- (ii) Again consider following optimization problem

$\int_0^\infty U(C)e^{-\rho t} dt$ . Now assume that the new production function is  $F(K, L, X)$ , net pollution increment is  $\dot{X} = -bX + \gamma F(K, L, X)$ , where  $X$  is the volume of pollution (a stock concept),  $b$  is pollution evaporation rate by natural environmental stock regeneration,  $\gamma$  is a parameter linking produced output to increments in pollution. Find the economic depreciation of environmental capital. 5

- (c) (i) How can we measure the weak sustainability of any closed country? 2