2025

ECONOMICS — HONOURS

Paper : DSCC-11

(Mathematical Economics - II)

Full Marks : 75

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Group - A

1. Answer ***any ten*** questions : 2×10

(a) What is a zero-sum game? Give one simple example.

(b) What is a mixed strategy? Why do players use it?

(c) Define Nash equilibrium in one sentence.

(d) What is backward induction? Name one game where it is used.

(e) Evaluate : $\int \left(3x^2+4\right)dx$.

(f) If $MR(X)=20-2x$, find the total revenue function $TR(x)$.

(g) Solve the first-order difference equation : $X_{t+1}=0.5\ x_t$.; $x_0=2$.

(h) What is a fixed point of a dynamic system?

(i) Solve : $\dfrac{dy}{dx}=4y$.

(j) Name one macroeconomic model that uses differential equations and write down the equation.

(k) What do you mean by 'dynamics' in economic analysis?

(l) What is the present value of a perpetual cash flow of ₹ 2,460 per year discounted at $r=8\%$?

(m) State whether the following differential equation is a first-order differential equation :

$$\left(\frac{dy}{dt}\right)^3+u(t)y=w(t).$$

(n) If the net investment rate $I(t)$ is given by $I(t)=6t^2+4t$, find the increase in capital stock (K) over the period from $t=0$ to $t=3$.

(o) Given the general solution $y(t)=A_1e^{r_1t}+A_2e^{r_2t}$. If $r_1=3$ and $r_2=-3$, will the system return to equilibrium as $t\to\infty$?

Group - B

Answer ***any five*** questions.

2. Find the Nash equilibrium of the Prisoners 'Dilemma Game : 5

		Player 2	
Player 1	Strategy	*NC*	*C*
	NC	(–1, –1)	(–10, 0)
	C	(0, –10)	(–5, –5)

3. Compute the integral using substitution : $\int x\sqrt{x^2+1}\,dx.$ 5

4. Draw a qualitative phase diagram of a one-variable system with a stable fixed point. Explain stability in your own words. 5

5. Set the Cobweb model and state the stability condition. Explain the model with the help of a diagram. 5

6. Let the demand and supply functions be :

$$Q_d = \alpha - \beta P - \gamma \frac{dP}{dt}$$

$$Q_s = \delta P \qquad (\alpha, \beta, \gamma, \delta > 0)$$

(a) Assuming that the market is cleared instantly, find the time path of price, $P(t)$.

(b) Does the market have a dynamically stable intertemporal equilibrium? 4+1

7. Consider a linear Phillips relation

$$\omega = \alpha - \beta U,$$

where ω is the rate of growth of money wage and U is the rate of unemployment. The rate of inflation (p) is defined as :

$$p = \omega - T,$$

where T is the rate of growth of labour productivity. Now consider the following expectations-augmented Phillips relation.

$$\omega = f(U) + g\pi \quad (0 < g \leq 1),$$

where π is the expected rate of inflation. Assuming perfect foresight i.e. $\pi = p$.

(a) Derive the differential equation in the variable p.

(b) What change in parameter restriction is necessary to make the differential equation meaningful? 4+1

8. Consider a closed economy with consumption (C) function, investment (I) function and national income (Y) identity are as shown below :

$$C_t = \gamma Y_{t-1} \qquad (0 < \gamma < 1)$$
$$I_t = \alpha\left(C_t - C_{t-1}\right) \qquad (\alpha > 0)$$
$$Y_t = C_t + I_t + G_0 \qquad \left(G_0 > 0\right)$$

(a) Make a second-order linear difference equation of Y from the above model.

(b) When will you get a convergent time path of Y? 3+2

9. Find the solution of the following difference equation :

$$y_{t+2} + y_{t+1} - 2y_t = 12$$

with $y_0 = 4$ and $y_1 = 5$. 5

Group - C

Answer ***any three*** questions.

10. (a) Explain the concept of iterated elimination of dominated strategies using the given fictional payoff matrix. Show all steps clearly and identify the final outcome.

Strategies	Player B					
		B_1	B_2	B_3	B_4	B_5
Player A	A_1	2	4	3	8	5
	A_2	4	5	2	6	7
	A_3	7	6	8	7	6
	A_4	3	1	7	4	2

(b) What is Fair game? Is the following game affair one? 6+4

	Player B	
	B_1	B_2
Player A A_1	0	2
A_2	2	5

Please Turn Over

11. Solve the system : $\frac{dx}{dt} = 2x + y,\ \frac{dy}{dt} = -x + 4y.$

(a) Find eigenvalues and eigenvectors.

(b) Classify the fixed point at the origin.

(c) Provide a qualitative sketch of the phase diagram. 4+3+3

12. Consider the following dynamic price adjustment model in a single market :

$$\frac{dp}{dt} = \alpha\left(D(p) - S(p)\right),$$

where demand and supply functions are given by

$$D(p) = a - bp, \quad S(p) = c + dp,$$

with $a,\ b,\ c,\ d,\ \alpha > 0.$

(a) Derive the differential equation in $p(t)$.

(b) Solve the equation to find $p(t)$.

(c) Find the equilibrium price p^*.

(d) Using the solution, determine the condition under which the equilibrium is **stable**.

(e) Provide a qualitative phase diagram showing stable or unstable adjustment. 2+2+2+2+2

13. Consider the following IS-LM model :

$C = a + bY - IR$	(consumption demand)
$I = \bar{I}$	(investment demand)
$G = \bar{G}$	(government demand)
$L = kY - hR$	(money demand)
$M = \bar{M}$	(money supply)

Assume money market clears instantly (i.e. money supply is always equal to money demand) but goods market adjusts gradually at speed 'α' in response to the gap between the aggregate demand and aggregate supply.

(a) Derive the differential equation for Y.

(b) Solve for $Y(t)$.

(c) Determine the condition on the parameters that must be satisfied for the equilibrium to be stable. 4+4+2

14. (a) Two firms share the market for a product. Firm 1's output is x; firm 2's output is y. The two reaction function of the firms are

$$x_{t+1} + \beta y_t = b \quad \beta \neq 1$$

$$y_{t+1} + \alpha x_t = b \quad \alpha \neq 1.$$

Derive and solve the second-order difference equation for x implied by the model.

(b) The demand function, supply function and the price adjustment process are shown by the following equations respectively,

$$Q_{dt} = 21 - 2P_t$$

$$Q_{st} = -3 + 6P_t$$

$$P_{t+1} = P_t - 0.3\,(Q_{st} - Q_{dt}).$$

Find the time path P_t and determine whether it is convergent. 5+(3+2)

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