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**Sr. No. of Question Paper : 3123**

Unique Paper Code : 2272201102

Name of the Paper : Basic Mathematics for  
Economic Analysis

Name of the Course : **B.A. (Prog.) ECONOMICS  
(Major) DSC-2**

Scheme/Mode of Examinations: I

Duration : 3 Hours

Maximum Marks : 90

**Instructions for Candidates**

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. All questions are compulsory.
3. The alternative questions for PWD students as specified separately within the question paper have to be attempted only by PWD students and not by other students.
4. Answers may be written either in English or Hindi; but the same medium should be used throughout the paper.

P.T.O.



### छात्रों के लिए निर्देश

1. इस प्रश्न-पत्र के मिलते ही ऊपर दिए अनुक्रमांक लिखिए।
2. सभी प्रश्न अनिवार्य हैं।
3. पीडब्ल्यूडी छात्रों के लिए वैकल्पिक प्रश्न, जैसा कि प्रश्न पत्र में अलग से निर्दिष्ट किया गया है, केवल पीडब्ल्यूडी छात्रों द्वारा किया जाना चाहिए, अन्य छात्रों द्वारा नहीं।
4. इस प्रश्न-पत्र का उत्तर अंग्रेजी या हिंदी किसी एक भाषा में दीजिए, लेकिन सभी उत्तरों का माध्यम एक ही होना चाहिए।

1. Attempt any **three** parts. Each part carries equal marks. (6×3=18)

(a) State whether the following statements are true or false.

(i)  $xy = 0 \Rightarrow x = 0 \text{ or } y = 0$

(ii)  $(x - 1)(x + 2)^2 = 0 \Rightarrow x = 1$

(iii) All relations are functions.

(iv)  $|x - a| \leq 1 \Rightarrow a - 1 \leq x \leq a + 1$

(v) A sequence is convergent if its  $n$ th term tends to 0 in the limit.



(b) Let A be the set of all even numbers of positive integers, C be the set of integers, D be the set of rational numbers, E be the set of all real numbers. Answer the following questions :

(i) Write the complement of set A in set notation form if R is the Universal set.

Is  $\sqrt{-1}$  a member of set A or its complement?

(ii) Find  $A \cup B$  and  $A \cap B$ .

(iii) Find  $B \cap C$ .

(iv) Find complement of D.

(c) Find asymptotes to the graphs of the following functions :

(i)  $f(x) = \sqrt{\frac{2+3x}{x-1}}$

(ii)  $g(x) = \frac{(px-q)^2}{(p-x)(q-x)(r-x)}$

(d) Define domain and range of a function. Find the domain and range of the following functions:



$$(i) f(x) = |x - 1| (x -$$

$$(ii) f(x) = 1 + \sqrt{2x-1}$$

किन्हीं तीन खंडों के उत्तर दीजिए। प्रत्येक खंड के समान अंक हैं।

(अ) बताएं कि निम्नलिखित कथन सत्य हैं या गलत हैं।

$$(i) xy = 0 \Rightarrow x = 0 \text{ or } y = 0$$

$$(ii) (x - 1)(x + 2)^2 = 0 \Rightarrow x = 1$$

(iii) सभी संबंध कार्य हैं।

$$(iv) |x - a| \leq 1 \Rightarrow a - 1 \leq x \leq a + 1$$

(v) एक अनुक्रम अभिसारी होता है यदि इसका  $n$  वां पद सीमान्त में 0 हो जाता है।

(ब) मान लीजिए A सभी सम संख्याओं का समुच्चय है, B धनात्मक पूर्णाकों का समुच्चय है, C ऋणात्मक पूर्णाकों का समुच्चय है, D परिमेय संख्याओं का समुच्चय है और R सभी वास्तविक संख्याओं का समुच्चय है। निम्नलिखित प्रश्नों का उत्तर दें:

(i) समुच्चय A का पूरक समुच्चय संकेतन रूप में लिखिए

यदि R सार्वत्रिक समुच्चय है। क्या  $\sqrt{-1}$  समुच्चय A



का सदस्य है या इसका पूरक

(ii)  $A \cup B$  और  $A \cap B$  ज्ञात

(iii)  $B \cap C$  ज्ञात कीजिए।

(iv)  $D$  का पूरक ज्ञात कीजिए।

(स) निम्नलिखित फलनों के आलेखों के लिए अनंतस्पर्शी खोजें :

$$(i) f(x) = \sqrt{\frac{2+3x}{x-1}}$$

$$(ii) g(x) = \frac{(px-q)^2}{(p-x)(q-x)(r-x)}$$

(द) एक फलन की प्रक्षेत्र और विस्तार परिभाषित करें। निम्नलिखित फलनों के आलेखों के लिए अनंतस्पर्शी खोजें :

$$(i) f(x) = |x - 1| (x - 1)^2$$

$$(ii) f(x) = 1 + \sqrt{2x-1}$$

2. Attempt any **five** parts. Each parts carries equal marks. (5×7=35)



(a) Solve the following inequa

$$(i) \frac{p-1}{p+1} \geq 2$$

$$(ii) \frac{1}{p} < 0 < \frac{p+1}{p}$$

$$(iii) |2p-3| \geq 1$$

(b) Find  $\frac{dy}{dx}$  and  $\frac{d^2y}{dx^2}$  for the following function:

$$y = x^n (a + b\sqrt{x})$$

(c) Using product rule of differentiation, what relationship is established between average and marginal functions? Explain your answer if the general average revenue function is  $AR = f(Q)$ . Also if  $AR = -2Q^2 + 15Q + 7$  in its suitable domain, find MR function using the average-marginal relationship.

(d) A firm earns ₹100 lakhs in the current year. After that, its earnings increase by 10% every year for the next nine years.



(i) What will be the total ea  
after 10 years?

(ii) What will be the earnings of the firm in  
the tenth year? If the discount rate remains  
8% throughout the period, what will be the  
present value of the earnings of the tenth  
year?

(e) Evaluate the following limits :

(i)  $\lim_{x \rightarrow a^+} \left( \frac{1}{x} - \frac{1}{x^2} \right)$

(ii)  $\lim_{x \rightarrow 3^+} \frac{x-9}{\sqrt{x}-3}$

(iii)  $\lim_{x \rightarrow 2^+} \frac{x + |x-2|}{x-1}$

(f) Determine if the following converges or diverges:

(i) The sequence  $\left\{ \frac{n^3 - 1}{n^2 - 2} \right\}$

(ii) The sequence  $\left\{ (-1)^{n-1} \frac{1}{2^n} \right\}$



- (iii) The series  $(1 + r)^{-1}$   
 $+ \dots \dots \dots$ ,  
 constant.

किन्ही पाँच खंडों का उत्तर दीजिए। प्रत्येक खंड के समान अंक हैं।

(अ)  $p$  के लिए निम्नलिखित असमानताओं को हल करें :

(i)  $\frac{p-1}{p+1} \geq 2$

(ii)  $\frac{1}{p} < 0 < \frac{p+1}{p}$

(iii)  $|2p - 3| \geq 1$

(ब) निम्नलिखित फलन के लिए  $\frac{dy}{dx}$  और  $\frac{d^2y}{dx^2}$  प्राप्त करें :

$$y = x^n (a + b\sqrt{x})$$

(स) अवकलन के उत्पाद नियम का उपयोग करते हुए औसत और सीमांत फलनों के बीच क्या संबंध स्थापित किया जाता है? यदि सामान्य औसत आगम फलन  $AR = f(Q)$  हो तो अपने उत्तर



(i) क्रम  $\left\{ \frac{n^3 - 1}{n^2 - 2} \right\}$

(ii) क्रम  $\left\{ (-1)^{n-1} \cdot \frac{1}{2^n} \right\}$

(iii) श्रृंखला  $(1+r)^{-1} + (1+r)^{-2} + (1+r)^{-3} + \dots$   
 $\dots \dots \dots$ , जहाँ  $r$  एक सकारात्मक स्थिरांक है।

3. Attempt any **one** part.

(13×1=13)

(a) Considering the following partial market equilibrium model –

$$Q_d = Q_s$$

$$Q_d = 14 - 3P - P^2$$

$$Q_s = -2 + 3P$$

Identify the endogenous variables in the above model and solve for their equilibrium values using all the three methods mentioned below. Also check if the solutions from various methods match each other or not.

(i) Algebraic method using Quadratic formula.



(ii) Graphical method by single quadratic function is derived condition.

(iii) Graphical method by drawing the graphs of quadratic demand function and linear supply function in one graph.

$$(4+5+4=13)$$

### ALTERNATIVE QUESTION FOR PWD STUDENTS:

(a) (i) Find rational roots of the following equations, if any :

$$(a) \quad x^3 + \frac{3}{4}x^2 - \frac{3}{8}x - \frac{1}{8} = 0$$

$$(b) \quad 8x^3 + 6x^2 - 3x - 1 = 0$$

(ii) Find a cubic equation with roots 3, 2 and 2.

(iii) Find a quartic equation with roots 4, 2, -1 and 3.

(b) Consider the function defined as

$$f(x) = \frac{|x|}{x}$$

(i) Draw the graph of  $f(x)$ .



(ii) Does  $\lim_{x \rightarrow 0} f(x)$  exist?

(iii) Is  $f(x)$  continuous at  $x = 0$ ?

say about differentiability of  $f(x)$  at  $x = 0$ ?

### ALTERNATIVE QUESTION FOR PWD STUDENTS:

Consider the function defined as

$$f(x) = \frac{x^2 + x - 42}{x - 7}$$

(i) Find  $\lim_{x \rightarrow 7} f(x)$ .

(ii) Show that the function is discontinuous at  $x = 7$ .

(iii) What type of discontinuity is it? Explain.

(iv) Can we redefine the function to make it continuous everywhere?

किन्ही एक खंड का उत्तर दीजिए।

(क) निम्नलिखित आंशिक बाजार संतुलन मॉडल को ध्यान में रखते हुए -

$$Q_d = Q_s$$

$$Q_d = 14 - 3P - P^2$$

$$Q_s = -2 + 3P$$



4. Attempt any **four** parts. Each marks.

- (a) Let the demand and supply functions of commodity 1 and commodity 2 in an economy that has only two commodities are given by

$$Q_{d1} = 3 - 2P_1 + 3P_2$$

$$Q_{s1} = 1 + 5P_1$$

$$Q_{d2} = 20 + P_1 - 6P_2$$

$$Q_{s2} = 5 + 3P_2$$

In equilibrium, quantity demanded of each commodity is equal to the supply of that commodity, i.e.,  $Q_{di} = Q_{si}$  for  $i = 1, 2$ .

Write down the equilibrium conditions for the two commodities and solve for  $P_1$ ,  $P_2$ ,  $Q_1$  and  $Q_2$  using Cramer's rule.

- (b) Find  $X$  such that matrix  $X$  satisfies the equation:

(i)  $AX = 2X + B$

$$A = \begin{bmatrix} 2 & 2 & 2 \\ 2 & 3 & 2 \\ 3 & 2 & 2 \end{bmatrix}, B = \begin{bmatrix} 3 & 2 & 1 \\ 1 & 0 & 0 \\ 1 & 0 & 1 \end{bmatrix}$$



- (ii) For what values of  $c$  equals the matrix  $E$  identity matrix

$$B = \begin{bmatrix} -2 & 3 \\ 2 & 0 \end{bmatrix} ?$$

- (c) For any three arbitrary matrices  $A$ ,  $B$  and  $C$  answer the following questions:

(i) Is  $AB = BA$ ? Why or why not?

(ii) Does  $AB = AC$  necessarily imply that  $B = C$ ? Explain your answer with the help of an example (Consider matrices of order  $2 \times 2$ ).

- (d) When is a set of vectors said to be a basis for the two-dimensional space,  $\mathbb{R}^2$ ? Show that the vectors

$u = \begin{pmatrix} 2 \\ 3 \end{pmatrix}$  and  $v = \begin{pmatrix} 1 \\ 4 \end{pmatrix}$  form a basis for  $\mathbb{R}^2$ . Can we

conclude the same about the vectors  $u = \begin{pmatrix} 2 \\ 3 \end{pmatrix}$  and

$v = \begin{pmatrix} 1 \\ 4 \end{pmatrix}$  and  $w = \begin{pmatrix} 1 \\ -1 \end{pmatrix}$ ? Explain.



(e) Consider a  $n \times n$  matrix  $A$  defined by

$$A = P(P^T P)^{-1} P^T$$

Answer the following questions :

- (i) Must  $P$  be a square matrix? Must  $P^T P$  be a square matrix?
- (ii) Show that matrix  $A$  is idempotent.
- (iii) How would your answer in part (ii) change for the matrix  $B = I - A$ ?

किन्हीं चार खंडों का उत्तर दीजिए। प्रत्येक खंड के समान अंक हैं।

(अ) मान लीजिए कि वस्तु 1 और वस्तु 2 की मांग और आपूर्ति फलन एक ऐसी अर्थव्यवस्था में है जिसमें केवल दो वस्तुएँ हैं

$$Q_{d1} = 3 - 2P_1 + 3P_2$$

$$Q_{s1} = 1 + 5P_1$$

$$Q_{d2} = 20 + P_1 - 6P_2$$

$$Q_{s2} = 5 + 3P_2$$

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