

# NCERT Discrete

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## Question GATE 23 ME 50:

The initial value problem  $\frac{dy}{dt} + 2y = 0, y(0) = 1$  is solved numerically using the forward Euler's method with a constant and positive time step of  $\delta$ .

Let  $y_n$  represent the numerical solution obtained after  $n$  steps. The condition  $|y_{n+1}| \leq |y_n|$  is satisfied if and only if  $\delta$  does not exceed

### Solution:

By forward Euler's method formula

$$y(n+1) = y(n) + \delta f(x, y) \quad (1)$$

From question we get

$$\frac{dy}{dx} = -2y = f(x, y) \quad (2)$$

From (2) in (1)

$$y(n+1) = y(n) + \delta(-2y(n)) \quad (3)$$

$$y(n+1) = y(n)(1 - 2\delta) \quad (4)$$

$$|y(n+1)| = |y(n)||1 - 2\delta| \leq |y(n)| \quad (5)$$

$$|1 - 2\delta| \leq 1 \quad (6)$$

$$\implies 0 \leq \delta \leq 1 \quad (7)$$

From this we can say that the maximum value of  $\delta$  is 1