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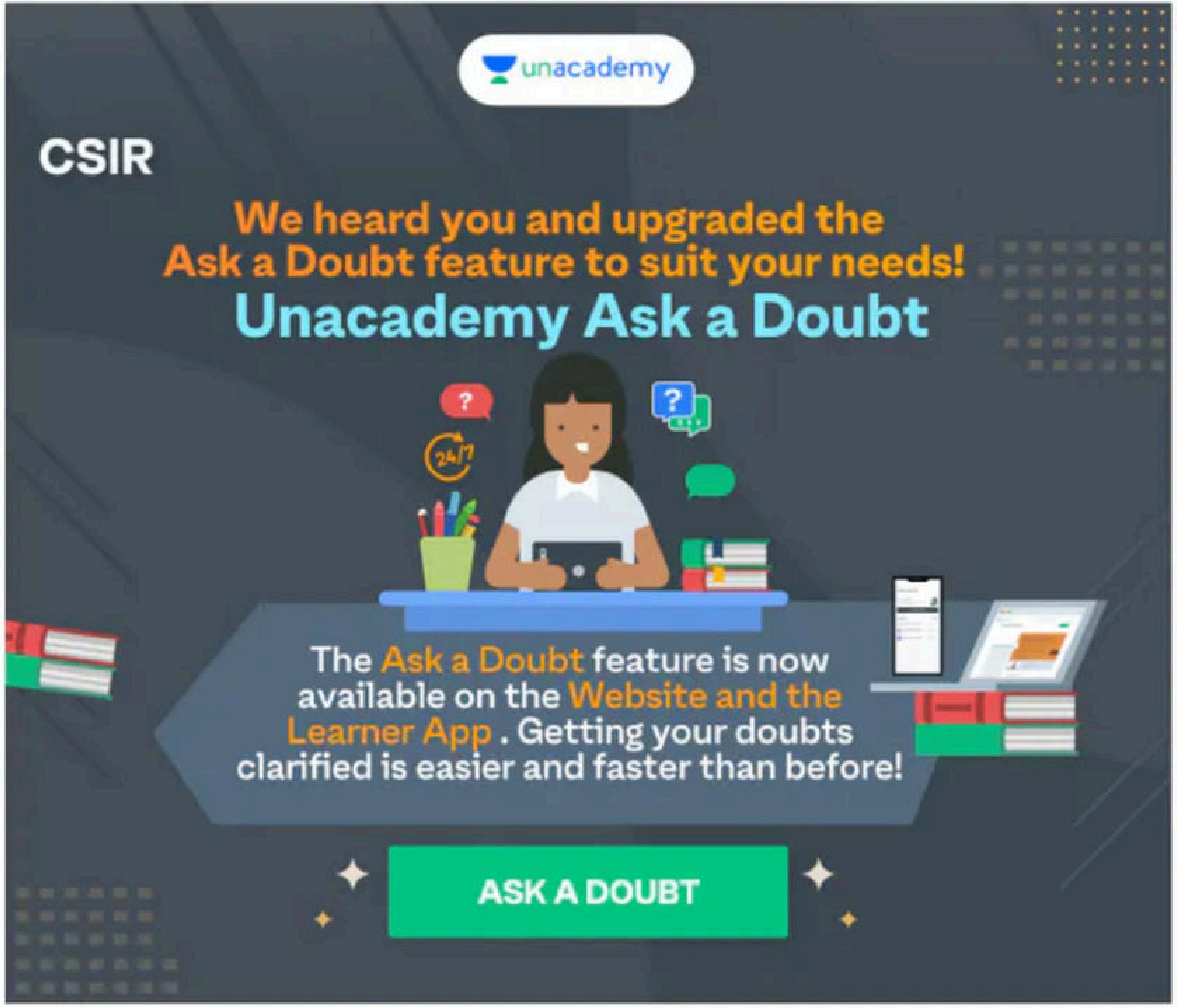
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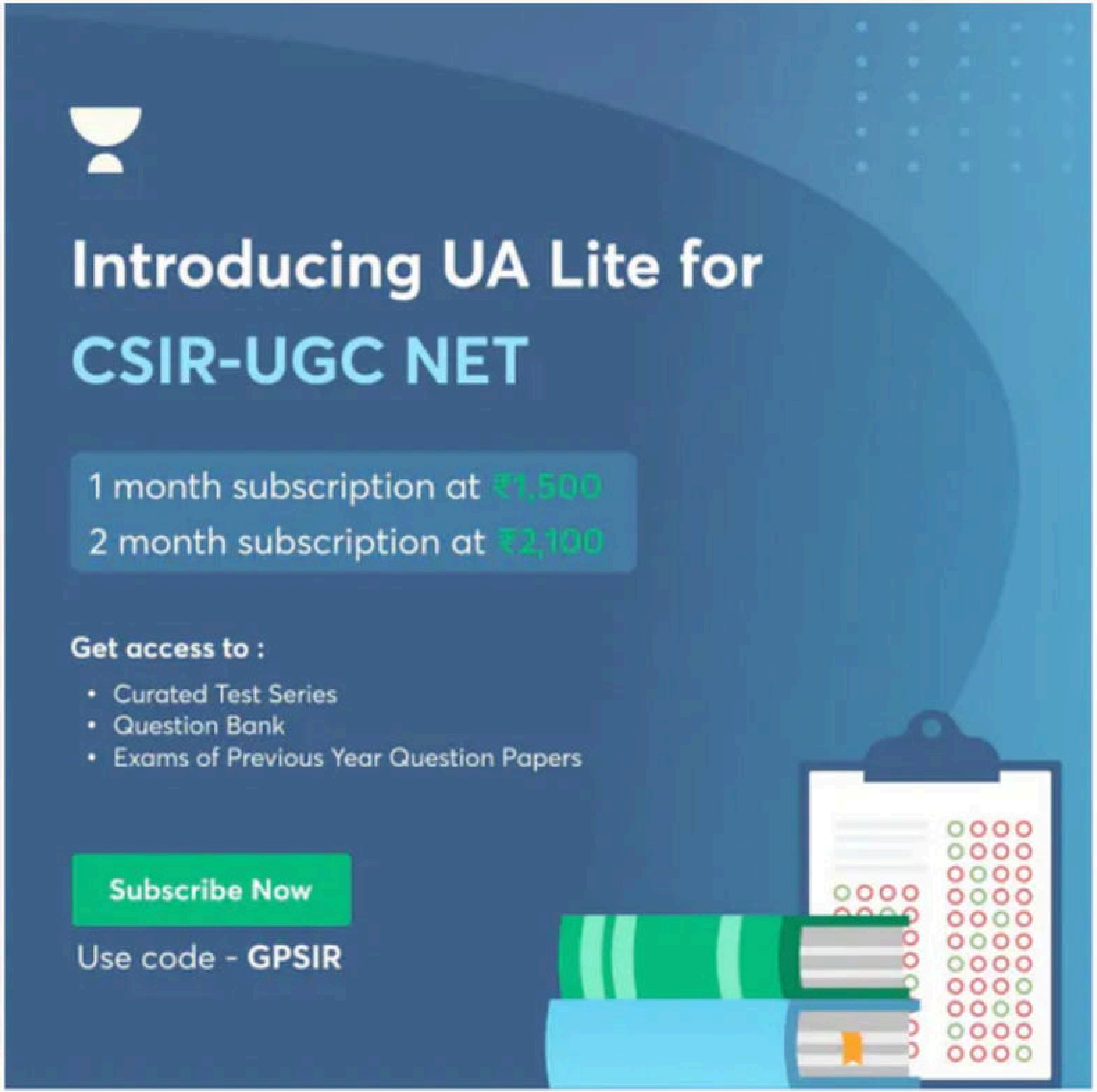
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Linear differential equation with constant coefficients

A linear differential equation with constant coefficients is that in which dependent variables and its differentials occur only in first degree, and not multiplied together, and coefficients are all constants

$$\frac{d^n y}{dx^n} + a_1 \frac{d^{n-1} y}{dx^{n-1}} + a_2 \frac{d^{n-2} y}{dx^{n-2}} + \ldots\ldots + a_{n-1} \frac{dy}{dx} + a_n y = X \quad ..(1)$$

Where X is a function of x only and $a_1, a_2, \ldots., a_n$ are constants is called linear differential equation with constant coefficients of n^{th} order.

We can write (1) as

$$D^n y + a_1 D^{n-1} y + a_2 D^{n-2} y + \ldots.. + a_n y = X$$

$$[D_n + a_n D^{n-1} + a_2 D^{n-2} + \ldots.. + a_n]\, y = X$$

$f(D)y = X$ .... (2)

Where $f(D) = D^n + a_1D^{n-1} + a_2D^{n-2} + \ldots.. + a_n$.

Now consider the differential equation $f(D)y = 0$.... (3)

The general solution of n^{th} order differential equation involved arbitrary constants. So, the general solution of (3) is of the form

$y = c_1y_1 + c_2y_2 + \ldots\ldots + c_ny_n$ .. (4)

Which is also called complementary function (CF) of (2).

Let V be the particular solution of (2) (due to X called PI)

Hence, $f(D)y = X$, has the complete solution as

$y = CF + PI$.

CF involves n arbitrary constants and PI does not involve any constant.

1 Complementary Function

For the sake of convenience, we consider a second order linear equation

$$\frac{d^2y}{dx^2}+a_1\frac{dy}{dx}+a_2y=0 \qquad \text{.....} (1)$$

Then auxiliary equation is $m^2 + a_1m + a_2 = 0$ .....(2)

Case I : The roots of (2) are real and distinct :

Let m_1, m_2 be the two real and distinct roots of (2).

Then e^{m_1x}, e^{m_2x} are the solutions of (1)

Hence, the complementary function of (1) is

$$y = c_1e^{m_1x} + c_2e^{m_2x} \qquad \text{....} (3)$$

Case II : The roots of (2) are real and equal :

Let roots $m_1 = m_2 = m$

then $y = (c_1 + c_2x)e^{mx}$

is a complementary function.

Case – III : The roots of (ii) are complex

Let $a + ib$ and $a - ib$ are the roots of (2)

Then the general solution of (1)

$$y = e^{ax}[A\cos bx + B\sin bx]$$

Q.1. Let y(x) be a solution of the differential equation $\frac{d^2y}{dx^2}-5\frac{dy}{dx}+4y=0$.s.t. $\lim_{x\to\infty} e^{-x}y(x)$ is finitely exist. Then y(log 2) is

(a) Constant

(b) in term of x

(c) in term of e^x

(d) None of these

Q.2. If y(x) is the solution of the initial value problem $\frac{d^2y}{dx^2}+2\frac{dy}{dx}+y=0, y(0)=1, \frac{dy}{dx}(0)=-2$, then y(ln 2) is

(a) ln2 (b) $(1-\ln 2)\frac{1}{2}$

(c) integer number (d) 0

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Q.3. If $y(x) = \lambda e^{2x} + e^{\beta x}$, $\beta \neq 2$, is a solution of the differential equation $\frac{d^2y}{dx^2} + \frac{dy}{dx} - 6y = 0$ satisfying $\frac{dy}{dx}(0) = 5$, then $y(0)$ is equal to

(a) 3　　(b) 4

(c) 5　　(d) 6

Q.4. The differential equation whose linearly independent solutions are cos 2x, sin 2x and e^x, is

(a) $(D^3 + D^2 + 4D)y = 0$ (b) $(D^3 - D^2 + 4D - 4)y = 0$

(c) $(D^3 + D^2 - 4D - 4)y = 0$ (d) $(D^3 - D^2 - 4D + 4)y = 0$

Q.5. The number of arbitrary constants in the complete primitive of differential equation $\frac{d^5y}{dx^5} + 2\frac{d^4y}{dx^4} = 0$ is/are not

(a) 5 (b) 4

(c) 1 (d) 6

Q.6 Let $P : R \to R$ be a continuous function such that $P(x) > 0$ for all $x \in R$. Let y be a twice differentiable function on R satisfying $y``(x) + P(x)y`(x) - y(x) = 0$ for all $x \in R$. Suppose that there exist two real numbers a, b $(a < b)$ such that $y(a) = y(b) = 0$. Then

(a) $y(x) > 0$ for all $x \in (a, b)$

(b) $y(x) < 0$ for all $x \in (a, b)$

(c) $y(x)$ changes sign on (a, b)

(d) $y(x) = 0$ for all $x \in [a, b]$

Q.7. The homogeneous part of the differential equation

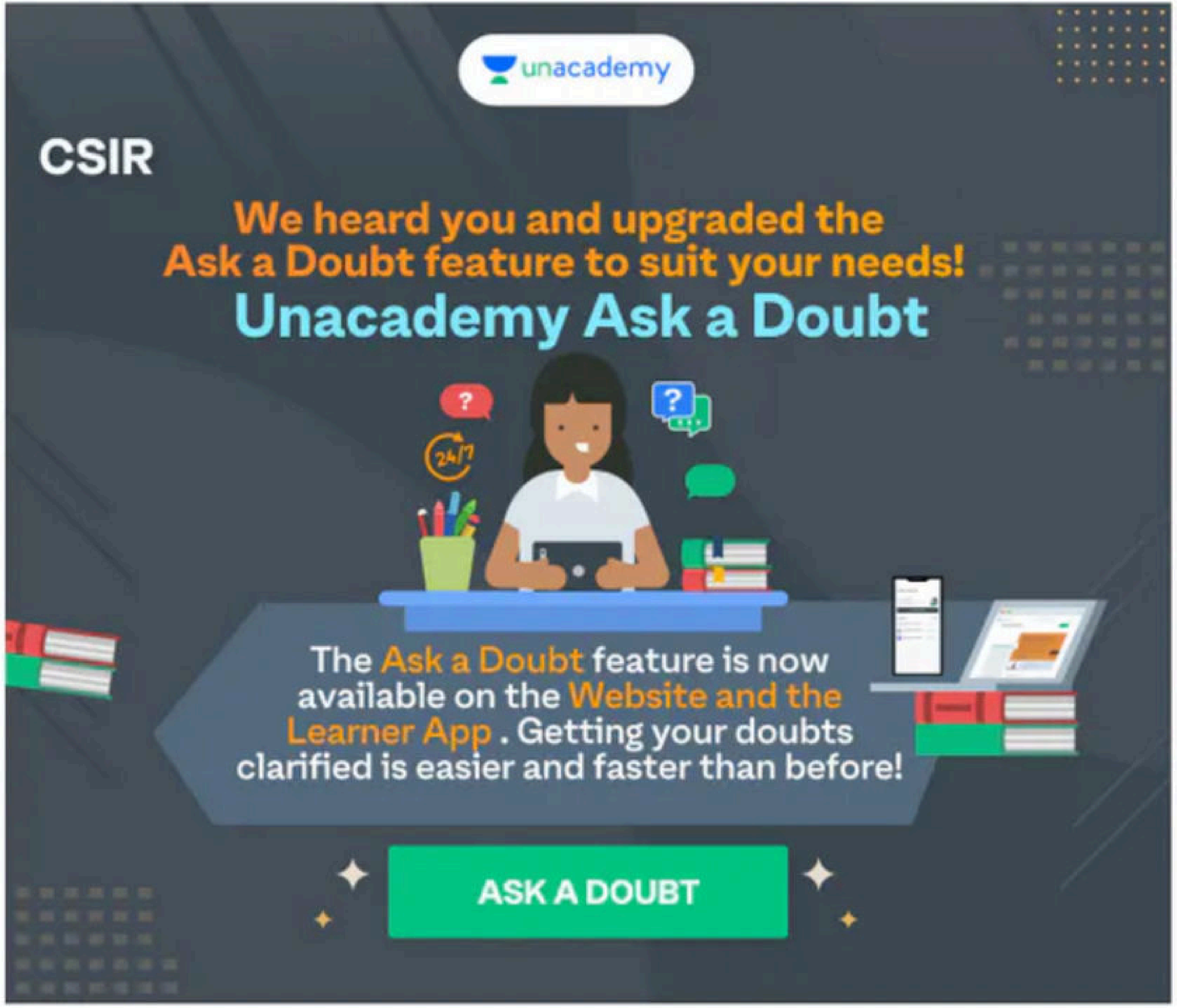
$\frac{d^2y}{dx^2}+p\frac{dy}{dx}+qy=r$ has real distinct real roots if

(a) $p^2-4q>0$

(b) $p^2-4q<0$

(c) $p^2-4q=0$

(d) $p^2-4q=r$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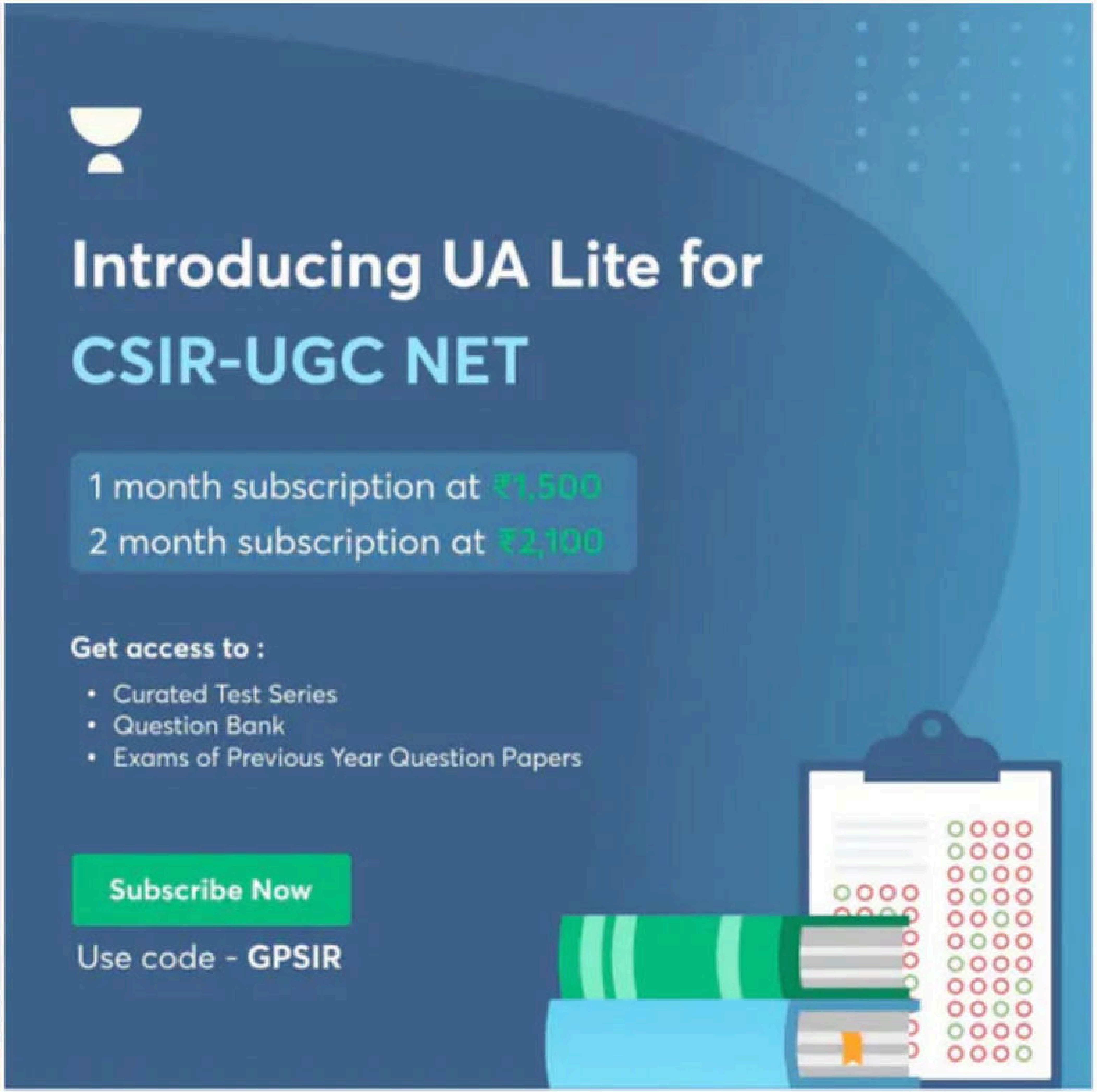
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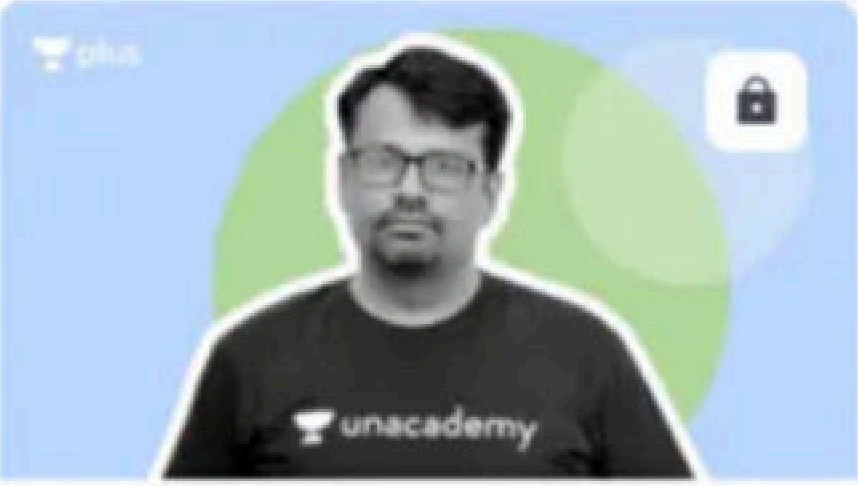

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Educator highlights

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- Studied at **M.Sc., NET, PhD(Algebra), MBA(Finance), BEd**
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- Lives in **Udaipur, Rajasthan, India**
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