System of ODE

Detailed Course on Differential Equation for IIT JAM' 23 - II

Gajendra Purohit • Lesson 16 • Aug 26, 2022

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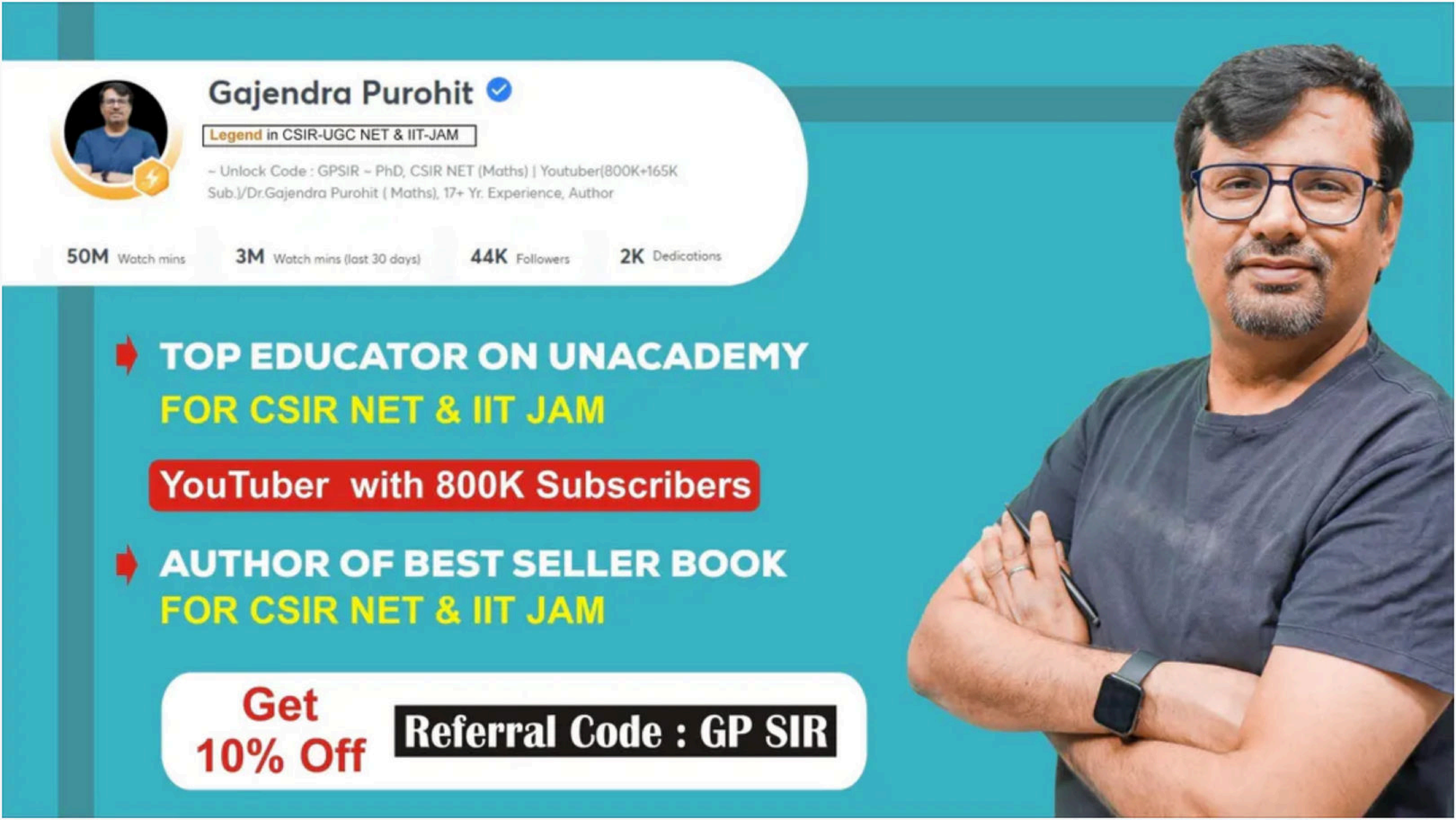
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Legendre's linear differential equation :

A linear differential equation of the form

$$[a_0(a+bx)^2\frac{d^2y}{dx^2}+a_1(a+bx)\frac{dy}{dx}+a_2y=X. \quad \ldots(1)$$

For solution

We put a + bx = e^z & z = log (a + bx)

$$\frac{dz}{dx}=\frac{b}{a+bx}$$

$$\frac{dy}{dx}=\frac{dy}{dz}.\frac{dz}{dx}$$

$$\Rightarrow \frac{b}{a+bx}\frac{dy}{dz}$$

$$\Rightarrow (a+bx)\frac{dy}{dx}=bDy \text{ where } D=\frac{d}{dz}$$

Q.1. Solution $(5+2x)^2\frac{d^2y}{dx^2}-6(5+2x)\frac{dy}{dx}+8y=0$.

(a) $y(x) = c_1(5 + 2x) + c_2(5 - 2x)$

(b) $y(x)=c_1(5+2x)^{2+\sqrt{2}}+c_2(5+2x)^{2-\sqrt{2}}$

(c) $y(x)=c_1(2+\sqrt{2})x+c_2(2-\sqrt{2}x)$

(d) none of these

Q.2. The general solution

$(1 + 2x)^2 y'' - 6(1 + 2x)y' + 16y = 8(1 + 2x)^2$.

(a) $c_1 \cos\{\log(1 + x)\} + c_2 \sin\{\log(1 + x)\} + 2\log(1 - 1x).\sin\{\log(1 + x)\}$

(b) $\frac{c_1}{x} + \frac{c_2}{x^2} - \frac{\sin x}{x^2}$

(c) $\{c_1 + c_2 \log(1 + 2x)\}(1 + 2x)^2 + (11 + 2x)^2 \{\log(1 + 2x)\}$

(d) None of these

Q.3. General solution of

$(1 + x^2)y`` + (1 + x)y` + y = 4 \cos\{\log(1 + x)\}$

(a) $\frac{c_1}{x} + \frac{c_2}{x^2} - \frac{\sin x}{x^2}$

(b) $\cos\{\log(1 + x)\} + c_2 \sin\{\log(1 + x)\} + 2 \log(1 - 1x).\sin\{\log(1 + x)\}$

(c) $\{c_1 + c_2 \log(1 + 2x)\}(1 + 2x)^2 + (11 + 2x)^2 \{\log(1 + 2x)\}$ (d) None of these

Second Order Variable Coefficient Differential Equation

$$\frac{d^2y}{dx^2}+P\frac{dy}{dx}+Qy=R$$

When One Part of CF is known

The given differential equation is of the forms

$$\frac{d^2y}{dx^2}+P\frac{dy}{dx}+Qy=R \qquad \ldots (1)$$

Where P, Q, R are as function of x alone

Suppose y = u be a known integral of CF

Now let CS is y = u v

Then v can be found by solution of equation

$$\frac{d^2v}{dx^2}+\left(P+\frac{2}{u}\frac{du}{dx}\right)\frac{dv}{dx}=\frac{R}{u}$$

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Rules for finding the one part of C.F

	Condition	An integral of CF
1	$P+Qx=0$	$y=x$
2	$2+2Px+Qx^2=0$	$y=x^2$
3	$m(m-1)+Pmx+Qx^2=0$	$y=x^m$
4	$1+P+Q=0$	$y=e^x$
5	$1-P+Q=0$	$y=e^{-x}$
6	$m^2+mP+Q=0$	$y=e^{mx}$

Q4. Given that $y(x)=x$ is a solution of differential equation $\left(1+x^2\right)y''-2xy'+2y=0,\ x>0$

Find second linearly independent solution

(a) $\left(x^2-1\right)$

(b) $\dfrac{1}{x}$

(c) e^x

(d) e^{-x}

Q5. Let $y = e^x$ be a solution of $x\frac{d^2y}{dx^2} - \frac{dy}{dx} + (1-x)y = 0$.

Then the second linearly independent solution of this ordinary differential equation is

(a) $xe^{-2x} + \frac{1}{2}$

(b) $\frac{1}{2}\left(x - \frac{1}{2}\right)e^{-x}$

(c) $\frac{1}{2}\left(x + \frac{1}{2}\right)e^{-2x}$

(d) $xe^{-2x} - \frac{1}{2}$

Q.6. If $y = x^2$ is a solution of the differential equation $y'' - \left(\frac{2}{x^2} + \frac{2}{x}\right)(xy' - y) = 0$, $0 < x < \infty$, then its general solution is

(a) $\alpha x^2 \int x^{-2} e^x dx + \beta$

(b) $\alpha x^{-2} \int x^2 e^x dx + \beta$

(c) $\alpha x^2 \int x^2 e^x dx + \beta$

(d) None of these


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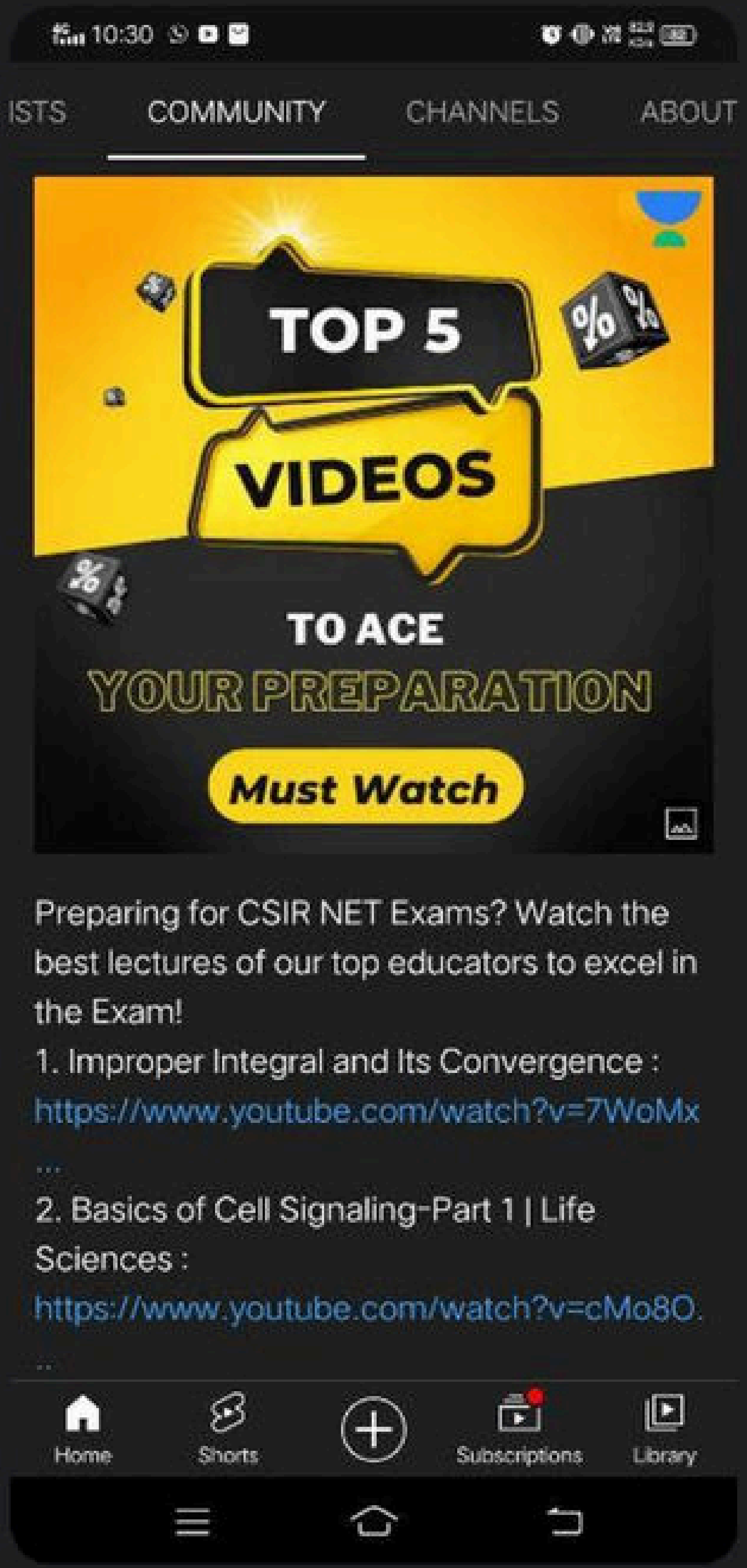

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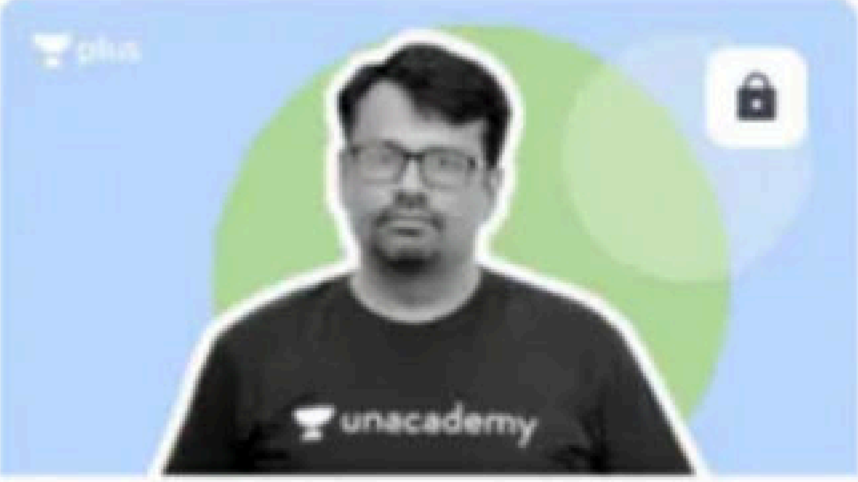

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- Works at **Pacific Science College**
- Studied at **M.Sc., NET, PhD(Algebra), MBA(Finance), BEd**
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