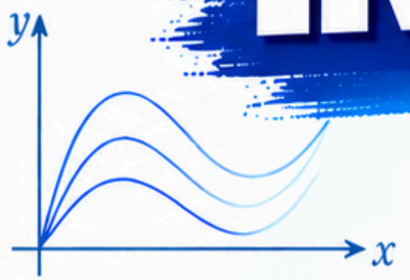
$\frac{dy}{dx} = f(x, y)$

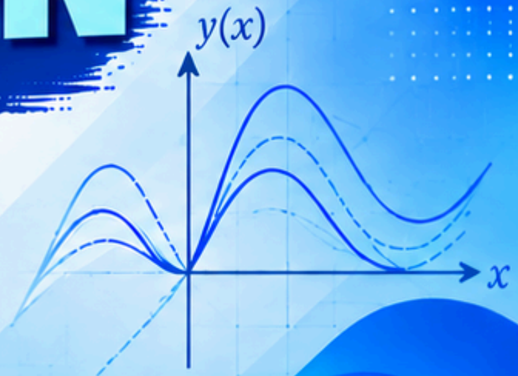
$y'' + p(x)y' + q(x)y = 0$

CSIR NET DEC 2026

INTEGRAL EQUATION

TO-DO LIST





- Exam Weightage
- YouTube Video Links
- Short Notes
- Previous Year Questions (PYQs)
- Practice Plan
- Important Formulas & Key Concepts

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Linear Integral Equations

$\int_a^b K(x,t)f(t)dt$

01

Linear integral equation of the first and second kind of Fredholm and Volterra type, Solutions with separable kernels. Characteristic numbers and eigenfunctions, resolvent kernel.

$$f(x) = \lambda \int_a^b K(x,t)f(t)\,dt$$



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Integral Equation

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Resolvant Kernel	WATCH NOW
Solution of Volterra Integral Equation	WATCH NOW
Solution of fredholm Integral Equation	WATCH NOW

PREVIOUS YEARS WEIGHTAGE

	ANALYSIS AND DISTRIBUTION OF QUESTIONS					
Subject	**July 2025**		**Feb 2025**		**July 2024**	
Integral Equation	**Part B**	**Part C**	**Part B**	**Part C**	**Part B**	**Part C**
	1	**2**	**0**	**2**	**1**	**1**

December 2025

Topics	Questions	Total Marks
Topology	3	12.85
Functional Analysis	1	4.75
Integral Equation	3	12.5
Markov Chain	2	7.75
COV (Calculus of Variations)	3	12.5
Numerical Analysis	3	12.5
Linear Programming Problems	1	3
Total	**16**	**65.85**

June 2025

Topics	Questions	Total Marks
Topology	2	7.75
Functional Analysis	1	4.75
Integral Equation	3	12.5
Markov Chain	1	4.75
Calculus of Variation	3	12.5
Numerical Analysis	3	12.5
Linear Programming Problem	1	3
Total	**14**	**57.75**

JULY-2026

14 QUESTIONS

TOPIC	NO. OF QUESTIONS	MARKS
Topology	3	12.5
Functional Analysis	1	4.75
Integral Equation	2	7.75
Marcov Chain	2	7.75
COV (Calculus of Variation)	1	4.75
Numerical Analysis	3	12.5
Linear Programming Problem	2	7.75
TOTAL	**14**	**57.75**

SHORT NOTES

Integral Equation

An integral equation is an equation in which an unknown function appears under integral sign. $g(x)y(x) = f(x) + \lambda\int_a k(x,t)y(t)dt$, where f(x) & k(x, t) are known function and y(t) is unknown function.

Conversion of ordinary differentia equation into integral equation

Let $\frac{d^n y}{dt^n} + a_1(t)\frac{d^{n-1}y}{dt^{n-1}} + ...a_n(t)y = F(t)$ be a n^{th} order ODE with condition $y(a) = c_0$, $y`(a) = c_1$,..... ,$y^{(n-1)}(a) = c_{n-1}$.Now, integration of ODE under limit 0 to x, then we get voltera IE,

Here (1) $\int_0^x \frac{d^n y}{dt^n}dt = y^{(n-1)}(x) - y^{(n-1)}(0)$

Conversion of multiple integral to single integral

$$\int_a^x\int_a^x .....\int_a^x f(t)dt.dt....dt = \frac{1}{(n-1)!}\int_a^x (x-t)^{n-1} f(t)dt$$
$$(n-times)$$

Solution of Integral Equation with degenerate kernel

Let $u(x) = f(x) + \lambda\int_a^b k(x,t)u(t)dt$ be an IE with degenerate kernel then

$$u(x) = f(x) + \lambda\int_a^b \sum_{i=1}^n \alpha_i(x)\beta_i(t)u(t)dt \quad .....(1)$$

$$u(x) = f(x) + \lambda\sum_{i=1}^n \alpha_i(x)\int_a^b \beta_i(t)u(t)dt$$

Let $\int_a^b \beta_i(t)u(t)dt = c_i$ ..... (2)

Then $u(x) = f(x) + \lambda\sum_{i=1}^n \alpha_i(x)c_i$ ....(3)

Put value of u(t) from (3) in (2) and we get c_i, then this c_i put in (3) and we get required solution.

Iterative kernel(Resolvent kernel) for Integral Equation

An Integral equation of 2nd kind is $$y(x) = f(x) + \lambda \int_a K(x,t)y(t)dt$$

Then resolvent kernel is $$R(x,t;\lambda) = \sum_{n=0}^{\infty} \lambda^n K_{n+1}(x,t)$$

Where $$K_{n+1}(x,t) = \int_a K(x,z)K_n(z,t)dz$$ and $K_1(x,t) = K(x,t)$

Solution of Voltera integral equation with help of resolvent kernel

$$y(x) = f(x) + \lambda \int_a^x k(x,t)y(t)dt$$ be given voltera integral equation $k_m(x,t)$ be the m^{th} iterated kernel and let $R(x, t; \lambda)$ be the resolvent kernel, then required solution

$$y(x) = f(x) + \lambda \int_a^x R(x,t;\lambda)f(t)dt$$

Solution of convolution voltera integral equation by laplace transform

Let $$y(x) = f(x) + \lambda \int_a^x k(x-t)y(t)dt$$ be a convolution voltera integral equation

then take laplace transform both side ,we get $$L[y(x)] = L[f(x)] + L\left[\lambda \int_a^x k(x-t)y(t)dt\right]$$

solve this and get required solution

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-:Previous Year Questions :-

NOTE:- click on abovetextyoucanrefertolinkofvideosolution of questions

1. If y(x) is the solution of the integral equation $y(x) = x^2 + 2\int_0^1 xty(t)dt$ then which of the following statements is true? **CSIR NET JULY 2025**

(a) $y(0) + y(1) = \frac{1}{2}$

(b) $y(-1) + y(1) = 1$

(c) $y'(0) + y'(1) = \frac{3}{2}$

(d) $y'(-1) + y'(1) = 3$

2. Let f and K be such that the solution of the initial value problem y'' – 3y' + 2y = 4sin(x), y(0) = 1, y'(0) = -2 satisfies the Volterra integral equation $y(x) = f(x) + \int_0^x K(x,t)y(t)dt$. Then which of the following statements are true?

(a) f'(π) = 3

(b) f(π) + f'(π) = 4 - π

(c) f(π) + f'(π) = 2 - π

(d) f(0) + f'(0) = -4

3. Let u(x) be the solution of the Volterra integral equation $u(x) = x^2 + 4\int_0^x (t-x)^2 u(t)dt$. Then which of the following statements are true?

(a) u(0) = 0

(b) $u\left(\frac{2\pi}{\sqrt{3}}\right) = \frac{1}{6}\left(e^{\frac{4\pi}{\sqrt{3}}} - e^{-\frac{2\pi}{\sqrt{3}}}\right)$

(c) $u\left(\frac{\pi}{2\sqrt{3}}\right) = \frac{1}{6}\left(e^{\frac{\pi}{\sqrt{3}}} - \sqrt{3}e^{-\frac{\pi}{2\sqrt{3}}}\right)$

(d) $u\left(\frac{\pi}{2\sqrt{3}}\right) = \frac{1}{6}\left(e^{\frac{\pi}{\sqrt{3}}} + \sqrt{3}e^{-\frac{\pi}{\sqrt{3}}}\right)$

4. If u is the solution of the volterra integral equation $u(x) = 3 + \sin x + \int_0^x \frac{3+\sin x}{x+\sin t} u(t)dt$

CSIR NET FEB. 2025

(a) $u(\pi/2) = 4e^{\pi/2}$

(b) $u(\pi) = 3e^{\pi}$

(c) $u(-\pi) = 4e^{-\pi}$

(d) $u(-\pi/2) = 4e^{\pi}$

5. The integral equation $u(x) = f(x) + \frac{2}{\pi}\int_0^{\pi} \sin(x-t)u(t)dt$ has a unique solution if

CSIR NET FEB 2025

(a) f(x) = cosx (b) f(x) = cos5x (c) f(x) = sinx (d) f(x) = sin5x

6. Let u be the solution of the volterra integral equation

$$\int_0^t \left[\frac{1}{2} + \sin(t-\tau)\right] u(\tau)\,d\tau = \sin t$$

CSIR NET JUNE 2024

Then the value of u(t) is

(a) 0 (b) 1

(c) 2 (d) $2e^{-1}$

7. For c ∈ R, consider the following fredholm integral equation

$y(x) = 1 + x + cx^2 + 2\int_0^1 (1-3xt)y(t)\,dt$, then the values of c for which the integral equation admits a solutions are:

CSIR NET JUNE 2024

(a) -8 (b) -6

(c) 2 (d) 6

8. The value of λ for which integral equation $y(x) = \lambda\int_0^1 x^2 e^{x+t} y(t)dt$ has a non-zero solution

CSIR DEC 2023

(a) $\frac{4}{e^2-1}$ (b) $\frac{e}{e^2-1}$ (c) $\frac{4}{e^2+1}$ (d) $\frac{2}{e^2+1}$

9. Consider the following Fredholm integral equation $y(x)-3\int_0^1 xty(t)dt=f(x)$ where f(x) is a continuous function defined on [0, 1]. Which of the following choice for f(x) have the property that above integral equation admits at least one solution? **CSIR DEC 2023**

(a) $f(x)=x^2-1/2$ (b) $f(x)=e^x$ (c) $f(x)=2-3x$ (d) $f(x)=x-1$

10. Let y be the solution to the Volterra integral equation $y(x)=e^x+\int_0^x \frac{1+x^2}{1+t^2}y(t)dt$.

Then which of the following are true? **CSIR DEC 2023**

(a) $y(1)=\left(1+\frac{\pi}{4}\right)e$ (b) $y(1)=\left(1+\frac{\pi}{2}\right)e$

(c) $y(\sqrt{3})=\left(1+\frac{3\pi}{4}\right)e^{\sqrt{3}}$ (d) $y(\sqrt{3})=\left(1+\frac{4\pi}{3}\right)e^{\sqrt{3}}$

Answer Key

1	2	3	4	5	6	7	8	9	10
d	a, b, d	a, b, c	a, b	a, b, c, d	a	a	a	a, c	b

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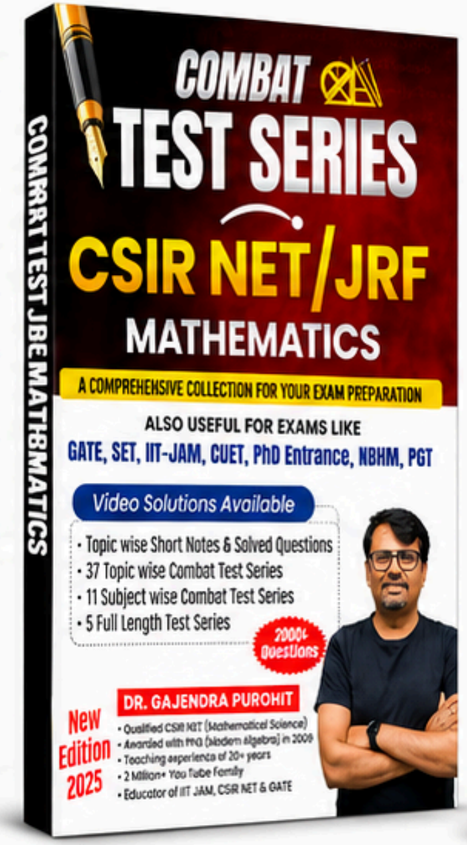
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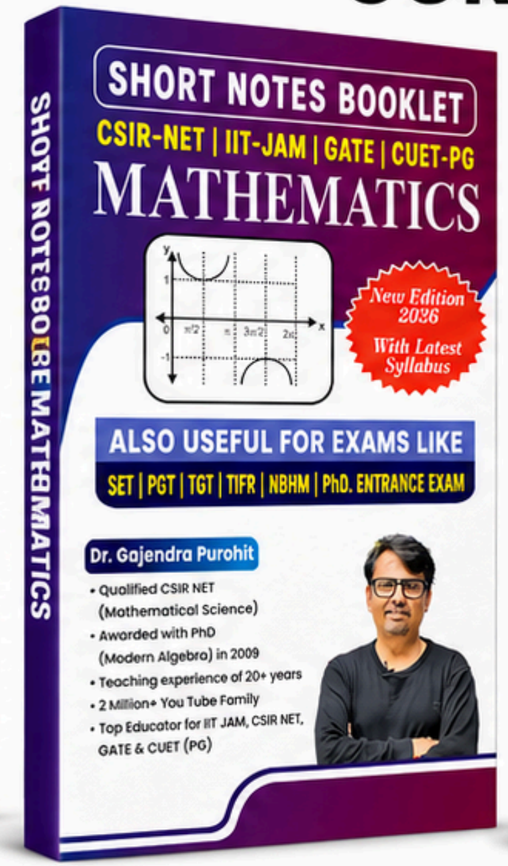
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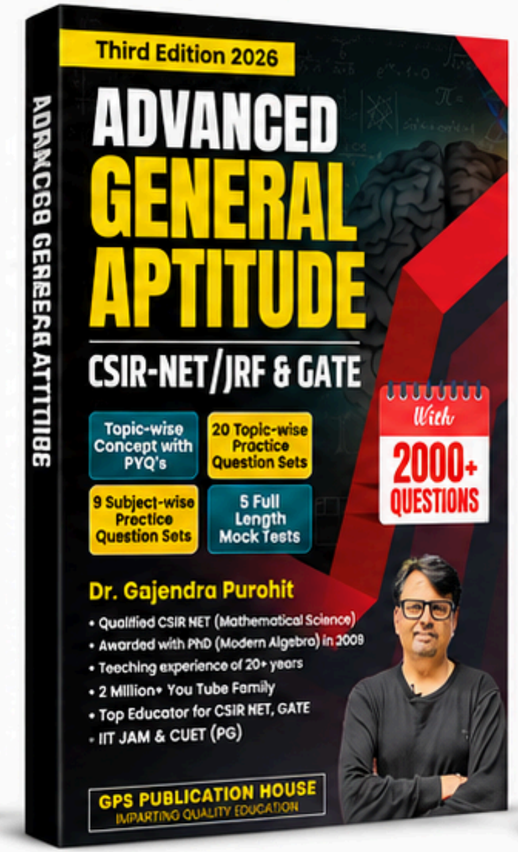
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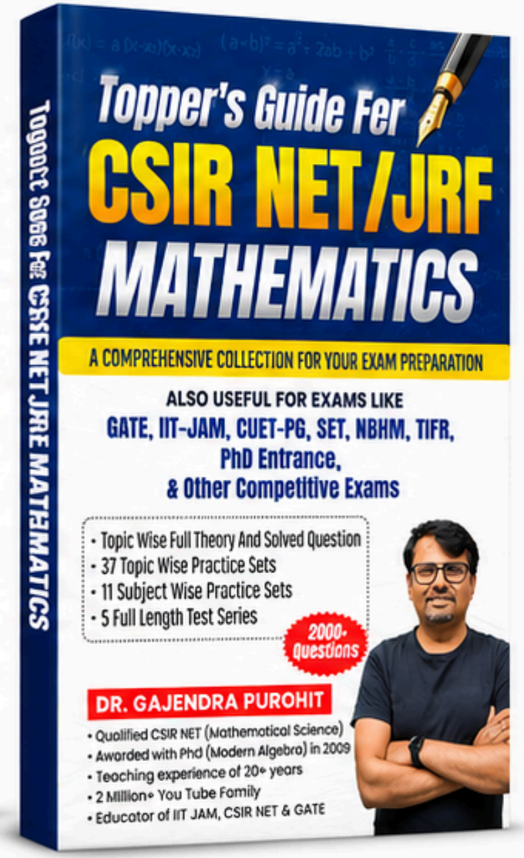
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