PhysicsByAaryan

CSIR NET . GATE . JEST . BARC - Physics

CSIR NET Physics - Mathematical Physics

All PYQs (2015-2025) with answer key

154 questions . Answer key included

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Q1. [Dec 2015] . 3.5 marks

Mathematical Physics > Basic Mathematics

CSIR NET	2015 Dec	3.5 M

If $y = \frac{1}{\tanh(x)}$, then x is

1. $ln\left(\frac{y+1}{y-1}\right)$
2. $ln\left(\frac{y-1}{y+1}\right)$
3. $ln\sqrt{\frac{y-1}{y+1}}$
4. $\ln\sqrt{\frac{y+1}{y-1}}$

Q2. [Dec 2015] . 3.5 marks

Mathematical Physics > Complex analysis

CSIR NET	2015 Dec	3.5 M

The function $\frac{Z}{\sin \pi Z^2}$ of a complex variable Z has

1. a simple pole at 0 and poles of order 2 at $\pm\sqrt{n}$ for $n = 1,2,3 \ldots$
2. a simple pole at 0 and poles of order 2 at $\pm\sqrt{n}$ and $\pm i\sqrt{n}$ for $n = 1,2,3 \ldots$
3. poles of order 2 at $\pm\sqrt{n}, n = 0,1,2,3 \ldots$
4. poles of order 2 at $\pm n, n = 0,1,2,3 \ldots$

Q3. [Dec 2015] . 3.5 marks

Mathematical Physics > Fourier Transform

CSIR NET	2015 Dec	3.5 M

The Fourier transform of $f(x)$ is $\tilde{f}(k) = \int_{-\infty}^{+\infty} dx e^{ikx} f(x)$.

If $f(x) = \alpha\delta(x) + \beta\delta'(x) + \gamma\delta''(x)$, where $\delta(x)$ is the Dirac delta-function (and prime denotes derivative), what is $\tilde{f}(k)$?

1. $\alpha + i\beta k + i\gamma k^2$
2. $\alpha + \beta k - \gamma k^2$
3. $\alpha - i\beta k - \gamma k^2$
4. $i\alpha + \beta k - i\gamma k^2$

Q4. [Dec 2015] . 3.5 marks

Mathematical Physics > Ordinary Differential Equations

CSIR NET	2015 Dec	3.5 M

The solution of the differential equation $\frac{dx}{dt} = 2\sqrt{1-x^2}$, with initial condition $x = 0$ at $t = 0$ is

1. $x = \begin{cases} \sin 2t, & 0 \le t < \frac{\pi}{4} \\ \sinh 2t, & t \ge \frac{\pi}{4} \end{cases}$

2. $x = \begin{cases} \sin 2t, & 0 \le t < \frac{\pi}{2} \\ 1, & t \ge \frac{\pi}{2} \end{cases}$

3. $x = \begin{cases} \sin 2t, & 0 \le t < \frac{\pi}{4} \\ 1, & t \ge \frac{\pi}{4} \end{cases}$

4. $x = 1 - \cos 2t, t \ge 0$

Q5. [Dec 2015] . 5.0 marks

Mathematical Physics > Special Functions

CSIR NET	2015 Dec	5 M

The Hermite polynomial $H_n(x)$ satisfies the differential equation $\frac{d^2H_n}{dx^2} - 2x\frac{dH_n}{dx} + 2nH_n(x) = 0$

The corresponding generating function $G(t,x) = \sum_{n=0}^{\infty} \frac{1}{n!} H_n(x)t^n$ satisfies the equation

1. $\frac{\partial^2 G}{\partial x^2} - 2x\frac{\partial G}{\partial x} + 2t\frac{\partial G}{\partial t} = 0$
2. $\frac{\partial^2 G}{\partial x^2} - 2x\frac{\partial G}{\partial x} - 2t^2\frac{\partial G}{\partial t} = 0$
3. $\frac{\partial^2 G}{\partial x^2} - 2x\frac{\partial G}{\partial x} + 2\frac{\partial G}{\partial t} = 0$
4. $\frac{\partial^2 G}{\partial x^2} - 2x\frac{\partial G}{\partial x} + 2\frac{\partial^2 G}{\partial x \partial t} = 0$

Q6. [Dec 2015] . 5.0 marks

Mathematical Physics > Fourier Transform

CSIR NET	2015 Dec	5 M

A function $f(x)$ satisfies the differential equation

$$\frac{d^2f}{dx^2} - \omega^2 f = -\delta(x-a)$$

where ω is positive. The Fourier transform $\tilde{f}(k) = f\int_{-\infty}^{+\infty} dx e^{ikx} f(x)$ of f, and the solution of the equation are, respectively,

1. $\frac{e^{ika}}{k^2+\omega^2}$ and $\frac{1}{2\omega}\left(e^{-\omega|x-a|} + e^{\omega|x-a|}\right)$

2. $\frac{e^{ika}}{k^2+\omega^2}$ and $\frac{1}{2\omega} e^{-\omega|x-a|}$

3. $\frac{e^{ika}}{k^2-\omega^2}$ and $\frac{1}{2\omega}\left(e^{-i\omega|x-a|} + e^{i\omega|x-a|}\right)$

4. $\frac{e^{ika}}{k^2-\omega^2}$ and $\frac{1}{2i\omega}\left(e^{-\omega|x-a|} - e^{i\omega|x-a|}\right)$

Q7. [Dec 2015] . 5.0 marks

Mathematical Physics > Numerical Methods

CSIR NET	2015 Dec	5 M

The value of the integral $\int_0^8 \frac{1}{x^2+5} dx$, valuated using Simpson's $\frac{1}{3}$ rule with $h = 2$ is

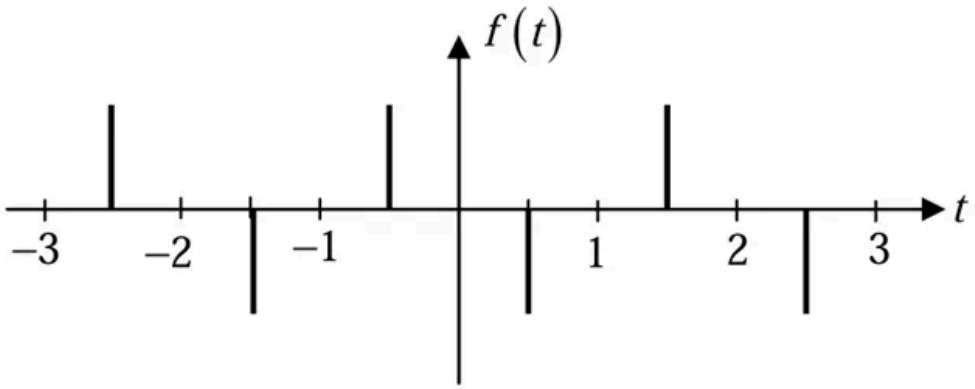
1. 0.565
2. 0.620
3. 0.698
4. 0.736

Q8. [June 2015] . 3.5 marks

Mathematical Physics > Fourier Series

CSIR NET	2015 June	3.5 M

Consider the periodic function f(t) with time period T as shown in the figure below



The spikes, located at $t = \frac{1}{2}(2n-1)$, where $n = 0, \pm 1, \pm 2, \cdots$, are Dirac-delta functions of strength ± 1. The amplitudes a_n in the Fourier expansion

$$f(t) = \sum_{n=-\infty}^{\infty} a_n e^{2\pi i n t/T}$$

are given by

1. $(-1)^n$
2. $\frac{1}{n\pi} \sin \frac{n\pi}{2}$
3. $i \sin \frac{n\pi}{2}$
4. $n\pi$

Q9. [June 2015] . 3.5 marks

Mathematical Physics > Vector Algebra and Vector Calculus

CSIR NET	2015 June	3.5 M

A particle moves in two dimensions on the ellipse $x^2 + 4y^2 = 8$. At a particular instant it is at the point $(x, y) = (2,1)$ and the x-component of its velocity is 6 (in suitable units). Then the y-component of its velocity is

1. -3
2. -2
3. 1
4. 4

Q10. [June 2015] . 3.5 marks

Mathematical Physics > Ordinary Differential Equations

CSIR NET	2015 June	3.5 M

Consider the differential equation $\frac{d^2x}{dt^2} - 3\frac{dx}{dt} + 2x = 0$. If $x = 0$ at $t = 0$ and $x = 1$ at $t = 1$, the value of x at $t = 2$ is

1. $e^2 + 1$
2. $e^2 + e$
3. $e + 2$
4. $2e$

Q11. [June 2015] . 3.5 marks

Mathematical Physics > Complex analysis

CSIR NET	2015 June	3.5 M

The value of the integral $\int_{-\infty}^{\infty} \frac{dx}{1+x^4}$ is

1. $\frac{\pi}{\sqrt{2}}$
2. $\frac{\pi}{2}$
3. $\sqrt{2}\pi$
4. 2π

Q12. [June 2015] . 3.5 marks

Mathematical Physics > Laplace transform

CSIR NET	2015 June	3.5 M

The Laplace transform of $6t^3 + 3\sin 4t$ is

1. $\frac{36}{s^4} + \frac{12}{s^2+16}$
2. $\frac{36}{s^4} + \frac{12}{s^2-16}$
3. $\frac{18}{s^4} + \frac{12}{s^2-16}$
4. $\frac{36}{s^3} + \frac{12}{s^2+16}$

Q13. [June 2015] . 5.0 marks

Mathematical Physics > Probability

CSIR NET	2015 June	5 M

Three real variables a, b and c are each randomly chosen from a uniform probability distribution in the interval $[0,1]$. The probability that $a + b > 2c$ is

1. $\frac{3}{4}$
2. $\frac{2}{3}$
3. $\frac{1}{2}$
4. $\frac{1}{4}$

Q14. [June 2015] . 5.0 marks

Mathematical Physics > Tensors

CSIR NET	2015 June	5 M

The rank-2 tensor $x_i x_j$, where x_i are the Cartesian coordinates of the position vector in three dimensions, has 6 independent elements. Under rotation, these 6 elements decompose into irreducible sets (that is, the elements of each set transform only into linear combinations of elements in that set) containing

1. 4 and 2 elements
2. 5 and 1 elements
3. 3, 2 and 1 elements
4. 4, 1 and 1 elements

Q15. [June 2015] . 5.0 marks

Mathematical Physics > Numerical Methods

CSIR NET	2015 June	5 M

Consider the differential equation $\frac{dy}{dx} = x^2 - y$ with the initial condition $y = 2$ at $x = 0$. Let $y_{(1)}$ and $y_{(1/2)}$ be the solutions at $x = 1$ obtained using Euler's forward algorithm with step size 1 and $\frac{1}{2}$ respectively.

The value of $\left(y_{(1)} - y_{(1/2)}\right)/y_{(1/2)}$ is

1. $-1/2$
2. -1
3. ½
4. 1

Q16. [June 2015] . 5.0 marks

Mathematical Physics > Partial Differential Equations

CSIR NET	2015 June	5 M

Let $f(x,t)$ be a solution of the wave equation $\frac{\partial^2 f}{\partial t^2} = v^2 \frac{\partial^2 f}{\partial x^2}$ in 1 -dimension. If at $t = 0, f(x,0) = e^{-x^2}$ and $\frac{\partial f}{\partial t}(x,0) = 0$ for all x, then $f(x,t)$ for all future times $t > 0$ is described by

1. $e^{-(x^2 - v^2 t^2)}$
2. $e^{-(x-vt)^2}$
3. $\frac{1}{4} e^{-(x-vt)^2} + \frac{3}{4} e^{-(x+vt)^2}$
4. $\frac{1}{2}\left[e^{-(x-vt)^2} + e^{-(x+vt)^2}\right]$

Q17. [Dec 2016] . 3.5 marks

Mathematical Physics > Probability

CSIR NET	2016 Dec	3.5M

Consider two radioactive atoms, each of which has a decay rate of 1 per year. The probability that at least one of them decays in the first two years is

1. $\frac{1}{4}$
2. $\frac{3}{4}$
3. $1 - e^{-4}$
4. $(1 - e^{-2})^2$

Q18. [Dec 2016] . 3.5 marks

Mathematical Physics > Fourier Transform

CSIR NET	2016 Dec	3.5M

The Fourier transform $\int_{-\infty}^{\infty} dx f(x) e^{ikx}$ of the function $f(x) = \frac{1}{x^2+2}$ is

1. $\sqrt{2}\pi e^{-\sqrt{2}|k|}$
2. $\sqrt{2}\pi e^{-\sqrt{2}k}$
3. $\frac{\pi}{\sqrt{2}} e^{-\sqrt{2}k}$
4. $\frac{\pi}{\sqrt{2}} e^{-\sqrt{2}|k|}$

Q19. [Dec 2016] . 3.5 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2016 Dec	3.5M

The matrix $M = \begin{pmatrix} 1 & 3 & 2 \\ 3 & -1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$ satisfies the equation

1. $M^3 - M^2 - 10M + 12I = 0$
2. $M^3 + M^2 - 12M + 10I = 0$
3. $M^3 - M^2 - 10M + 10I = 0$
4. $M^3 + M^2 - 10M + 10I = 0$

Q20. [Dec 2016] . 3.5 marks

Mathematical Physics > Laplace transform

CSIR NET	2016 Dec	3.5M

The Laplace transform of

$$f(t) = \begin{cases} \frac{t}{T}, & 0 < t < T \\ 1 & t > T \end{cases}$$ is

1. $-(1 - e^{-sT})/s^2T$
2. $(1 - e^{-sT})/s^2T$
3. $(1 + e^{-sT})/s^2T$
4. $(1 - e^{sT})/s^2T$

Q21. [Dec 2016] . 5.0 marks

Mathematical Physics > Basic Mathematics

CSIR NET	2016 Dec	5M

A stable asymptotic solution of the equation $x_{n+1} = 1 + \frac{3}{1+x_n}$ is $x = 2$. If we take $x_n = 2 + \epsilon_n$ and $x_{n+1} = 2 + \epsilon_{n+1}$, where ϵ_n and ϵ_{n+1} are both small, the ratio $\epsilon_{n+1}/\epsilon_n$ is approximately

1. $-\frac{1}{2}$
2. $-\frac{1}{4}$
3. $-\frac{1}{3}$
4. $-\frac{2}{3}$

Q22. [Dec 2016] . 5.0 marks

Mathematical Physics > Group Theory

CSIR NET	2016 Dec	5M

The 2×2 identity matrix I and the Pauli matrices $\sigma^x, \sigma^y, \sigma^z$ do not form a group under matrix multiplication. The minimum number of 2×2 matrices, which includes these four matrices, and form a group (under matrix multiplication) is

1. 20
2. 8
3. 12
4. 16

Q23. [Dec 2016] . 5.0 marks

Mathematical Physics > Numerical Methods

CSIR NET	2016 Dec	5M

Given the values $\sin 45^\circ = 0.7071$, $\sin 50^\circ = 0.7660$, $\sin 55^\circ = 0.8192$ and $\sin 60^\circ = 0.8660$, the approximate value of $\sin 52^\circ$, computed by Newton's forward difference method, is

1. 0.804
2. 0.776
3. 0.788
4. 0.798

Q24. [Dec 2016] . 5.0 marks

Mathematical Physics > Partial Differential Equations

CSIR NET	2016 Dec	5M

Let $f(x,t)$ be a solution of the heat equation

$\frac{\partial f}{\partial t} = D\frac{\partial^2 f}{\partial x^2}$ in one dimension. The initial condition at $t = 0$ is $f(x,0) = e^{-x^2}$ for $-\infty < x < \infty$. Then for all $t > 0, f(x,t)$ is given by

[Useful integral: $\int_{-\infty}^{\infty} dx e^{-\alpha x^2} = \sqrt{\pi/\alpha}$.]

1. $\frac{1}{\sqrt{1+Dt}} e^{-\frac{x^2}{1+Dt}}$
2. $\frac{1}{\sqrt{1+2Dt}} e^{-\frac{x^2}{1+2Dt}}$
3. $\frac{1}{\sqrt{1+4Dt}} e^{-\frac{x^2}{1+4Dt}}$
4. $e^{-\frac{x^2}{1+Dt}}$

Q25. [June 2016] . 3.5 marks

Mathematical Physics > Basic Mathematics

CSIR NET	2016 June	3.5M

The radius of convergence of the Taylor series expansion of the function $\frac{1}{\cosh(x)}$ around $x = 0$, is

1. ∞
2. π
3. $\frac{\pi}{2}$
4. 1

Q26. [June 2016] . 3.5 marks

Mathematical Physics > Complex analysis

CSIR NET	2016 June	3.5M

The value of the contour integral

$$\frac{1}{2\pi i}\oint_C \frac{e^{4z}-1}{\cosh(z)-2\sinh(z)}dz$$

around the unit circle C traversed in the anti-clockwise direction, is

1. 0
2. 2
3. $-8/\sqrt{3}$
4. $-\tanh\left(\frac{1}{2}\right)$

Q27. [June 2016] . 3.5 marks

Mathematical Physics > Fourier Series

CSIR NET	2016 June	3.5M

The Gauss hypergeometric function $F(a,b,c;z)$, defined by the Taylor series expansion around $z=0$ as $F(a,b,c;z) =$

$$\sum_{n=0}^{\infty} \frac{a(a+1)\cdots(a+n-1)b(b+1)\cdots(b+n-1)}{c(c+1)\cdots(c+n-1)n!} z^n,$$

satisfies the recursion relation

1. $\frac{d}{dz}F(a,b,c;z) = \frac{c}{ab}F(a-1,b-1,c-1;z)$
2. $\frac{d}{dz}F(a,b,c;z) = \frac{c}{ab}F(a+1,b+1,c+1;z)$
3. $\frac{d}{dz}F(a,b,c;z) = \frac{ab}{c}F(a-1,b-1,c-1;z)$
4. $\frac{d}{dz}F(a,b,c;z) = \frac{ab}{c}F(a+1,b+1,c+1;z)$

Q28. [June 2016] . 3.5 marks

Mathematical Physics > Probability

CSIR NET	2016 June	3.5M

Let X and Y be two independent random variables, each of which follow a normal distribution with the same standard deviation σ, but with means $+\mu$ and $-\mu$, respectively. Then the sum $X+Y$ follows a

1. distribution with two peaks at $\pm\mu$ and mean 0 and standard deviation $\sigma\sqrt{2}$
2. normal distribution with mean 0 and standard deviation 2σ
3. distribution with two peaks at $\pm\mu$ and mean 0 and standard deviation 2σ
4. normal distribution with mean 0 and standard deviation $\sigma\sqrt{2}$

Q29. [June 2016] . 5.0 marks

Mathematical Physics > Fourier Transform

CSIR NET	2016 June	5M

What is the Fourier transform $\int dx e^{ikx} f(x)$ of

$$f(x) = \delta(x) + \sum_{n=1}^{\infty} \frac{d^n}{dx^n} \delta(x)$$

where $\delta(x)$ is the Dirac delta-function?

1. $\frac{1}{1-ik}$
2. $\frac{1}{1+ik}$
3. $\frac{1}{k+i}$
4. $\frac{1}{k-i}$

Q30. [June 2016] . 5.0 marks

Mathematical Physics > Integral Equations

CSIR NET	2016 June	5M

The integral equation

$$\phi(x,t) = \lambda \int dx' dt'$$

$$\int \frac{d\omega dk}{(2\pi)^2} \frac{e^{-ik(x-x')+i\omega(t-t')}}{\omega^2 - k^2 - m^2 + i\epsilon} \phi^3(x', t')$$

is equivalent to the differential equation

1. $\left(\frac{\partial^2}{\partial t^2} + \frac{\partial^2}{\partial x^2} - m^2 + i\epsilon\right)\phi(x,t) = -\frac{1}{6}\lambda\phi^3(x,t)$
2. $\left(\frac{\partial^2}{\partial t^2} - \frac{\partial^2}{\partial x^2} + m^2 - i\epsilon\right)\phi(x,t) = \lambda\phi^2(x,t)$
3. $\left(\frac{\partial^2}{\partial t^2} - \frac{\partial^2}{\partial x^2} + m^2 - i\epsilon\right)\phi(x,t) = -3\lambda\phi^2(x,t)$
4. $\left(\frac{\partial^2}{\partial t^2} - \frac{\partial^2}{\partial x^2} + m^2 - i\epsilon\right)\phi(x,t) = -\lambda\phi^3(x,t)$

Q31. [June 2016] . 5.0 marks

Mathematical Physics > Group Theory

CSIR NET	2016 June	5M

A part of the group multiplication table for a six element group $G = \{e, a, b, c, d, f\}$ is shown below. (In the following e is the identity element of G.)

	e	a	b	c	d	f
e	e	a	b	c	d	f
a	a	b	e	d		
b	b	e	x	f	y	z
c	c					
d	d					
f	f					

The entries x, y and z should be

1. $x = a, y = d$ and $z = c$
2. $x = c, y = a$ and $z = d$
3. $x = c, y = d$ and $z = a$
4. $x = a, y = c$ and $z = d$

Q32. [June 2016] . 5.0 marks

Mathematical Physics > Numerical Methods

CSIR NET	2016 June	5M

In finding the roots of the polynomial $f(x) = 3x^3 - 4x - 5$ using the iterative Newton-Raphson method, the initial guess is taken to be $x = 2$. In the next iteration its value is nearest to

1. 1.671
2. 1.656
3. 1.559
4. 1.551

Q33. [Dec 2017] . 3.5 marks

Mathematical Physics > Laplace transform

CSIR NET	2017 Dec	3.5M

Consider the differential equation $\frac{dy}{dt} + ay = e^{-bt}$ with the initial condition $y(0) = 0$. Then the Laplace transform $Y(s)$ of the solution $y(t)$ is

1. $\frac{1}{(s+a)(s+b)}$
2. $\frac{1}{b(s+a)}$
3. $\frac{1}{a(s+b)}$
4. $\frac{e^{-a}-e^{-b}}{b-a}$

Q34. [Dec 2017] . 3.5 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2017 Dec	3.5M

Consider the matrix equation

$$\begin{pmatrix} 1 & 1 & 1 \\ 1 & 2 & 3 \\ 2 & b & 2c \end{pmatrix} \begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix}$$

The condition for existence of a non-trivial solution and the corresponding normalised solution (upto a sign) is

1. $b = 2c$ and $(x, y, z) = \frac{1}{\sqrt{6}}(1, -2, 1)$
2. $c = 2b$ and $(x, y, z) = \frac{1}{\sqrt{6}}(1, 1, -2)$
3. $c = b + 1$ and $(x, y, z) = \frac{1}{\sqrt{6}}(2, -1, -1)$
4. $b = c + 1$ and $(x, y, z) = \frac{1}{\sqrt{6}}(1, -2, 1)$

Q35. [Dec 2017] . 3.5 marks

Mathematical Physics > Basic Mathematics

CSIR NET	2017 Dec	3.5M

Consider the real function $f(x) = 1/(x^2 + 4)$. The Taylor expansion of $f(x)$ about $x = 0$ converges

1. for all values of x
2. for all values of x except $x = \pm 2$
3. in the region $-2 < x < 2$
4. for $x > 2$ and $x < -2$

Q36. [Dec 2017] . 3.5 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2017 Dec	3.5M

Let A be a non-singular 3×3 matrix, the columns of which are denoted by the vectors $\vec{a}, \vec{b}$ and $\vec{c}$, respectively. Similarly, $\vec{u}, \vec{v}$ and $\vec{w}$ denote the vectors that form the corresponding columns of $(A^T)^{-1}$. Which of the following is true?

1. $\vec{u} \cdot \vec{a} = 0, \vec{u} \cdot \vec{b} = 0, \vec{u} \cdot \vec{c} = 1$
2. $\vec{u} \cdot \vec{a} = 0, \vec{u} \cdot \vec{b} = 1, \vec{u} \cdot \vec{c} = 0$
3. $\vec{u} \cdot \vec{a} = 1, \vec{u} \cdot \vec{b} = 0, \vec{u} \cdot \vec{c} = 0$
4. $\vec{u} \cdot \vec{a} = 0, \vec{u} \cdot \vec{b} = 0, \vec{u} \cdot \vec{c} = 0$

Q37. [Dec 2017] . 3.5 marks

Mathematical Physics > Ordinary Differential Equations

CSIR NET	2017 Dec	3.5M

The number of linearly independent power series solutions, around $x = 0$, of the second order linear differential equation $x\frac{d^2y}{dx^2} + \frac{dy}{dx} + xy = 0$, is

1. 0 (this equation does not have a power series solution)
2. 1
3. 2
4. 3

Q38. [Dec 2017] . 5.0 marks

Mathematical Physics > Group Theory

CSIR NET	2017 Dec	5M

Consider an element $U(\varphi)$ of the group $SU(2)$, where φ is any one of the parameters of the group. Under an infinitesimal change $\varphi \to \varphi + \delta\varphi$, it changes as $U(\varphi) \to U(\varphi) + \delta U(\varphi) = (1 + X(\delta\varphi))U(gj)$. To order $\delta\varphi$, the matrix $X(\delta\varphi)$ should always be

1. positive definite
2. real symmetric
3. Hermitian
4. anti-hermitian

Q39. [Dec 2017] . 5.0 marks

Mathematical Physics > Numerical Methods

CSIR NET	2017 Dec	5M

The differential equation $\frac{dy(x)}{dx} = \alpha x^2$, with the initial condition $y(0) = 0$, is solved using Euler's method. If $y_E(x)$ is the exact solution and $y_N(x)$ the numerical solution obtained using n steps of equal length, then the relative error $\left|\frac{(y_N(x) - y_E(x))}{y_E(x)}\right|$ is proportional to

1. $\frac{1}{n^2}$
2. $\frac{1}{n^3}$
3. $\frac{1}{n^4}$
4. $\frac{1}{n}$

Q40. [Dec 2017] . 5.0 marks

Mathematical Physics > Numerical Methods

CSIR NET	2017 Dec	5M

The interval $[0,1]$ is divided into n parts of equal length to calculate the integral $\int_0^1 e^{i2\pi x} dx$ using the trapezoidal rule. The minimum value of n for which the result is exact, is

1. 2
2. 3
3. 4
4. ∞

Q41. [Dec 2017] . 5.0 marks

Mathematical Physics > Integral Equations

CSIR NET	2017 Dec	5M

The generating function $G(t,x)$ for the Legendre polynomials $P_n(t)$ is

$$G(t,x)=\frac{1}{\sqrt{1-2xt+x^2}}=\sum_{n=0}^{\infty}x^nP_n(t),\ \text{for}\ |x|<1$$

If the function $f(x)$ is defined by the integral equation $\int_0^x f(x')dx'=xG(1,x)$, it can be expressed as

1. $\sum_{n,m=0}^{\infty} x^{n+m}P_n(1)P_m\left(\frac{1}{2}\right)$
2. $\sum_{n,m=0}^{\infty} x^{n+m}P_n(1)P_m(1)$
3. $\sum_{n,m=0}^{\infty} x^{n-m}P_n(1)P_m(1)$
4. $\sum_{n,m=0}^{\infty} x^{n-m}P_n(0)P_m(1)$

Q42. [June 2017] . 3.5 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2017 June	3.5M

Which of the following can not be the eigenvalues of a real 3×3 matrix

1. $2i, 0, -2i$
2. $1,1,1$
3. $e^{i\theta}, e^{-i\theta}, 1$
4. $i, 1, 0$

Q43. [June 2017] . 3.5 marks

Mathematical Physics > Complex analysis

CSIR NET	2017 June	3.5M

Let $u(x,y) = e^{ax}\cos(by)$ be the real part of a function $f(z) = u(x,y) + iv(x,y)$ of the complex variable $z = x + iy$, where a, b are real constants and $a \neq 0$. The function $f(z)$ is complex analytic everywhere in the complex plane if and only if

1. $b = 0$
2. $b = \pm a$
3. $b = \pm 2\pi a$
4. $b = a \pm 2\pi$

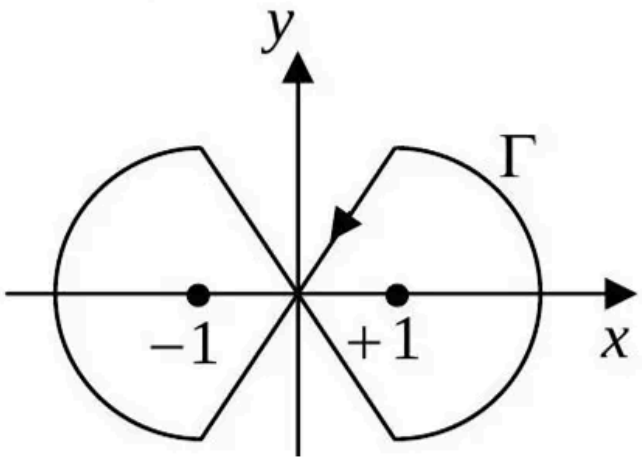
Q44. [June 2017] . 3.5 marks

Mathematical Physics > Complex analysis

CSIR NET	2017 June	3.5M

The integral $\oint_{\Gamma} \frac{ze^{i\pi z/2}}{z^2-1} dz$ along the closed contour Γ shown in the figure is

1. 0
2. 2π
3. -2π
4. $4\pi i$



Q45. [June 2017] . 3.5 marks

Mathematical Physics > Ordinary Differential Equations

CSIR NET	2017 June	3.5M

The function $y(x)$ satisfies the differential equation $x\frac{dy}{dx} + 2y = \frac{\cos\pi x}{x}$. If $y(1) = 1$, the value of $y(2)$ is

1. π
2. 1
3. 1/2
4. 1/4

Q46. [June 2017] . 3.5 marks

Mathematical Physics > Probability

CSIR NET	2017 June	3.5M

The random variable x $(-\infty < x < \infty)$ is distributed according to the normal distribution $P(x) = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{x^2}{2\sigma^2}}$. The probability density of the random variable $y = x^2$ is

1. $\frac{1}{\sqrt{2\pi\sigma^2 y}} e^{-y/2\sigma^2},\ 0 \le y < \infty$
2. $\frac{1}{2\sqrt{2\pi\sigma^2 y}} e^{-y/2\sigma^2},\ 0 \le y < \infty$
3. $\frac{1}{\sqrt{2\sigma^2}} e^{-y/2\sigma^2},\ 0 \le y < \infty$
4. $\frac{1}{\sqrt{2\pi\sigma^2 y}} e^{-y/\sigma^2},\ 0 \le y < \infty$

Q47. [June 2017] . 3.5 marks

Mathematical Physics > Vector Algebra and Vector Calculus

CSIR NET	2017 June	3.5M

The two vectors $\binom{a}{0}$ and $\binom{b}{c}$ are orthonormal if

1. $a = \pm 1, b = \pm 1/\sqrt{2}, c = \pm 1/\sqrt{2}$
2. $a = \pm 1, b = \pm 1, c = 0$
3. $a = \pm 1, b = 0, c = \pm 1$
4. $a = \pm 1, b = \pm 1/2, c = 1/2$

Q48. [June 2017] . 5.0 marks

Mathematical Physics > Green Function

CSIR NET	2017 June	5M

The Green's function satisfying

$$\frac{d^2}{dx^2}g(x,x_0) = \delta(x-x_0)$$

with the boundary conditions $g(-L,x_0) = 0 = g(L,x_0)$, is

1. $\begin{cases} \frac{1}{2L}(x_0-L)(x+L), & -L \le x < x_0 \\ \frac{1}{2L}(x_0+L)(x-L), & x_0 \le x \le L \end{cases}$

2. $\begin{cases} \frac{1}{2L}(x_0+L)(x+L), & -L \le x < x_0 \\ \frac{1}{2L}(x_0-L)(x-L), & x_0 \le x \le L \end{cases}$

3. $\begin{cases} \frac{1}{2L}(L-x_0)(x+L), & -L \le x < x_0 \\ \frac{1}{2L}(x_0+L)(L-x), & x_0 \le x \le L \end{cases}$

4. $\frac{1}{2L}(x-L)(x+L), -L \le x \le L$

Q49. [June 2017] . 5.0 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2017 June	5M

Let $\sigma_x, \sigma_y, \sigma_z$ be the Pauli matrices and

$$x'\sigma_x + y'\sigma_y + z'\sigma_z = \exp\left(\frac{i\theta\sigma_z}{2}\right) \times [x\sigma_x + y\sigma_y + z\sigma_z] \exp\left(-\frac{i\theta\sigma_z}{2}\right).$$

Then the coordinates are related as follows

1. $\begin{pmatrix} x' \\ y' \\ z' \end{pmatrix} = \begin{pmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \end{pmatrix}$

2. $\begin{pmatrix} x' \\ y' \\ z' \end{pmatrix} = \begin{pmatrix} \cos\theta & \sin\theta & 0 \\ -\sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \end{pmatrix}$

3. $\begin{pmatrix} x' \\ y' \\ z' \end{pmatrix} = \begin{pmatrix} \cos\frac{\theta}{2} & \sin\frac{\theta}{2} & 0 \\ -\sin\frac{\theta}{2} & \cos\frac{\theta}{2} & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \end{pmatrix}$

4. $\begin{pmatrix} x' \\ y' \\ z' \end{pmatrix} = \begin{pmatrix} \cos\frac{\theta}{2} & -\sin\frac{\theta}{2} & 0 \\ \sin\frac{\theta}{2} & \cos\frac{\theta}{2} & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \end{pmatrix}$

Q50. [June 2017] . 5.0 marks

Mathematical Physics > Numerical Methods

CSIR NET	2017 June	5M

The interval $[0,1]$ is divided into $2n$ parts of equal length to calculate the integral $\int_0^1 e^{i2\pi x} dx$ using Simpson's $\frac{1}{3}$ rule. What is the minimum value of n for the result to be exact?

1. ∞
2. 2
3. 3
4. 4

Q51. [June 2017] . 5.0 marks

Mathematical Physics > Group Theory

CSIR NET	2017 June	5M

Which of the following sets of 3×3 matrices (in which a and b are real numbers) forms a group under matrix multiplication?

1. $\left\{\begin{pmatrix} 1 & 0 & a \\ 0 & 1 & 0 \\ b & 0 & 1 \end{pmatrix}; a, b \in \mathbb{R}\right\}$

2. $\left\{\begin{pmatrix} 1 & a & 0 \\ 0 & 1 & b \\ 0 & 0 & 1 \end{pmatrix}; a, b \in \mathbb{R}\right\}$

3. $\left\{\begin{pmatrix} 1 & 0 & a \\ 0 & 1 & b \\ 0 & 0 & 1 \end{pmatrix}; a, b \in \mathbb{R}\right\}$

4. $\left\{\begin{pmatrix} 1 & a & 0 \\ b & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}; a, b \in \mathbb{R}\right\}$

Q52. [June 2017] . 5.0 marks

Mathematical Physics > Probability

CSIR NET	2017 June	5M

A random variable n obeys Poisson statistics. The probability of finding $n = 0$ is 10^{-6}. The expectation value of n is nearest to

1. 14
2. 10^6
3. e
4. 10^2

Q53. [Dec 2018] . 3.5 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2018 Dec	3.5M

One of the eigenvalues of the matrix e^A is e^a, where $A = \begin{pmatrix} a & 0 & 0 \\ 0 & 0 & a \\ 0 & a & 0 \end{pmatrix}$. The product of the other two eigenvalues of e^A is

1. e^{2a}
2. e^{-a}
3. e^{-2a}
4. 1

Q54. [Dec 2018] . 3.5 marks

Mathematical Physics > Special Functions

CSIR NET	2018 Dec	3.5M

The polynomial $f(x) = 1 + 5x + 3x^2$ is written as linear combination of the Legendre polynomials $\left(P_0(x) = 1, P_1(x), P_2(x) = \frac{1}{2}(3x^2 - 1)\right)$ as $f(x) = \sum_n c_n P_n(x)$. The value of c_0 is

1. $\frac{1}{4}$
2. $\frac{1}{2}$
3. 2
4. 4

Q55. [Dec 2018] . 3.5 marks

Mathematical Physics > Complex analysis

CSIR NET	2018 Dec	3.5M

The value of the integral $\oint_C \frac{dz}{z}\frac{\tanh 2z}{\sin \pi z}$, where C is a circle of radius $\frac{\pi}{2}$, traversed counterclockwise, with center at $z = 0$, is

1. 4
2. $4i$
3. $2i$
4. 0

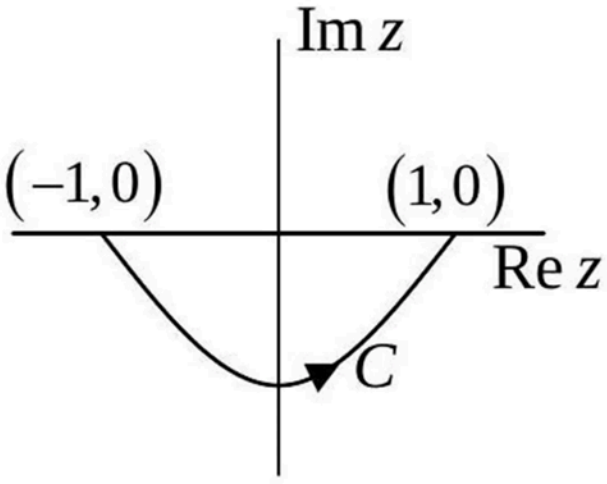
Q56. [Dec 2018] . 3.5 marks

Mathematical Physics > Complex analysis

CSIR NET	2018 Dec	3.5M

The integral $I = \int_C e^z dz$ is evaluated from the point $(-1,0)$ to $(1,0)$ along the contour C, which is an arc of the parabola $y = x^2 - 1$, as shown in the figure. The value of I is

1. 0
2. $2 sin\, h\, 1$
3. $e^{2i} sin\, h\, 1$
4. $e + e^{-1}$



Q57. [Dec 2018] . 3.5 marks

Mathematical Physics > Ordinary Differential Equations

CSIR NET	2018 Dec	3.5M

In terms of arbitrary constants A and B, the general solution to the differential equation

$$x^2\frac{d^2y}{dx^2} + 5x\frac{dy}{dx} + 3y = 0 \text{ is}$$

1. $y = \frac{A}{x} + Bx^3$
2. $y = Ax + \frac{B}{x^3}$
3. $y = Ax + Bx^3$
4. $y = \frac{A}{x} + \frac{B}{x^3}$

Q58. [Dec 2018] . 5.0 marks

Mathematical Physics > Green Function

CSIR NET	2018 Dec	5M

The Green's function $G(x,x')$ for the equation $\frac{d^2y(x)}{dx^2} = f(x)$, with the boundary values $y(0) = 0$ and $y(1) = 0$, is

1. $G(x,x') = \begin{cases} \frac{1}{2}x(1-x'), & 0 < x < x' < 1 \\ \frac{1}{2}x'(1-x) & 0 < x' < x < 1 \end{cases}$

2. $G(x,x') = \begin{cases} x(x'-1), & 0 < x < x' < 1 \\ x'(1-x) & 0 < x' < x < 1 \end{cases}$

3. $G(x,x') = \begin{cases} -\frac{1}{2}x(1-x'), & 0 < x < x' < 1 \\ \frac{1}{2}x'(1-x) & 0 < x' < x < 1 \end{cases}$

4. $G(x,x') = \begin{cases} x(x'-1), & 0 < x < x' < 1 \\ x'(x-1) & 0 < x' < x < 1 \end{cases}$

Q59. [Dec 2018] . 5.0 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2018 Dec	5M

A 4×4 complex matrix A satisfies the relation $A^{\dagger}A = 4I$, where I is the 4×4 identity matrix. The number of independent real parameters of A is

1. 32
2. 10
3. 12
4. 16

Q60. [Dec 2018] . 5.0 marks

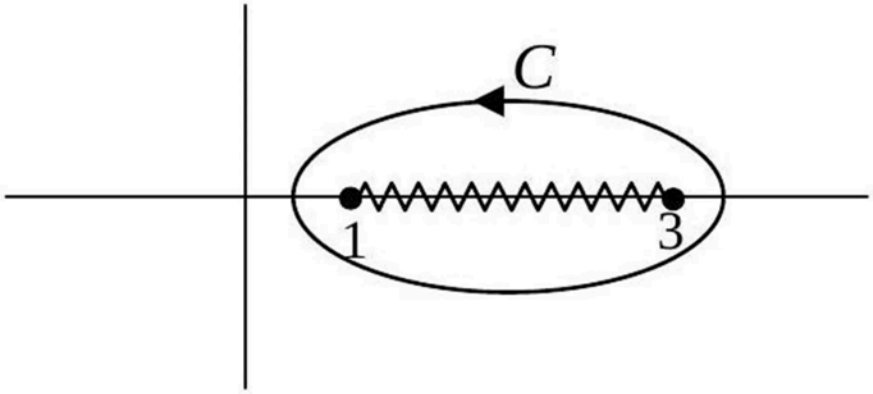
Mathematical Physics > Complex analysis

CSIR NET	2018 Dec	5M

The contour C of the following integral

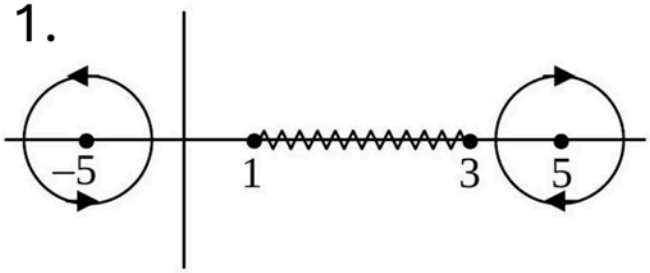
$$\oint_C dz \frac{\sqrt{(z-1)(z-3)}}{(z^2-25)^3}$$

in the complex z plane is shown in the figure below.

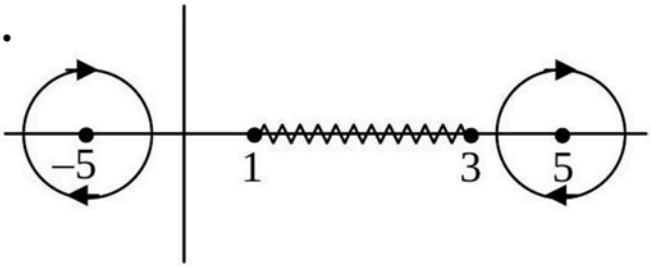


This integral is equivalent to an integral along the contours

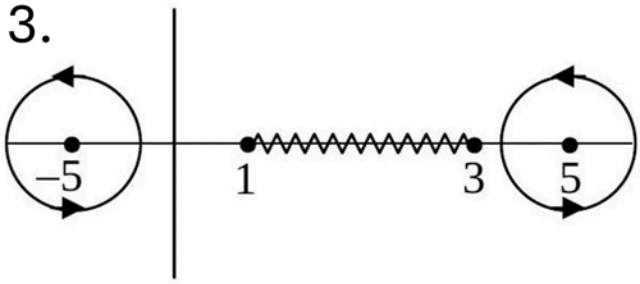
1.



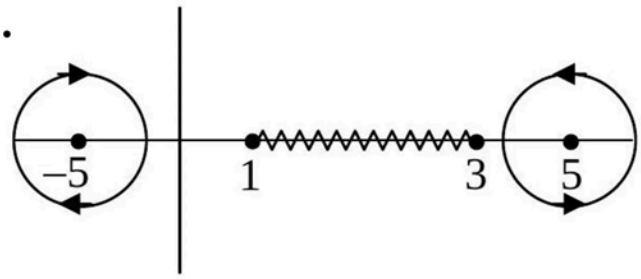
2.



3.



4.



Q61. [Dec 2018] . 5.0 marks

Mathematical Physics > Numerical Methods

CSIR NET	2018 Dec	5M

The value of the integral $\int_0^1 x^2 dx$, evaluated using the trapezoidal rule with a step size of 0.2 , is

1. 0.30
2. 0.39
3. 0.34
4. 0.27

Q62. [Dec 2018] . 5.0 marks

Mathematical Physics > Probability

CSIR NET	2018 Dec	5M

The standard deviation of the following set of data $\{10.0,10.0,9.9,9.9,9.8,9.9,9.9,9.9,9.8,9.9\}$ is nearest to

1. 0.10
2. 0.07
3. 0.01
4. 0.04

Q63. [June 2018] . 3.5 marks

Mathematical Physics > Vector Algebra and Vector Calculus

CSIR NET	2018 June	3.5M

Consider the three vectors $\vec{v}_1 = 2\hat{i} + 3\hat{k}, \vec{v}_2 = \hat{i} + 2\hat{j} + 2\hat{k}$ and $\vec{v}_3 = 5\hat{i} + \hat{j} + a\hat{k}$ where $\hat{i}, \hat{j}$ and $\hat{k}$ are the standard unit vectors in a three-dimensional Euclidean space. These vectors will be linearly dependent if the value of a is

1. $\frac{31}{4}$
2. $\frac{23}{4}$
3. $\frac{27}{4}$
4. 0

Q64. [June 2018] . 3.5 marks

Mathematical Physics > Fourier Transform

CSIR NET	2018 June	3.5M

The Fourier transform $\int_{-\infty}^{\infty} dx f(x) e^{ikx}$ of the function $f(x) = e^{-|x|}$

1. $-\frac{2}{1+k^2}$
2. $-\frac{1}{2(1+k^2)}$
3. $\frac{2}{1+k^2}$
4. $\frac{2}{(2+k^2)}$

Q65. [June 2018] . 3.5 marks

Mathematical Physics > Dirac Delta Function

CSIR NET	2018 June	3.5M

The value of the integral

$$\int_{-\pi/2}^{\pi/2} dx \int_{-1}^{+1} dy.\,\delta(\sin 2x)\delta(x-y) \text{ is}$$

1. 0
2. $\frac{1}{2}$
3. $\frac{1}{\sqrt{2}}$
4. 1

Q66. [June 2018] . 3.5 marks

Mathematical Physics > Ordinary Differential Equations

CSIR NET	2018 June	3.5M

Consider the following ordinary differential equation

$$\frac{d^2x}{dt^2} + \frac{1}{x}\left(\frac{dx}{dt}\right)^2 - \frac{dx}{dt} = 0$$

with the boundary conditions $x(t = 0) = 0$ and $x(t = 1) = 1$. The value of $x(t)$ at $t = 2$ is

1. $\sqrt{e - 1}$
2. $\sqrt{e^2 + 1}$
3. $\sqrt{e + 1}$
4. $\sqrt{e^2 - 1}$

Q67. [June 2018] . 3.5 marks

Mathematical Physics > Complex analysis

CSIR NET	2018 June	3.5M

What is the value of a for which $f(x,y) = 2x + 3(x^2 - y^2) + 2i(3xy + ay)$ is an analytic function of complex variable $z = x + iy$

1. 1
2. 0
3. 3
4. 2

Q68. [June 2018] . 5.0 marks

Mathematical Physics > Special Functions

CSIR NET	2018 June	5M

In the function $P_n(x)e^{-x^2}$ of a real variable x, $P_n(x)$ is polynomial of degree n. The maximum number of extrema that this function can have is

1. n+2
2. n-1
3. n+1
4. n

Q69. [June 2018] . 5.0 marks

Mathematical Physics > Green Function

CSIR NET	2018 June	5M

The Green's function $G(x,x')$ for the equation $\frac{d^2y(x)}{dx^2}+y(x)=f(x)$, with the boundary values $y(0)=y\left(\frac{\pi}{2}\right)=0$, is

1. $G(x,x') = \begin{cases} x\left(x'-\frac{\pi}{2}\right), & 0<x<x'<\frac{\pi}{2} \\ \left(x-\frac{\pi}{2}\right)x', & 0<x'<x<\frac{\pi}{2} \end{cases}$

2. $G(x,x') = \begin{cases} -\cos x' \sin x, & 0<x<x'<\frac{\pi}{2} \\ -\sin x' \cos x, & 0<x'<x<\frac{\pi}{2} \end{cases}$

3. $G(x,x') = \begin{cases} \cos x' \sin x, & 0<x<x'<\frac{\pi}{2} \\ \sin x' \cos x, & 0<x'<x<\frac{\pi}{2} \end{cases}$

4. $G(x,x') = \begin{cases} x\left(\frac{\pi}{2}-x'\right), & 0<x<x'<\frac{\pi}{2} \\ x'\left(\frac{\pi}{2}-x\right), & 0<x'<x<\frac{\pi}{2} \end{cases}$

Q70. [June 2018] . 5.0 marks

Mathematical Physics > Numerical Methods

CSIR NET	2018 June	5M

The fractional error in estimating the integral $\int_0^1 xdx$ using Simpson's $\frac{1}{3}$ rule, using a step size 0.1, is nearest to

1. 10^{-4}

2. 0

3. 10^{-2}

4. 3×10^{-4}

Q71. [June 2018] . 5.0 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2018 June	5M

Which of the following statements is true for a 3×3 real orthogonal matrix with determinant +1 ?

1. the modulus of each of its eigenvalues need not be 1 , but their product must be 1
2. at least one of its eigenvalues is +1
3. all of its eigenvalues must be real
4. none of its eigenvalues must be real

Q72. [Dec 2019] . 3.5 marks

Mathematical Physics > Vector Algebra and Vector Calculus

CSIR NET	2019 Dec	3.5M

Consider the set of polynomials $\{x(t) = a_0 + a_1 t + \cdots + a_{n-1} t^{n-1}\}$ in t of degree less than n, such that $x(0) = 0$ and $x(1) = 1$. This set

1. constitutes a vector space of dimension n
2. constitutes a vector space of dimension $n - 1$
3. constitutes a vector space of dimension $n - 2$
4. does not constitute a vector space

Q73. [Dec 2019] . 3.5 marks

Mathematical Physics > Complex analysis

CSIR NET	2019 Dec	3.5M

Let C be the circle of radius $\frac{\pi}{4}$ centered at $z = \frac{1}{4}$ in the complex z-plane that is traversed counter-clockwise. The value of the contour integral $\oint_C \frac{z^2}{\sin^2 4z} dz$ is

1. 0
2. $\frac{i\pi^2}{4}$
3. $\frac{i\pi^2}{16}$
4. $\frac{i\pi}{4}$

Q74. [Dec 2019] . 3.5 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2019 Dec	3.5M

If the rank of an $n \times n$ matrix A is m, where m and n are positive integers with $1 \leq m \leq n$, then the rank of the matrix A^2 is

1. m
2. $m - 1$
3. 2 m
4. $m - 2$

Q75. [Dec 2019] . 3.5 marks

Mathematical Physics > Vector Algebra and Vector Calculus

CSIR NET	2019 Dec	3.5M

The values of a and b for which the force $F = (axy + z^3)\hat{i} + x^2\hat{j} + bxz^2\hat{k}$ is conservative are

1. $a = 2, b = 3$
2. $a = 1, b = 3$
3. $a = 2, b = 6$
4. $a = 3, b = 2$

Q76. [Dec 2019] . 3.5 marks

Mathematical Physics > Probability

CSIR NET	2019 Dec	3.5M

A box contains 5 white and 4 black balls. Two balls are packed together at random from the box. What is the probability that these two balls are of different colours?

1. $\frac{1}{2}$
2. $\frac{5}{18}$
3. $\frac{1}{3}$
4. $\frac{5}{9}$

Q77. [Dec 2019] . 5.0 marks

Mathematical Physics > Numerical Methods

CSIR NET	2019 Dec	5M

The positive zero of the polynomials $f(x) = x^2 - 4$ is determined using Newton-Raphson method, using initial guess $x = 1$. Let the estimate, after two iterations, be $x^{(2)}$. The percentage error $\left|\frac{x^{(2)}-2}{2}\right| \times 100\%$ is

1. 7.5%
2. 5.0%
3. 1.0%
4. 2.5%

Q78. [Dec 2019] . 5.0 marks

Mathematical Physics > Fourier Series

CSIR NET	2019 Dec	5M

The function $f(t)$ is a periodic function of period 2π. In the range $(-\pi, \pi)$, it equals e^{-t}. If $f(t) = \sum_{-\infty}^{\infty} c_n e^{\text{int}}$ denotes its Fourier series expansion, the sum $\sum_{-\infty}^{\infty} |c_n|^2$ is

1. 1
2. $\frac{1}{2\pi}$
3. $\frac{1}{2\pi}\cosh(2\pi)$
4. $\frac{1}{2\pi}\sinh(2\pi)$

Q79. [June 2019] . 3.5 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2019 June	3.5M

The element of a 3×3 matrix A are the products if its row and column indices $A_{ij} = ij$

(where $i, j = 1,2,3$). The eigenvalues of A are

1. $(7,7,0)$
2. $(7,4,3)$
3. $(14,0,0)$
4. $\left(\frac{14}{3}, \frac{14}{3}, \frac{14}{3}\right)$

Q80. [June 2019] . 3.5 marks

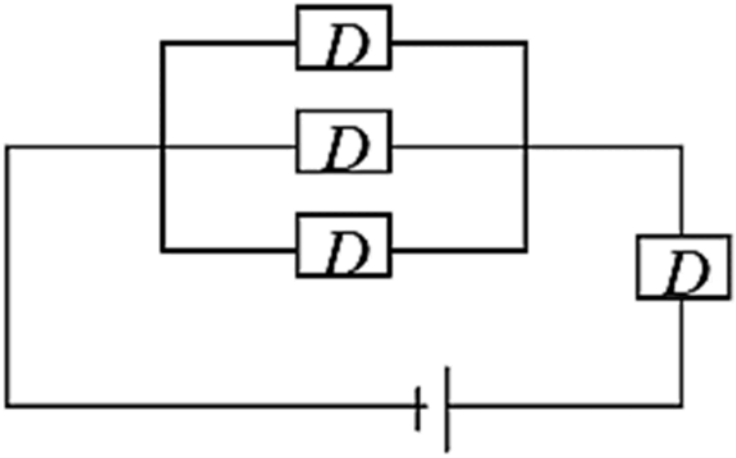
Mathematical Physics > Probability

CSIR NET	2019 June	3.5M

In the following circuit, each device D may be an insulator with probability p or a conductor with probability $(1-p)$.

The probability that a non-zero current flows through the circuit is

1. $2-p-p^3$
2. $(1-p)^4$
3. $(1-p)^2p^2$
4. $(1-p)(1-p^3)$



Q81. [June 2019] . 3.5 marks

Mathematical Physics > Ordinary Differential Equations

CSIR NET	2019 June	3.5M

The solution of the differential equation

$x\frac{dy}{dx}+(1+x)y=e^{-x}$ with the boundary condition $y(x=1)=0$, is

1. $\frac{(x-1)}{x}e^{-x}$
2. $\frac{(x-1)}{x^2}e^{-x}$
3. $\frac{(1-x)}{x^2}e^{-x}$
4. $(x-1)^2e^{-x}$

Q82. [June 2019] . 3.5 marks

Mathematical Physics > Complex analysis

CSIR NET	2019 June	3.5M

The value of the definite integral $\int_0^{\pi} \frac{d\theta}{5+4\cos\theta}$ is

1. $\frac{4\pi}{3}$
2. $\frac{2\pi}{3}$
3. π
4. $\frac{\pi}{3}$

Q83. [June 2019] . 5.0 marks

Mathematical Physics > Numerical Methods

CSIR NET	2019 June	5M

If the Newton-Raphson method is used to find the positive root of the equation $x = 2\sin x$, the iteration equation is

1. $x_{n+1} = \frac{2x_n - 2(\sin x_n + x_n \cos x_n)}{1 - 2\cos x_n}$
2. $x_{n+1} = \frac{2(\sin x_n - x_n \cos x_n)}{1 - 2\cos x_n}$
3. $x_{n+1} = \frac{x_n^2 - 1 + 2(\cos x_n - x_n \sin x_n)}{x_n - 2\sin x_n}$
4. $x_{n+1} = \frac{x_n^2 - 1 - 2(\cos x_n + \sin x_n)}{x_n - 2\sin x_n}$

Q84. [June 2020] . 3.5 marks

Mathematical Physics > Vector Algebra and Vector Calculus

CSIR NET	2020 June	3.5M

Two time dependent non-zero vectors $\vec{u}(t)$ and $\vec{v}(t)$, which are not initially parallel to each other, satisfy $\vec{u} \times \frac{d\vec{v}}{dt} - \vec{v} \times \frac{d\vec{u}}{dt} = 0$ at all time t. If the area of the parallelogram formed by $\vec{u}(t)$ and $\vec{v}(t)$ be $A(t)$ and the unit normal vector to it be $\hat{n}(t)$, then

1. $A(t)$ increases linearly with t, but $\hat{n}(t)$ is a constant
2. $A(t)$ increases linearly with t, and $\hat{n}(t)$ rotates about $\vec{u}(t) \times \vec{v}(t)$
3. $A(t)$ is a constant, but $\hat{n}(t)$ rotates about $\vec{u}(t) \times \vec{v}(t)$
4. $A(t)$ and $\hat{n}(t)$ are constants

Q85. [June 2020] . 3.5 marks

Mathematical Physics > Probability

CSIR NET	2020 June	3.5M

A basket consists of an infinite number of red and black balls in the proportion $p:(1-p)$. Three balls are drawn at random without replacement. The probability of their being two red and one black is a maximum for

1. $p = \frac{3}{4}$
2. $p = \frac{3}{5}$
3. $p = \frac{1}{2}$
4. $p = \frac{2}{3}$

Q86. [June 2020] . 3.5 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2020 June	3.5M

The eigenvalues of the 3×3 matrix $M = \begin{pmatrix} a^2 & ab & ac \\ ab & b^2 & bc \\ ac & bc & c^2 \end{pmatrix}$ are

1. $a^2 + b^2 + c^2, 0, 0$
2. $b^2 + c^2, a^2, 0$
3. $a^2 + b^2, c^2, 0$
4. $a^2 + c^2, b^2, 0$

Q87. [June 2020] . 3.5 marks

Mathematical Physics > Complex analysis

CSIR NET	2020 June	3.5M

A function of a complex variable z is defined by the integral $f(z) = \oint_\Gamma \frac{w^2-2}{w-z} dw$, where Γ is a circular contour of radius 3, centred at origin, running counter-clockwise in the w - plane. The value of the function at $z = (2 - i)$ is

1. 0
2. $1 - 4i$
3. $8\pi + 2\pi i$
4. $-\frac{2}{\pi} - \frac{i}{2\pi}$

Q88. [June 2020] . 5.0 marks

Mathematical Physics > Numerical Methods

CSIR NET	2020 June	5M

Using the following values of x and f(x) the integral $I = \int_0^{1.5} f(x)dx$, evaluated by the Trapezoidal rule, is 5/16. The value of a is

x	0	0.5	1.0	1.5
f(x)	1	a	0	−5/4

1. 3/4
2. 3/2
3. 7/4
4. 19/24

Q89. [June 2020] . 5.0 marks

Mathematical Physics > Green Function

CSIR NET	2020 June	5M

The Green's function for the differential equation $\frac{d^2x}{dt^2} + x = f(t)$, satisfying the initial conditions $x(0) = \frac{dx}{dt}(0) = 0$ is

$$G(t,\tau) = \begin{cases} 0 & \text{for} \quad 0 < t < \tau \\ \sin(t-\tau) & \text{for} \quad t > \tau \end{cases}$$

The solution of the differential equation when the source $f(t) = \theta(t)$ (the Heaviside step function) is

1. $\sin t$
2. $1 - \sin t$
3. $1 - \cos t$
4. $\cos^2 t - 1$

Q90. [June 2020] . 5.0 marks

Mathematical Physics > Ordinary Differential Equations

CSIR NET	2020 June	5M

The solution of the differential equation $\left(\frac{dy}{dx}\right)^2 - \frac{d^2y}{dx^2} = e^y$, with the boundary conditions $y(0) = 0$ and $y'(0) = -1$, is

1. $-\ln\left(\frac{x^2}{2} + x + 1\right)$
2. $-x\ln(e + x)$
3. $-xe^{-x^2}$
4. $-x(x + 1)e^{-x}$

Q91. [June 2021] . 3.5 marks

Mathematical Physics > Ordinary Differential Equations

CSIR NET	2021 June	3.5M

The equation of motion of a one-dimensional forced harmonic oscillator in the presence of a dissipative force is described by $\frac{d^2x}{dt^2} + 10\frac{dx}{dt} + 16x = 6te^{-8t} + 4t^2e^{-2t}$. The general form of the particular solution, in terms of constants A, B etc., is

1. $t(At^2 + Bt + C)e^{-2t} + (Dt + E)e^{-8t}$
2. $(At^2 + Bt + C)e^{-2t} + (Dt + E)e^{-8t}$
3. $t(At^2 + Bt + C)e^{-2t} + t(Dt + E)e^{-8t}$
4. $(At^2 + Bt + C)e^{-2t} + t(Dt + E)e^{-8t}$

Q92. [June 2021] . 3.5 marks

Mathematical Physics > Basic Mathematics

CSIR NET	2021 June	3.5M

The volume of the region common to the interiors of two infinitely long cylinders defined by $x^2 + y^2 = 25$ and $x^2 + 4z^2 = 25$ is best approximated by

1. 225
2. 333
3. 423
4. 625

Q93. [June 2021] . 3.5 marks

Mathematical Physics > Vector Algebra and Vector Calculus

CSIR NET	2021 June	3.5M

The volume integral $I = \iiint_V \vec{A} \cdot (\vec{\nabla} \times \vec{A}) d^3x$ is over a region V bounded by a surface $\sum$ (an infinitesimal area element being $\hat{nds}$, where $\hat{n}$ is the outward unit normal). If it changes to $I + \Delta I$ when the vector $\vec{A}$ is changed to $\vec{A} + \vec{\nabla}\Lambda$, then ΔI can be expressed as

1. $\iiint_V \vec{\nabla} \cdot (\vec{\nabla}\Lambda \times \vec{A}) d^3x$
2. $-\iiint_V \nabla^2 \Lambda d^3x$
3. $-\oiint_\Sigma (\vec{\nabla}\Lambda \times \vec{A}) \cdot \hat{n} ds$
4. $\oiint_\Sigma \vec{\nabla}\Lambda . \hat{n} ds$

Q94. [June 2021] . 3.5 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2021 June	3.5M

A generic 3×3 real matrix A has eigenvalues 0,1 and 6, and I is the 3×3 identity matrix. The quantity/quantities that cannot be determined from this information is/are the

1. eigenvalue of $(\mathrm{I} + \mathrm{A})^{-1}$
2. eigenvalue of $\left(\mathrm{I} + \mathrm{A}^{\mathrm{T}}\mathrm{A}\right)$
3. determinant of $\mathrm{A}^{\mathrm{T}}\mathrm{A}$
4. rank of A

Q95. [June 2021] . 3.5 marks

Mathematical Physics > Probability

CSIR NET	2021 June	3.5M

A discrete random variable X takes a value from the set $\{-1,0,1,2\}$ with the corresponding probabilities $p(X) = 3/10,2/10,2/10$ and $3/10$, respectively. The probability distribution $q(Y) = (q(0), q(1), q(4))$ of the random variable $Y = X^2$ is

1. $\left(\frac{1}{5}, \frac{3}{5}, \frac{1}{5}\right)$
2. $\left(\frac{1}{5}, \frac{1}{2}, \frac{3}{10}\right)$
3. $\left(\frac{2}{5}, \frac{2}{5}, \frac{1}{5}\right)$
4. $\left(\frac{3}{10}, \frac{3}{10}, \frac{2}{5}\right)$

Q96. [June 2021] . 3.5 marks

Mathematical Physics > Tensors

CSIR NET	2021 June	3.5M

The components of the electric field, in a region of space devoid of any change or current sources, are given to be $E_i = a_i + \sum_{j=1,2,3} b_{ij}x_j$, where a_i and b_{ij} are constants independent of the coordinates. The number of independent components of the matrix b_{ij} is

1. 5
2. 6
3. 3
4. 4

Q97. [June 2021] . 5.0 marks

Mathematical Physics > Fourier Transform

CSIR NET	2021 June	5M

If we use the Fourier transform

$$\phi(x,y) = \int e^{ikx}\phi_k(y)dk$$

to solve the partial differential equation

$$-\frac{\partial^2\phi(x,y)}{\partial y^2} - \frac{1}{y^2}\frac{\partial^2\phi(x,y)}{\partial x^2} + \frac{m^2}{y^2}\phi(x,y) = 0$$

in the half-plane $\{(x,y): -\infty < x < \infty, 0 < y < \infty\}$ the Fourier modes $\phi_k(y)$ depend on y as y^α and y^β. The value of α and β are

1. $\frac{1}{2} + \sqrt{1 + 4(k^2 + m^2)}$ and $\frac{1}{2} - \sqrt{1 + 4(k^2 + m^2)}$
2. $1 + \sqrt{1 + 4(k^2 + m^2)}$ and $1 - \sqrt{1 + 4(k^2 + m^2)}$
3. $\frac{1}{2} + \frac{1}{2}\sqrt{1 + 4(k^2 + m^2)}$ and $\frac{1}{2} - \frac{1}{2}\sqrt{1 + 4(k^2 + m^2)}$
4. $1 + \frac{1}{2}\sqrt{1 + 4(k^2 + m^2)}$ and $1 - \frac{1}{2}\sqrt{1 + 4(k^2 + m^2)}$

Q98. [June 2021] . 5.0 marks

Mathematical Physics > Numerical Methods

CSIR NET	2021 June	5M

The Newton-Raphson method is to be used to determine the reciprocal of the number $x = 4$. If we start with the initial guess 0.20 then after the first iteration the reciprocal is

1. 0.23
2. 0.24
3. 0.25
4. 0.26

Q99. [June 2021] . 5.0 marks

Mathematical Physics > Special Functions

CSIR NET	2021 June	5M

The Legendre polynomials $P_n(x), n = 0,1,2, \ldots$, satisfying the orthogonality condition $\int_{-1}^{1} P_n(x) p_m(x) dx = \frac{2}{2n+1}\delta_{nm}$ on the interval $[-1, +1]$, may be defined by the Rodrigues formula $P_n(x) = \frac{1}{2^n n!}\frac{d^n}{dx^n}(x^2 - 1)^n$. The value of the definite integral $\int_{-1}^{1}(4 + 2x - 3x^2 + 4x^3)P_3(x)dx$ is

1. 3/5
2. 11/15
3. 23/32
4. 16/35

Q100. [June 2022] . 3.5 marks

Mathematical Physics > Gamma and beta functions

CSIR NET	2022 June	3.5M

The value of the integral $\int_0^\infty dx e^{-x^{2m}}$, where m is a positive integer, is

1. $\Gamma\left(\frac{m+1}{2m}\right)$
2. $\Gamma\left(\frac{m-1}{2m}\right)$
3. $\Gamma\left(\frac{2m+1}{2m}\right)$
4. $\Gamma\left(\frac{2m-1}{2m}\right)$

Q101. [June 2022] . 3.5 marks

Mathematical Physics > Complex analysis

CSIR NET	2022 June	3.5M

At $z = 0$, the function $\frac{1}{z-\sin z}$ of a complex variable z has

1. no singularity
2. a simple pole
3. a pole of order 2
4. a pole of order 3

Q102. [June 2022] . 3.5 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2022 June	3.5M

Two $n \times n$ invertible real matrices A and B satisfy the relation $(AB)^T = -(A^{-1}B)^{-1}$

If B is orthogonal then A must be

1. Lower triangular
2. Orthogonal
3. Symmetric
4. Antisymmetric

Q103. [June 2022] . 3.5 marks

Mathematical Physics > Basic Mathematics

CSIR NET	2022 June	3.5M

The infinite series $\sum_{n=0}^{\infty}(n^2 + 3n + 2)x^n$ evaluated at $x = \frac{1}{2}$, is

1. 16
2. 32
3. 8
4. 24

Q104. [June 2022] . 3.5 marks

Mathematical Physics > Complex analysis

CSIR NET	2022 June	3.5M

If $z = i^{i^{i'}}$ (note that the exponent continues indefinitely), then a possible value of $\frac{1}{z}\ln z$ is

1. $2i \ln i$
2. $l n i$
3. $i \ln i$
4. $2\ln i$

Q105. [June 2022] . 5.0 marks

Mathematical Physics > Probability

CSIR NET	2022 June	5M

A bucket contains 6 red and 4 blue balls. A ball is taken out of the bucket at random and two balls of the same colour are put back. This step is repeated once more. The probability that the numbers of red and blue balls are equal at the end, is

1. $4/11$
2. $2/11$
3. $1/4$
4. $3/4$

Q106. [June 2022] . 5.0 marks

Mathematical Physics > Complex analysis

CSIR NET	2022 June	5M

The value of the integral $\int_{-\infty}^{\infty} \frac{\cos \alpha x}{x^2+1} dx$, for $\alpha > 0$, is

1. πe^{α}
2. $\pi e^{-\alpha}$
3. $\pi e^{-\alpha/2}$
4. $\pi e^{\alpha/2}$

Q107. [June 2022] . 5.0 marks

Mathematical Physics > Laplace transform

CSIR NET	2022 June	5M

The Laplace transform $L[f](y)$ of the function

$f(x) = \begin{cases} 1 \text{ for } 2n \leq x \leq 2n+1 \\ 0 \text{ for } 2n+1 \leq x \leq 2n+2 \end{cases}$, $n = 0,1,2, \ldots$ is

1. $\frac{e^{-y}(e^{-y}+1)}{y(e^{-2y}+1)}$
2. $\frac{e^{y}-e^{-y}}{y}$
3. $\frac{e^{y}+e^{-y}}{y}$
4. $\frac{e^{y}(e^{y}-1)}{y(e^{2y}-1)}$

Q108. [June 2022] . 5.0 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2022 June	5M

The matrix corresponding to the differential operator $\left(1+\frac{d}{dx}\right)$ in the space of polynomials of degree at most two, in the basis spanned by $f_1 = 1$, $f_2 = x$ and $f_3 = x^2$, is

1. $\begin{pmatrix} 1 & 1 & 0 \\ 0 & 1 & 2 \\ 0 & 0 & 1 \end{pmatrix}$
2. $\begin{pmatrix} 1 & 0 & 0 \\ 1 & 1 & 0 \\ 0 & 2 & 1 \end{pmatrix}$
3. $\begin{pmatrix} 1 & 1 & 0 \\ 0 & 1 & 1 \\ 0 & 0 & 2 \end{pmatrix}$
4. $\begin{pmatrix} 1 & 0 & 0 \\ 1 & 1 & 0 \\ 0 & 1 & 2 \end{pmatrix}$

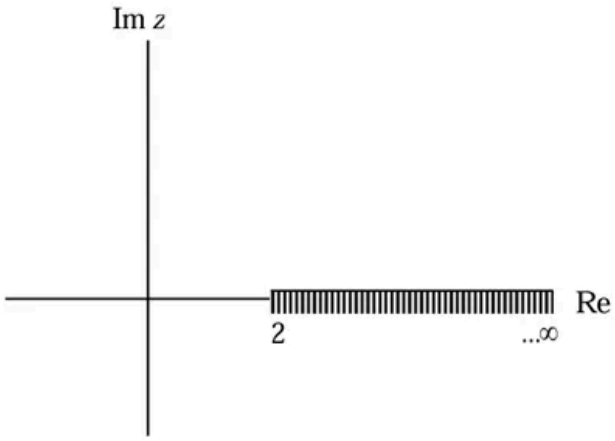
Q109. [Dec 2023] . 3.5 marks

Mathematical Physics > Complex analysis

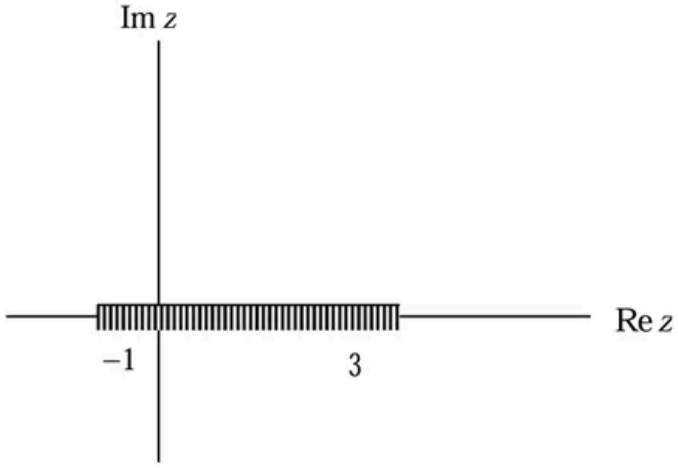
CSIR NET	2023 Dec	3.5 M

The branch line for the function $f(z) = \sqrt{\frac{z^2-5z+6}{z^2+2z+1}}$ is

1.



2.



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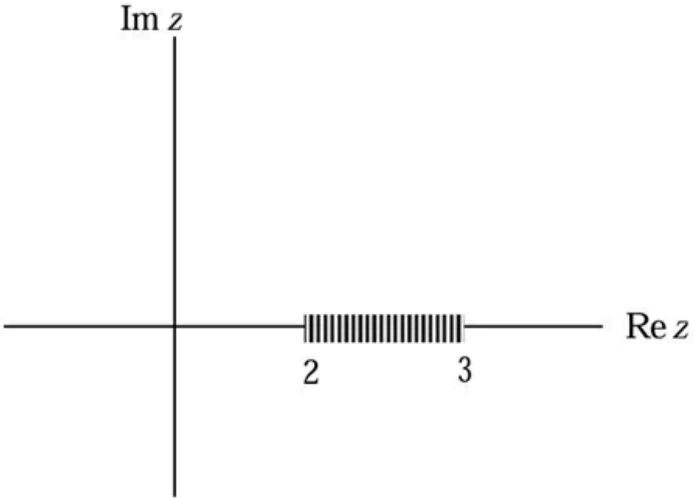
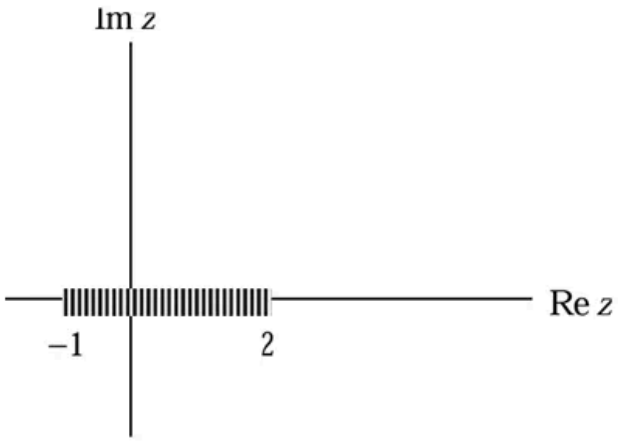


4.



Q110. [Dec 2023] . 3.5 marks

Mathematical Physics > Gamma and beta functions

CSIR NET	2023 Dec	3.5 M

The Beta function is defined as

$$B(x,y) = \int_0^1 t^{x-1}(1-t)^{y-1}dt.$$

Then $B(x, y+1) + B(x+1, y)$ can be expressed as

1. $B(x, y-1)$
2. $B(x+y, 1)$
3. $B(x+y, x-y)$
4. $B(x, y)$

Q111. [Dec 2023] . 3.5 marks

Mathematical Physics > Complex analysis

CSIR NET	2023 Dec	3.5 M

If z is a complex number, which among the following sets is neither open nor closed?

1. $\{z|0 \leq |z-1| \leq 2\}$
2. $\{z||z| \leq 1\}$
3. $\{z \mid z \in (\mathbf{C} - \{3\}) \text{ and } |z| \leq 100\}$
4. $\left\{z \mid z = re^{i\theta}, 0 \leq \theta \leq \frac{\pi}{4}\right\}$

Q112. [Dec 2023] . 3.5 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2023 Dec	3.5 M

Let M be a 3×3 real matrix such that

$$e^{M\theta} = \begin{vmatrix} \cos\theta & \sin\theta & 0 \\ -\sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{vmatrix}$$ where θ is a real parameter. Then M is given by

1. $\begin{bmatrix} -1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$
2. $\begin{bmatrix} 0 & 1 & 0 \\ -1 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$
3. $\begin{bmatrix} 0 & 0 & 1 \\ 0 & -1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$
4. $\begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

Q113. [Dec 2023] . 5.0 marks

Mathematical Physics > Group Theory

CSIR NET	2023 Dec	5 M

The regular representation of two nonidentity elements of the group of order 3 are given by

1. $\begin{pmatrix}0&1&0\\1&0&0\\0&0&1\end{pmatrix}, \begin{pmatrix}0&0&1\\0&1&0\\1&0&0\end{pmatrix}$
2. $\begin{pmatrix}1&0&0\\0&0&1\\0&1&0\end{pmatrix}, \begin{pmatrix}0&1&0\\1&0&0\\0&0&1\end{pmatrix}$
3. $\begin{pmatrix}0&0&1\\1&0&0\\0&1&0\end{pmatrix}, \begin{pmatrix}0&1&0\\0&0&1\\1&0&0\end{pmatrix}$
4. $\begin{pmatrix}0&0&1\\0&1&0\\1&0&0\end{pmatrix}, \begin{pmatrix}0&0&1\\1&0&0\\0&1&0\end{pmatrix}$

Q114. [Dec 2023] . 5.0 marks

Mathematical Physics > Numerical Methods

CSIR NET	2023 Dec	5 M

Given the date points

x	1	3	5
y	4	28	92

Using Lagrange's method of interpolation, the value of y at $x = 4$ is closest to

1. 54
2. 55
3. 53
4. 56

Q115. [Dec 2023] . 5.0 marks

Mathematical Physics > Complex analysis

CSIR NET	2023 Dec	5 M

The function $f(z) = \frac{1}{(z+1)(z+3)}$ is defined on the complex plane. The coefficient of the $(z - z_0)^2$ term of the Laurent series of $f(z)$ about $z_0 = 1$ is

1. $\frac{7}{64}$
2. $\frac{7}{128}$
3. $\frac{9}{64}$
4. $\frac{9}{128}$

Q116. [Dec 2023] . 5.0 marks

Mathematical Physics > Ordinary Differential Equations

CSIR NET	2023 Dec	5 M

The solution $y(x)$ of the differential equation $y'' + \frac{y}{4} = \frac{x}{2}$, where $0 \leq x \leq \pi$, together with the boundary conditions $y(0) = y(\pi) = 0$ is

1. $\frac{2}{\pi}\sum_{n=1}^{\infty}(-1)^n \frac{\pi}{n}\frac{\sin nx}{\frac{1}{4}-n^2}$
2. $\frac{2}{\pi}\sum_{n=1}^{\infty}(-1)^n \frac{\pi}{2n}\frac{\sin nx}{\frac{1}{4}-n^2}$
3. $\frac{2}{\pi}\sum_{n=1}^{\infty}(-1)^{n+1} \frac{\pi}{n}\frac{\sin nx}{\frac{1}{4}-n^2}$
4. $\frac{2}{\pi}\sum_{n=1}^{\infty}(-1)^{n+1} \frac{\pi}{2n}\frac{\sin nx}{\frac{1}{4}-n^2}$

Q117. [June 2023] . 3.5 marks

Mathematical Physics > Basic Mathematics

CSIR NET	2023 June	3.5M

The value of the integral $I = \int_0^{\infty} e^{-x} x \sin(x) dx$ is

1. 3/4
2. 2/3
3. 1/2
4. 1/4

Q118. [June 2023] . 3.5 marks

Mathematical Physics > Probability

CSIR NET	2023 June	3.5M

A jar J1 contains equal number of balls of red, blue and green colours, while another jar J2 contains balls of only red and blue colours, which are also equal in number. The probability of choosing J1 is twice as large as choosing J2. If a ball picked at random from one of the jars turns out to be red, the probability that it came from

1. 2/3
2. 3/5
3. 2/5
4. 4/7

Q119. [June 2023] . 3.5 marks

Mathematical Physics > Complex analysis

CSIR NET	2023 June	3.5M

The locus of the curve $\mathrm{Im}\left(\frac{\pi(z-1)-1}{z-1}\right) = 1$ in the complex z-plane is a circle centred at (x_0, y_0) and radius R. The values of (x_0, y_0) and R, respectively, are

1. $\left(1, \frac{1}{2}\right)$ and $\frac{1}{2}$
2. $\left(1, -\frac{1}{2}\right)$ and $\frac{1}{2}$
3. $(1,1)$ and 1
4. $(1,-1)$ and 1

Q120. [June 2023] . 3.5 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2023 June	3.5M

The matrix $M = \begin{pmatrix} 3 & -1 & 2 \\ -1 & 2 & 0 \\ 2 & 0 & 1 \end{pmatrix}$ satisfies the equation $M^3 + \alpha M^2 + \beta M + 3 = 0$ if (α, β) are

1. $(-2,2)$
2. $(-3,3)$
3. $(-6,6)$
4. $(-4,4)$

Q121. [June 2023] . 5.0 marks

Mathematical Physics > Probability

CSIR NET	2023 June	5M

A random variable Y obeys a normal distribution

$$P(Y) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left[-\frac{(Y-\mu)^2}{2\sigma^2}\right]$$

The mean value of e^r is

1. $e^{\mu+\frac{\sigma^2}{2}}$
2. $e^{\mu-\sigma^2}$
3. $e^{\mu+\sigma^2}$
4. $e^{\mu-\frac{\sigma^2}{2}}$

Q122. [June 2023] . 5.0 marks

Mathematical Physics > Numerical Methods

CSIR NET	2023 June	5M

The bisection method is used to find a zero x_0 of the polynomial $f(x) = x^3 - x^2 - 1$. Since $f(1) = -1$, while $f(2) = 3$, the values $a = 1$ and $b = 2$ are chosen as the boundaries of the interval in which the x_0 lies. If the bisection method is iterated three times, the resulting value of x_0 is

1. 15/8
2. 13/8
3. 11/8
4. 9/8

Q123. [June 2023] . 5.0 marks

Mathematical Physics > Dirac Delta Function

CSIR NET	2023 June	5M

The value of the integral $\int_{-\infty}^{\infty} dx 2^{-\frac{|x|}{\pi}} \delta(\sin x)$ where $\delta(x)$ is the Dirac delta function, is

1. 3
2. 0
3. 5
4. 1

Q124. [June 2023] . 5.0 marks

Mathematical Physics > Special Functions

CSIR NET	2023 June	5M

If the Bessel function of integer order n is defined as $J_n(x) = \sum_{k=0}^{\infty} \frac{(-1)^k}{k!(n+k)!}\left(\frac{x}{2}\right)^{2k+n}$ then $\frac{d}{dx}[x^{-n}J_n(x)]$ is

1. $-x^{-[n+1]}J_{n+1}(x)$
2. $-x^{-[n+1]}J_{n-1}(x)$
3. $-x^{-n}J_{n-1}(x)$
4. $-x^{-n}J_{n+1}(x)$

Q125. [June 2023] . 5.0 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2023 June	5M

The matrix $R_{\hat{n}}(\theta)$ represents a rotation by an angle

to the matrix $\begin{pmatrix} -1 & 0 & 0 \\ 0 & -\frac{1}{3} & \frac{2\sqrt{2}}{3} \\ 0 & \frac{2\sqrt{2}}{3} & \frac{1}{3} \end{pmatrix}$, respectively, are

1. $\pi/2$ and $\left(0, -\sqrt{\frac{2}{3}}, \frac{1}{\sqrt{3}}\right)$
2. $\pi/2$ and $\left(0, \frac{1}{\sqrt{3}}, \sqrt{\frac{2}{3}}\right)$
3. π and $\left(0, -\sqrt{\frac{2}{3}}, \frac{1}{\sqrt{3}}\right)$
4. π and $\left(0, \frac{1}{\sqrt{3}}, \sqrt{\frac{2}{3}}\right)$

Q126. [Dec 2024] . 3.5 marks

Mathematical Physics > Basic Mathematics

CSIR NET	2024 Dec	3.5M

Given the sum of the infinite series

$$\frac{1}{1^4}+\frac{1}{2^4}+\frac{1}{3^4}+\frac{1}{4^4}\cdots=\frac{\pi^4}{90}$$

the sum of the infinite series

$$\frac{1}{1^4}+\frac{1}{3^4}+\frac{1}{5^4}+\cdots$$

would be

1. $\frac{\pi^4}{128}$
2. $\frac{\pi^4}{144}$
3. $\frac{\pi^4}{120}$
4. $\frac{\pi^4}{96}$

Q127. [Dec 2024] . 3.5 marks

Mathematical Physics > Complex analysis

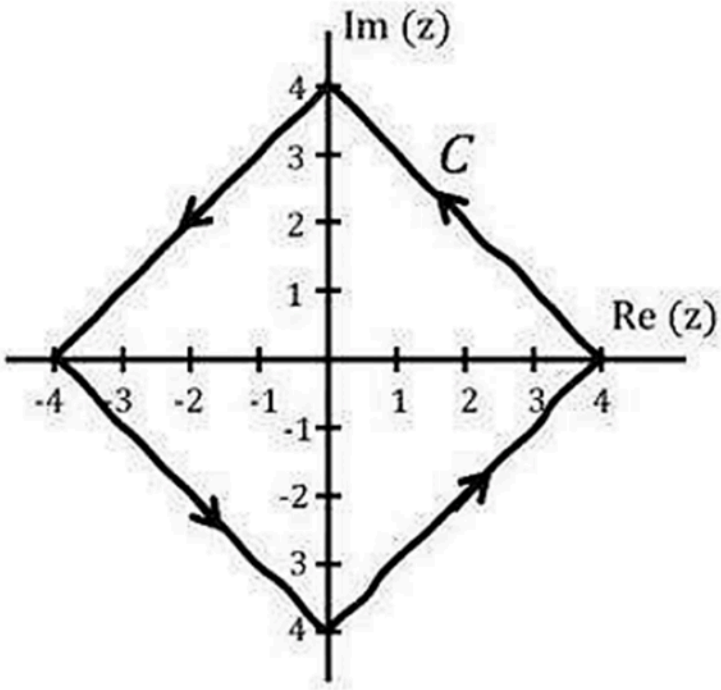
CSIR NET	2024 Dec	3.5M

The value of the integral (where k is a constant),

$$\frac{1}{2\pi i}\oint_C \frac{5}{(z-2)^2}\sin(kz)dz$$

over the closed contour C as shown below, is

1. $5k\cos(2k)$
2. $5k\sin(2k)$
3. $5\cos(2k)$
4. $-5k^2\sin(2k)$



Q128. [Dec 2024] . 3.5 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2024 Dec	3.5M

If I is an $n \times n$ identity matrix and $\text{adj}(2I) = 2^k I$, then k is equal to

1. 1
2. n
3. $n-1$
4. 2

Q129. [Dec 2024] . 5.0 marks

Mathematical Physics > Complex analysis

CSIR NET	2024 Dec	5M

The complex integral $\int_c z^4 \exp\left(\frac{1}{2z}\right) dz$, where C is the unit circle centered around the origin traversed counter-clock-wise, equals

1. $\frac{\pi i}{120}$
2. $\frac{\pi i}{960}$
3. 0
4. $\frac{\pi i}{1920}$

Q130. [Dec 2024] . 5.0 marks

Mathematical Physics > Complex analysis

CSIR NET	2024 Dec	5M

Gamma function with argument z is defined as

$$\Gamma[z] = \int_0^\infty dt t^{z-1} e^{-t}$$

where z is a complex variable and $\mathrm{Re} z \geq 0$. $\Gamma[z]$ has

1. a branch point at $z = 0$
2. a simple pole at $z = 0$
3. a removable singularity at $z = 0$
4. an essential singularity at $z = 0$

Q131. [Dec 2024] . 5.0 marks

Mathematical Physics > Probability

CSIR NET	2024 Dec	5M

A class has 60% boys and 40% girls. In an examination 8% of the boys and 12% of the girls got an ' A ' grade. If a randomly selected student had an ' A ' grade, what is the probability that the student is male?

1. 0.7
2. 0.6
3. 0.4
4. 0.5

Q132. [June 2024] . 3.5 marks

Mathematical Physics > Probability

CSIR NET	2024 June	3.5M

Probability density function of a variable x is given by $P(x) = \frac{1}{2}[\delta(x-a) + \delta(x+a)]$. The variance of x is

1. a^2
2. 0
3. $2a^2$
4. $\frac{a^2}{2}$

Q133. [June 2024] . 3.5 marks

Mathematical Physics > Vector Algebra and Vector Calculus

CSIR NET	2024 June	3.5M

Vorticity of a vector field $\vec{B}$ is defined as $\vec{V} = \vec{\nabla} \times \vec{B}$. Given $\vec{B} = kxyz\hat{r}$, where k is a constant, which one of the following is correct?

1. Vorticity is a null vector for all finite x, y, z
2. Vorticity is parallel to the vector field everywhere
3. The angle between vorticity and vector field depends on x, y, z
4. Vorticity is perpendicular to the vector field everywhere

Q134. [June 2024] . 3.5 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2024 June	3.5M

The matrix A is given by $A = \begin{bmatrix} 1 & 2 & -3 \\ 0 & 3 & 2 \\ 0 & 0 & -2 \end{bmatrix}$

The eigenvalues of $3A^3 + 5A^2 - 6A + 2I$, where I is the identity matrix, are

1. 4, 9, 27
2. 1,9,44
3. 1,110,8
4. 4, 110, 10

Q135. [June 2024] . 3.5 marks

Mathematical Physics > Gamma and beta functions

CSIR NET	2024 June	3.5M

An integral is given by

$$\int_{-\infty}^{\infty} dx \int_{-\infty}^{\infty} dy \exp\left[-\left(x^2 + y^2 + 2axy\right)\right],$$

where a is a real parameter. The full range of values of a for which the integral is finite, is

1. $-\infty < a < \infty$
2. $-2 < a < 2$
3. $-1 < a < 1$
4. $-1 \leq a \leq 1$

Q136. [June 2024] . 5.0 marks

Mathematical Physics > Group Theory

CSIR NET	2024 June	5M

The following four matrices form a representation of a group

$$I = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}, A = \begin{pmatrix} -1 & 0 \\ 0 & -1 \end{pmatrix},$$
$$B = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}, C = \begin{pmatrix} 0 & -1 \\ -1 & 0 \end{pmatrix}$$

Which of the following represents the multiplication table for the same group?

1.

	I	A	B	C
I	I	A	B	C
A	A	I	C	B
B	B	C	A	I
C	C	B	I	A

2.

	I	A	B	C
I	I	A	B	C
A	A	B	C	I
B	B	C	I	A
C	C	I	A	B

3.

	I	A	B	C
I	I	A	B	C
A	A	C	I	B
B	B	I	C	A
C	C	B	A	I

4.

	I	A	B	C
I	I	A	B	C
A	A	I	C	B
B	B	C	I	A
C	C	B	A	I

Q137. [June 2024] . 5.0 marks

Mathematical Physics > Integral Equations

CSIR NET	2024 June	5M

An integral transform $\tilde{f}(x)$ of a function $f(x)$ can be regarded as a result of applying an operator F to the function such that

$$(Ff)(x) \equiv \tilde{f}(x) = \int_{-\infty}^{\infty} dy e^{-ixy} f(y)$$

If I is the identity operator, then the operator F^4 is given by

1. $(2\pi)^4 \mathrm{I}$
2. $(2\pi)\mathrm{I}$
3. I
4. $(2\pi)^2 \mathrm{I}$

Q138. [June 2024] . 5.0 marks

Mathematical Physics > Ordinary Differential Equations

CSIR NET	2024 June	5M

The general solution for the second order differential equation

$$\frac{d^2y}{dx^2} - y = x\sin x$$

will be

1. $C_1e^x + C_2e^{-x} - \frac{1}{2}(x\sin x + cos\, x)$
2. $C_1e^x + C_2e^{-x} - \frac{1}{2}(sin\, x - x\cos x)$
3. $C_1e^x + C_2e^{-x} + \frac{1}{2}x(sin\, x - cos\, x)$
4. $C_1e^x + C_2e^{-x} + \frac{1}{2}x(\sin x + \cos x)$

(where C_1 and C_2 are arbitrary constants)

Q139. [June 2024] . 5.0 marks

Mathematical Physics > Numerical Methods

CSIR NET	2024 June	5M

The integral $I = \int_0^1 \frac{2x}{1+x^2} dx$ is estimated using Simpson's $1/3$rd rule with a grid value of $h = 0.5$. The difference ($I_{\text{estimated}} - I_{\text{exact}}$) is closest to

1. 0.007
2. 0.001
3. 0.0007
4. -0.005

Q140. [Dec 2025] . 3.5 marks

Mathematical Physics > Probability

CSIR NET	2025 Dec	3.5M	MMP

Let $p(x)$ be the probability density function for a positive real variable x, and

$g(\alpha) = \int_0^\infty p(x)e^{-\alpha x}dx.$

If $g'(\alpha)$ and $g''(\alpha)$ are respectively first and second derivatives of $g(\alpha)$ with respect to α, which of the following gives the variance of x ?

1. $g''(0) - [g'(0)]^2$
2. $g''(0) + [g'(0)]^2$
3. $[g''(0) - g'(0)]^2$
4. $\frac{g''(0)}{g'(0)g(0)}$

Q141. [Dec 2025] . 3.5 marks

Mathematical Physics > Complex analysis

CSIR NET	2025 Dec	3.5M	MMP

If C be the unit circle traversed clockwise, then the integral $\oint_C dz|1 + 2z|^2$ equals

1. $-4\pi i$
2. $-\pi i$
3. 0
4. $-2\pi i$

Q142. [Dec 2025] . 3.5 marks

Mathematical Physics > Complex analysis

CSIR NET	2025 Dec	3.5M	MMP

The residue of $f(z) = \frac{\cos(\pi z)}{(1-z^2)^3}$ at $z = 1$ is

1. $\frac{\pi^2}{16}$
2. $\frac{3}{16}$
3. $\frac{3+\pi^2}{16}$
4. $\frac{3-\pi^2}{16}$

Q143. [Dec 2025] . 3.5 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2025 Dec	3.5M	MMP

Commutator of two matrices A and B is defined as $[A, B] = AB - BA$ and the anti-commutator as $\{A, B\} = AB + BA$. If $\{A, B\} = 0$. Then we can express $[A, BC]$ as

1. $B\{A, C\}$
2. $-B[A, C]$
3. $-B\{A, C\}$
4. $[A, B]C$

Q144. [Dec 2025] . 5.0 marks

Mathematical Physics > Probability

CSIR NET	2025 Dec	5M	MMP

In a heap of 20 biased coins, 17 have a 60% probability of showing heads while the other three special coins have a 90% probability of doing so. A coin is selected at random and tossed. If the result is a head, the probability that it was one of the three special coins is best approximated by

1. 0.18
2. 0.14
3. 0.21
4. 0.26

Q145. [Dec 2025] . 5.0 marks

Mathematical Physics > Special Functions

CSIR NET	2025 Dec	5M	MMP

A sequence of polynomial $Q_n(x)[n = 0,1,2 \dots]$ satisfies the recursion relation

$$Q_{n+1}(x) - 2xQ_n(x) + 2nQ_{n-1}(x) = 0, \text{ for all } n \geq 0$$

$$[\text{ here } Q_{-1}(x) = 0]$$

The generating function for the polynomials,

$g(x,t) = \sum_{n=0}^{\infty} \frac{t^n}{n!} Q_n(x)$, satisfies

1. $\frac{\partial g}{\partial t} = 2(t + x)g$
2. $\frac{\partial g}{\partial t} = 2(x - t)g$
3. $\frac{\partial g}{\partial t} = \frac{2(x-t)}{t} g$
4. $\frac{\partial g}{\partial t} = 2 + (x + t)g$

Q146. [Dec 2025] . 5.0 marks

Mathematical Physics > Basic Mathematics

CSIR NET	2025 Dec	5M	MMP

Find the curve that extremizes the functional

$$I(y) = \int_0^1 \left[\left(\frac{dy}{dx}\right)^2 + 12xy\right] dx$$

for the given boundary conditions $y(0) = 0$ and $y(1) = 1$

1. $y = x^3$
2. $y = x^2$
3. $y = 2x^2 - x$
4. $y = 3x^3 - 2x^2$

Q147. [June 2025] . 3.5 marks

Mathematical Physics > Ordinary Differential Equations

CSIR NET	2025 June	3.5M	MMP

The solutions of the differential equation

$$\frac{dy}{dx} = -\frac{x}{y+1}$$

are a family of

1. ellipses with different eccentricities
2. circles with different centres
3. circles with different radii
4. ellipses with different foci

Q148. [June 2025] . 3.5 marks

Mathematical Physics > Complex analysis

CSIR NET	2025 June	3.5M	MMP

For the function $f(z) = \exp\left[z - 1 + \frac{1}{z-1}\right]$

1. $z = 1$ is a pole of order one.
2. $z = 1$ is an essential singularity.
3. $z = 1$ is a pole of order two.
4. $z = 1$ is a removable singular point.

Q149. [June 2025] . 3.5 marks

Mathematical Physics > Matrices and Linear Algebra

CSIR NET	2025 June	3.5M	MMP

For the matrix $A = \begin{bmatrix} 2 & -1 & 0 \\ -1 & 3 & 1 \\ 0 & 1 & 0 \end{bmatrix}$, which of the following is true?

1. $A^3 = 5A^2 - 4A - 2$
2. $A^3 = 4A^2 - 6A + 3$
3. $A^3 = 5A^2 - 5A - 1$
4. $A^3 = 8A^2 + 3A - 4$

Q150. [June 2025] . 3.5 marks

Mathematical Physics > Dirac Delta Function

CSIR NET	2025 June	3.5M	MMP

The value of the integral

$$\int_1^e dy \int_0^5 dx\delta(x^2 - y^2)\ln(xy)$$

is

1. $\frac{1}{2}$
2. $\frac{1}{3}$
3. $\frac{1}{e}$
4. $\frac{e}{5}$

Q151. [June 2025] . 5.0 marks

Mathematical Physics > Special Functions

CSIR NET	2025 June	5M	MMP

Let $P_n(x)$ be a polynomial of degree n with real coefficients, where $n = 0,1,2,3,\cdots$. If $\int_2^4 P_n(x)P_m(x)dx = \delta_{mn}$, then

1. $P_1(x) = \pm\sqrt{\frac{3}{2}}(3-x)$
2. $P_1(x) = \pm\sqrt{\frac{3}{2}}(2-x)$
3. $P_1(x) = \pm\sqrt{\frac{3}{2}}(1-x)$
4. $P_1(x) = \pm\sqrt{3}(3+x)$

Q152. [June 2025] . 5.0 marks

Mathematical Physics > Complex analysis

CSIR NET	2025 June	5M	MMP

The value of the integral $\int_0^\infty \frac{\cos(\alpha x)}{1+x^2}dx$, where α is a positive real number, is

1. $\frac{\pi}{2}e^{-\alpha}$
2. $\pi e^{-\alpha}$
3. $\frac{\pi}{2}e^{-(\alpha/2)}$
4. $\pi e^{-(\alpha/2)}$

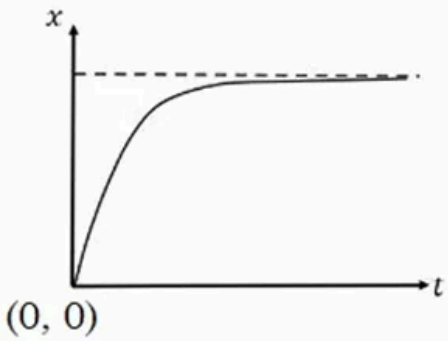
Q153. [June 2025] . 5.0 marks

Mathematical Physics > Ordinary Differential Equations

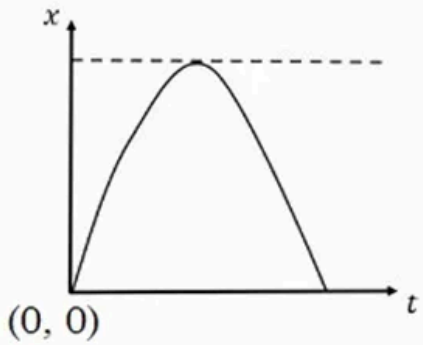
CSIR NET	2025 June	5M	MMP

Which one of the following curves best represents the solution of the differential equation $\frac{dx}{dt} + x = 1$, with the initial condition $x(0) = 0$?

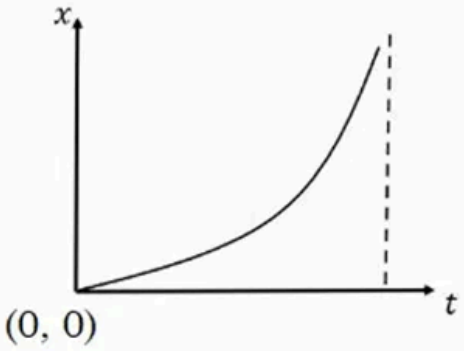
1.



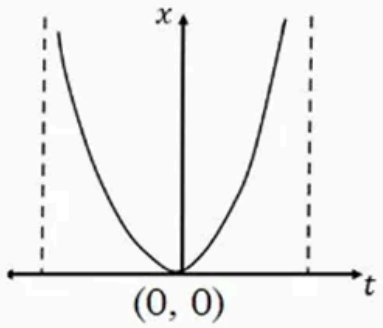
3.



2.



4.



Q154. [June 2025] . 5.0 marks

Mathematical Physics > Probability

CSIR NET	2025 June	5M	MMP

From a straight-line segment of unit length, three points are chosen at random, one after another. The probability that they are in increasing order is

1. $\frac{1}{3}$
2. $\frac{1}{8}$
3. $\frac{1}{9}$
4. $\frac{1}{6}$

Answer Key

154 questions . Subject and topic for quick revision

Q. No	Subject	Topic	Answer
Q1	Mathematical Physics	Basic Mathematics	**4**
Q2	Mathematical Physics	Complex analysis	**2**
Q3	Mathematical Physics	Fourier Transform	**3**
Q4	Mathematical Physics	Ordinary Differential Equations	**3**
Q5	Mathematical Physics	Special Functions	**1**
Q6	Mathematical Physics	Fourier Transform	**2**
Q7	Mathematical Physics	Numerical Methods	**1**
Q8	Mathematical Physics	Fourier Series	**3**
Q9	Mathematical Physics	Vector Algebra and Vector Calculus	**1**
Q10	Mathematical Physics	Ordinary Differential Equations	**2**
Q11	Mathematical Physics	Complex analysis	**1**
Q12	Mathematical Physics	Laplace transform	**1**
Q13	Mathematical Physics	Probability	**3**
Q14	Mathematical Physics	Tensors	**2**
Q15	Mathematical Physics	Numerical Methods	**2**
Q16	Mathematical Physics	Partial Differential Equations	**4**
Q17	Mathematical Physics	Probability	**3**
Q18	Mathematical Physics	Fourier Transform	**4**
Q19	Mathematical Physics	Matrices and Linear Algebra	**3**
Q20	Mathematical Physics	Laplace transform	**2**
Q21	Mathematical Physics	Basic Mathematics	**3**
Q22	Mathematical Physics	Group Theory	**4**
Q23	Mathematical Physics	Numerical Methods	**3**
Q24	Mathematical Physics	Partial Differential Equations	**3**
Q25	Mathematical Physics	Basic Mathematics	**3**
Q26	Mathematical Physics	Complex analysis	**3**
Q27	Mathematical Physics	Fourier Series	**4**
Q28	Mathematical Physics	Probability	**4**
Q29	Mathematical Physics	Fourier Transform	**2**
Q30	Mathematical Physics	Integral Equations	**4**
Q31	Mathematical Physics	Group Theory	**4**
Q32	Mathematical Physics	Numerical Methods	**2**
Q33	Mathematical Physics	Laplace transform	**1**
Q34	Mathematical Physics	Matrices and Linear Algebra	**4**
Q35	Mathematical Physics	Basic Mathematics	**3**
Q36	Mathematical Physics	Matrices and Linear Algebra	**3**
Q37	Mathematical Physics	Ordinary Differential Equations	**2**
Q38	Mathematical Physics	Group Theory	**4**
Q39	Mathematical Physics	Numerical Methods	**4**
Q40	Mathematical Physics	Numerical Methods	**1**

Answer Key (cont.)

Q. No	Subject	Topic	Answer
Q41	Mathematical Physics	Integral Equations	**2**
Q42	Mathematical Physics	Matrices and Linear Algebra	**4**
Q43	Mathematical Physics	Complex analysis	**2**
Q44	Mathematical Physics	Complex analysis	**3**
Q45	Mathematical Physics	Ordinary Differential Equations	**4**
Q46	Mathematical Physics	Probability	**1**
Q47	Mathematical Physics	Vector Algebra and Vector Calculus	**3**
Q48	Mathematical Physics	Green Function	**1**
Q49	Mathematical Physics	Matrices and Linear Algebra	**2**
Q50	Mathematical Physics	Numerical Methods	**2**
Q51	Mathematical Physics	Group Theory	**3**
Q52	Mathematical Physics	Probability	**1**
Q53	Mathematical Physics	Matrices and Linear Algebra	**4**
Q54	Mathematical Physics	Special Functions	**3**
Q55	Mathematical Physics	Complex analysis	**None**
Q56	Mathematical Physics	Complex analysis	**2**
Q57	Mathematical Physics	Ordinary Differential Equations	**4**
Q58	Mathematical Physics	Green Function	**4**
Q59	Mathematical Physics	Matrices and Linear Algebra	**4**
Q60	Mathematical Physics	Complex analysis	**2**
Q61	Mathematical Physics	Numerical Methods	**3**
Q62	Mathematical Physics	Probability	**2**
Q63	Mathematical Physics	Vector Algebra and Vector Calculus	**1**
Q64	Mathematical Physics	Fourier Transform	**3**
Q65	Mathematical Physics	Dirac Delta Function	**2**
Q66	Mathematical Physics	Ordinary Differential Equations	**3**
Q67	Mathematical Physics	Complex analysis	**1**
Q68	Mathematical Physics	Special Functions	**3**
Q69	Mathematical Physics	Green Function	**2**
Q70	Mathematical Physics	Numerical Methods	**2**
Q71	Mathematical Physics	Matrices and Linear Algebra	**2**
Q72	Mathematical Physics	Vector Algebra and Vector Calculus	**4**
Q73	Mathematical Physics	Complex analysis	**3**
Q74	Mathematical Physics	Matrices and Linear Algebra	**1**
Q75	Mathematical Physics	Vector Algebra and Vector Calculus	**1**
Q76	Mathematical Physics	Probability	**4**
Q77	Mathematical Physics	Numerical Methods	**4**
Q78	Mathematical Physics	Fourier Series	**4**
Q79	Mathematical Physics	Matrices and Linear Algebra	**3**
Q80	Mathematical Physics	Probability	**4**
Q81	Mathematical Physics	Ordinary Differential Equations	**1**

Answer Key (cont.)

Q. No	Subject	Topic	Answer
Q82	Mathematical Physics	Complex analysis	**4**
Q83	Mathematical Physics	Numerical Methods	**2**
Q84	Mathematical Physics	Vector Algebra and Vector Calculus	**4**
Q85	Mathematical Physics	Probability	**4**
Q86	Mathematical Physics	Matrices and Linear Algebra	**1**
Q87	Mathematical Physics	Complex analysis	**3**
Q88	Mathematical Physics	Numerical Methods	**1**
Q89	Mathematical Physics	Green Function	**3**
Q90	Mathematical Physics	Ordinary Differential Equations	**1**
Q91	Mathematical Physics	Ordinary Differential Equations	**3**
Q92	Mathematical Physics	Basic Mathematics	**2**
Q93	Mathematical Physics	Vector Algebra and Vector Calculus	**3**
Q94	Mathematical Physics	Matrices and Linear Algebra	**2**
Q95	Mathematical Physics	Probability	**2**
Q96	Mathematical Physics	Tensors	**1**
Q97	Mathematical Physics	Fourier Transform	**3**
Q98	Mathematical Physics	Numerical Methods	**2**
Q99	Mathematical Physics	Special Functions	**4**
Q100	Mathematical Physics	Gamma and beta functions	**3**
Q101	Mathematical Physics	Complex analysis	**4**
Q102	Mathematical Physics	Matrices and Linear Algebra	**4**
Q103	Mathematical Physics	Basic Mathematics	**1**
Q104	Mathematical Physics	Complex analysis	**2**
Q105	Mathematical Physics	Probability	**2**
Q106	Mathematical Physics	Complex analysis	**2**
Q107	Mathematical Physics	Laplace transform	**4**
Q108	Mathematical Physics	Matrices and Linear Algebra	**1**
Q109	Mathematical Physics	Complex analysis	**3**
Q110	Mathematical Physics	Gamma and beta functions	**4**
Q111	Mathematical Physics	Complex analysis	**3**
Q112	Mathematical Physics	Matrices and Linear Algebra	**2**
Q113	Mathematical Physics	Group Theory	**3**
Q114	Mathematical Physics	Numerical Methods	**2**
Q115	Mathematical Physics	Complex analysis	**2**
Q116	Mathematical Physics	Ordinary Differential Equations	**4**
Q117	Mathematical Physics	Basic Mathematics	**3**
Q118	Mathematical Physics	Probability	**4**
Q119	Mathematical Physics	Complex analysis	**1**
Q120	Mathematical Physics	Matrices and Linear Algebra	**3**
Q121	Mathematical Physics	Probability	**1**
Q122	Mathematical Physics	Numerical Methods	**3**

Answer Key (cont.)

Q. No	Subject	Topic	Answer
Q123	Mathematical Physics	Dirac Delta Function	**1**
Q124	Mathematical Physics	Special Functions	**4**
Q125	Mathematical Physics	Matrices and Linear Algebra	**4**
Q126	Mathematical Physics	Basic Mathematics	**4**
Q127	Mathematical Physics	Complex analysis	**1**
Q128	Mathematical Physics	Matrices and Linear Algebra	**3**
Q129	Mathematical Physics	Complex analysis	**4**
Q130	Mathematical Physics	Complex analysis	**2**
Q131	Mathematical Physics	Probability	**4**
Q132	Mathematical Physics	Probability	**1**
Q133	Mathematical Physics	Vector Algebra and Vector Calculus	**4**
Q134	Mathematical Physics	Matrices and Linear Algebra	**4**
Q135	Mathematical Physics	Gamma and beta functions	**3**
Q136	Mathematical Physics	Group Theory	**4**
Q137	Mathematical Physics	Integral Equations	**4**
Q138	Mathematical Physics	Ordinary Differential Equations	**1**
Q139	Mathematical Physics	Numerical Methods	**1**
Q140	Mathematical Physics	Probability	**1**
Q141	Mathematical Physics	Complex analysis	**1**
Q142	Mathematical Physics	Complex analysis	**4**
Q143	Mathematical Physics	Matrices and Linear Algebra	**3**
Q144	Mathematical Physics	Probability	**3**
Q145	Mathematical Physics	Special Functions	**2**
Q146	Mathematical Physics	Basic Mathematics	**1**
Q147	Mathematical Physics	Ordinary Differential Equations	**3**
Q148	Mathematical Physics	Complex analysis	**2**
Q149	Mathematical Physics	Matrices and Linear Algebra	**1**
Q150	Mathematical Physics	Dirac Delta Function	**1**
Q151	Mathematical Physics	Special Functions	**1**
Q152	Mathematical Physics	Complex analysis	**1**
Q153	Mathematical Physics	Ordinary Differential Equations	**1**
Q154	Mathematical Physics	Probability	**4**

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