FINAL JEE–MAIN EXAMINATION – APRIL,2019

(Held On Wednesday 10th APRIL, 2019) TIME : 2 : 30 PM To 5 : 30 PM

MATHEMATICS

TEST PAPER WITH ANSWER & SOLUTION

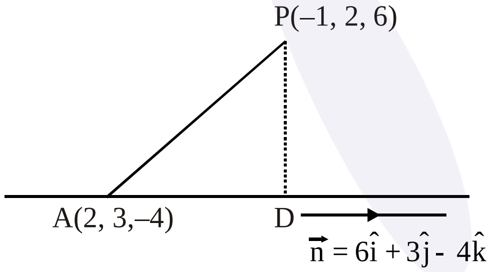
1. The distance of the point having position vector $-\hat{i}+2\hat{j}+6\hat{k}$ from the straight line passing through the point (2, 3, –4) and parallel to the vector, $6\hat{i}+3\hat{j}-4\hat{k}$ is :

(1) 7 (2) $4\sqrt{3}$

(3) $2\sqrt{13}$ (4) 6

Official Ans. by NTA (1)

Sol.



$$AD=\left|\frac{\overrightarrow{AP}.\vec{n}}{|\vec{n}|}\right|=\sqrt{61}$$

$$\Rightarrow \quad PD=\sqrt{AP^2-AD^2}=\sqrt{110-61}=7$$

2. If both the mean and the standard deviation of 50 observations $x_1, x_2, ..., x_{50}$ are equal to 16, then the mean of $(x_1-4)^2, (x_2-4)^2, ... (x_{50}-4)^2$ is :

(1) 525 (2) 380

(3) 480 (4) 400

Official Ans. by NTA (4)

Sol. Mean $(\mu)=\frac{\sum x_i}{50}=16$

standard deviation $(\sigma)=\sqrt{\frac{\sum x_i^2}{50}-(\mu)^2}=16$

$\Rightarrow (256)\times 2=\frac{\sum x_i^2}{50}$

$\Rightarrow$ New mean

$$=\frac{\sum(x_i-4)^2}{50}=\frac{\sum x_i^2+16\times 50-8\sum x_i}{50}$$

$= (256)\times 2+16-8\times 16=400$

3. A perpendicular is drawn from a point on the line $\frac{x-1}{2}=\frac{y+1}{-1}=\frac{z}{1}$ to the plane x + y + z = 3 such that the foot of the perpendicular Q also lies on the plane x – y + z = 3. Then the co-ordinates of Q are :

(1) (2, 0, 1) (2) (4, 0, –1)

(3) (–1, 0, 4) (4) (1, 0, 2)

Official Ans. by NTA (1)

Sol. Let point P on the line is $(2\lambda+1, -\lambda-1, \lambda)$

foot of perpendicular Q is given by

$$\frac{x-2\lambda-1}{1}=\frac{y+\lambda+1}{1}=\frac{z-\lambda}{1}=\frac{-(2\lambda-3)}{3}$$

$\because$ Q lies on x + y + z = 3 & x – y + z = 3

$\Rightarrow$ x + z = 3 & y = 0

$y=0\Rightarrow \lambda+1=\frac{-2\lambda+3}{3}\Rightarrow \lambda=0$

$\Rightarrow$ Q is (2, 0, 1)

4. The tangent and normal to the ellipse $3x^2+5y^2=32$ at the point P(2, 2) meet the x-axis at Q and R, respectively. Then the area (in sq. units) of the triangle PQR is :

(1) $\frac{14}{3}$ (2) $\frac{16}{3}$ (3) $\frac{68}{15}$ (4) $\frac{34}{15}$

Official Ans. by NTA (3)

Sol. $3x^2+5y^2=32$

$$\left.\frac{dy}{dx}\right|_{(2,2)}=-\frac{3}{5}$$

Tangent : $y-2=-\frac{3}{5}(x-2)\Rightarrow Q\left(\frac{16}{3},0\right)$

Normal : $y-2=\frac{5}{3}(x-2)\Rightarrow R\left(\frac{4}{5},0\right)$

Area is $=\frac{1}{2}(QR)\times 2=QR=\frac{68}{15}$.

5. Let λ be a real number for which the system of linear equations

$x + y + z = 6$

$4x + \lambda y - \lambda z = \lambda - 2$

$3x + 2y - 4z = -5$

has infinitely many solutions. Then λ is a root of the quadratic equation.

(1) $\lambda^2 - 3\lambda - 4 = 0$ (2) $\lambda^2 - \lambda - 6 = 0$

(3) $\lambda^2 + 3\lambda - 4 = 0$ (4) $\lambda^2 + \lambda - 6 = 0$

Official Ans. by NTA (2)

Sol. D = 0

$$\begin{vmatrix} 1 & 1 & 1 \\ 4 & \lambda & -\lambda \\ 3 & 2 & -4 \end{vmatrix} = 0 \Rightarrow \lambda = 3$$

6. The smallest natural number n, such that the coefficient of x in the expansion of $\left(x^2 + \frac{1}{x^3}\right)^n$ is ${}^nC_{23}$, is :

(1) 35 (2) 38

(3) 23 (4) 58

Official Ans. by NTA (2)

Sol. $T_r = \sum_{r=0}^{n} {}^nC_r x^{2n-2r}.x^{-3r}$

$2n - 5r = 1 \Rightarrow 2n = 5r + 1$

for r = 15. n = 38

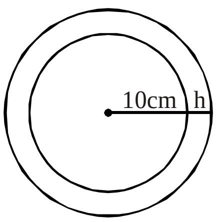
smallest value of n is 38.

7. A spherical iron ball of radius 10 cm is coated with a layer of ice of uniform thickness that melts at a rate of 50 cm^3/min. When the thickness of the ice is 5cm, then the rate at which the thickness (in cm/min) of the ice decreases, is :

(1) $\frac{1}{9\pi}$ (2) $\frac{5}{6\pi}$ (3) $\frac{1}{18\pi}$ (4) $\frac{1}{36\pi}$

Official Ans. by NTA (3)

Sol. $V = \frac{4}{3}\pi\left((10+h)^3 - 10^3\right)$



$\frac{dV}{dt} = 4\pi(10+h)^2\frac{dh}{dt}$

$-50 = 4\pi\ (10 + 5)^2\frac{dh}{dt}$

$\Rightarrow \frac{dh}{dt} = -\frac{1}{18}\frac{cm}{min}$

8. If 5x + 9 = 0 is the directrix of the hyperbola $16x^2 - 9y^2 = 144$, then its corresponding focus is :

(1) $\left(-\frac{5}{3}, 0\right)$ (2) (5, 0)

(3) (–5, 0) (4) $\left(\frac{5}{3}, 0\right)$

Official Ans. by NTA (3)

Sol. $\frac{x^2}{9} - \frac{y^2}{16} = 1$

a = 3, b = 4 & $e = \sqrt{1+\frac{16}{9}} = \frac{5}{3}$

corresponding focus will be (–ae, 0) i.e., (–5, 0).

9. The sum $1 + \frac{1^3+2^3}{1+2} + \frac{1^3+2^3+3^3}{1+2+3} + ...$

$+ \frac{1^3+2^3+3^3+....+15^3}{1+2+3+....+15} - \frac{1}{2}(1+2+3+....+15)]$

(1) 1240 (2)1860

(3) 660 (4) 620

Official Ans. by NTA (4)

Sol. Sum $= \sum_{n=1}^{15}\frac{1^3+2^3+....n^3}{1+2+....+n} - \frac{1}{2}.\frac{15.16}{2}$

$= \sum_{n=1}^{15}\frac{n(n+1)}{2} - 60$

$= \sum_{n=1}^{15}\frac{n(n+1)(n+2-(n-1))}{6} - 60$

$= \frac{15.16.17}{6} - 60 = 620$

10. If the line ax + y = c, touches both the curves $x^2 + y^2 = 1$ and $y^2 = 4\sqrt{2}x$, then | c | is equal to :

(1) 1/2 (2) 2

(3) $\sqrt{2}$ (4) $\frac{1}{\sqrt{2}}$

Official Ans. by NTA (3)

Sol. Tangent to $y^2 = 4\sqrt{2}\,x$ is $y = mx + \frac{\sqrt{2}}{m}$

it is also tangent to $x^2 + y^2 = 1$

$\Rightarrow \left|\frac{\sqrt{2}/m}{\sqrt{1+m^2}}\right| = 1 \quad \Rightarrow m = \pm 1$

$\Rightarrow$ Tagent will be $y = x + \sqrt{2}$ or $y = -x - \sqrt{2}$

compare with y = – ax + C

$\Rightarrow a = \pm 1$ & $C = \pm\sqrt{2}$

11. If $\cos^{-1}x - \cos^{-1}\frac{y}{2} = \alpha$,

where $-1 \le x \le 1, -2 \le y \le 2, x \le \frac{y}{2}$,

then for all x, y, $4x^2 - 4xy\cos\alpha + y^2$ is equal to

(1) $4\sin^2\alpha - 2x^2y^2$ (2) $4\cos^2\alpha + 2x^2y^2$

(3) $4\sin^2\alpha$ (4) $2\sin^2\alpha$

Official Ans. by NTA (3)

Sol. $\cos^{-1}x - \cos^{-1}\frac{y}{2} = \alpha$

$\cos(\cos^{-1}x - \cos^{-1}\frac{y}{2}) = \cos\alpha$

$\Rightarrow x \times \frac{y}{2} + \sqrt{1-x^2}\sqrt{1-\frac{y^2}{4}} = \cos\alpha$

$\Rightarrow \left(\cos\alpha - \frac{xy}{2}\right)^2 = \left(1-x^2\right)\left(1-\frac{y^2}{4}\right)$

$x^2 + \frac{y^2}{4} - xy\cos\alpha = 1 - \cos^2\alpha = \sin^2\alpha$

12. If $\int x^5 e^{-x^2}dx = g(x)e^{-x^2} + c$, where c is a constant of integration, then g(–1) is equal to :

(1) $-\frac{5}{2}$ (2) 1

(3) $-\frac{1}{2}$ (4) –1

Official Ans. by NTA (1)

Sol. Let $x^2 = t$ $\quad 2xdx = dt$

$\Rightarrow \frac{1}{2}\int t^2.e^{-t}dt = \frac{1}{2}\left[-t^2.e^{-t} + \int 2t.e^{-t}.dt\right]$

$= \frac{1}{2}\left(-t^2.e^{-t}\right) + \left(-t.e^{-t} + \int 1.e^{-t}.dt\right)$

$= -\frac{t^2e^{-t}}{2} - te^{-t} - e^{-t} = \left(-\frac{t^2}{2} - t - 1\right)e^{-t}$

$= \left(-\frac{x^4}{2} - x^2 - 1\right)e^{-x^2} + C$

$g(x) = -1 - x^2 - \frac{x^4}{2} + ke^{x^2}$

for k = 0

$g(-1) = -1 - 1 - \frac{1}{2} = -\frac{5}{2}$

13. The locus of the centres of the circles, which touch the circle, $x^2 + y^2 = 1$ externally, also touch the y-axis and lie in the first quadrant, is :

(1) $y = \sqrt{1+4x}$, $x \ge 0$

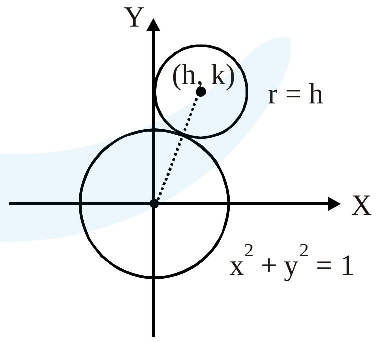
(2) $x = \sqrt{1+4y}$, $y \ge 0$

(3) $x = \sqrt{1+2y}$, $y \ge 0$

(4) $y = \sqrt{1+2x}$, $x \ge 0$

Official Ans. by NTA (4)

Sol.



$\sqrt{h^2 + k^2} = |h| + 1$

$\Rightarrow x^2 + y^2 = x^2 + 1 + 2x$

$\Rightarrow y^2 = 1 + 2x$

$\Rightarrow y = \sqrt{1+2x}$; $x \ge 0$.

14. Lines are drawn parallel to the line $4x - 3y + 2 = 0$, at a distance $\frac{3}{5}$ from the origin.

Then which one of the following points lies on any of these lines ?

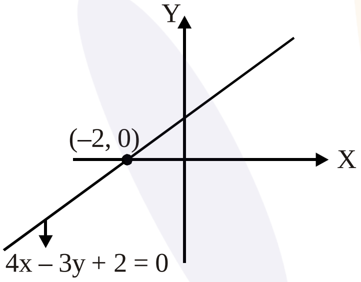
(1) $\left(-\frac{1}{4}, \frac{2}{3}\right)$ (2) $\left(\frac{1}{4}, \frac{1}{3}\right)$

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

Official Ans. by NTA (1)

Sol. Required line is $4x - 3y + \lambda = 0$

$$\left|\frac{\lambda}{5}\right| = \frac{3}{5}$$



$\Rightarrow \lambda = \pm 3.$

So, required equation of line is $4x - 3y + 3 = 0$ and $4x - 3y - 3 = 0$

(1) $4\left(-\frac{1}{4}\right) - 3\left(\frac{2}{3}\right) + 3 = 0$

15. The area (in sq. units) of the region bounded by the curves $y = 2^x$ and $y = |x + 1|$, in the first quadrant is :

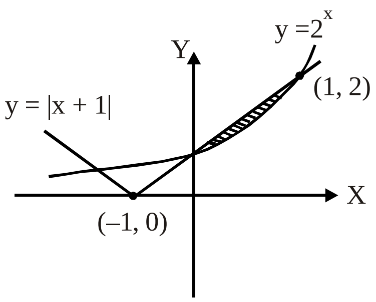
(1) $\frac{3}{2} - \frac{1}{\log_e 2}$ (2) $\frac{1}{2}$

(3) $\log_e 2 + \frac{3}{2}$ (4) $\frac{3}{2}$

Official Ans. by NTA (1)

Sol. Required Area

$$\int_0^1 \left((x+1) - 2^x\right)dx$$



$$= \left(\frac{x^2}{2} + x - \frac{2^x}{\ln 2}\right)_0^1$$

$$= \left(\frac{1}{2} + 1 - \frac{2}{\ln 2}\right) - \left(0 + 0 - \frac{1}{\ln 2}\right)$$

$$= \frac{3}{2} - \frac{1}{\ln 2}$$

16. If the plane $2x - y + 2z + 3 = 0$ has the distances $\frac{1}{3}$ and $\frac{2}{3}$ units from the planes $4x - 2y + 4z + \lambda = 0$ and $2x - y + 2z + \mu = 0$, respectively, then the maximum value of $\lambda + \mu$ is equal to :

(1) 15 (2) 5

(3) 13 (4) 9

Official Ans. by NTA (3)

Sol. $4x - 2y + 4z + 6 = 0$

$$\frac{|\lambda - 6|}{\sqrt{16+4+16}} = \left|\frac{\lambda - 6}{6}\right| = \frac{1}{3}$$

$|\lambda - 6| = 2$

$\lambda = 8, 4$

$$\frac{|\mu - 3|}{\sqrt{4+4+1}} = \frac{2}{3}$$

$|\mu - 3| = 2$

$\mu = 5, 1$

$\therefore$ Maximum value of $(\mu + \lambda) = 13$.

17. If z and w are two complex numbers such that $|zw| = 1$ and $\arg(z) - \arg(w) = \frac{\pi}{2}$, then :

(1) $\bar{z}w = i$ (2) $\bar{z}w = -i$

(3) $z\bar{w} = \frac{1-i}{\sqrt{2}}$ (4) $z\bar{w} = \frac{-1+i}{\sqrt{2}}$

Official Ans. by NTA (2)

Sol. $|z|.\ |w| = 1 \quad z = re^{i(\theta + \pi/2)}$ and $w = \frac{1}{r}e^{i\theta}$

$$\bar{z}.w = e^{-i(\theta+\pi/2)}.e^{i\theta} = e^{-i(\pi/2)} = -i$$

$$z.\bar{w} = e^{i(\theta+\pi/2)}.e^{-i\theta} = e^{i(\pi/2)} = i$$

18. Let a, b and c be in G. P. with common ratio r, where $a \neq 0$ and $0 < r \leq \frac{1}{2}$. If 3a, 7b and 15c are the first three terms of an A. P., then the 4th term of this A. P. is :

(1) $\frac{7}{3}a$ (2) a

(3) $\frac{2}{3}a$ (4) 5a

Official Ans. by NTA (2)

Sol. $b = ar$

$c = ar^2$

3a, 7b and 15 c are in A.P.

$\Rightarrow 14b = 3a + 15c$

$\Rightarrow 14(ar) = 3a + 15\,ar^2$

$\Rightarrow 14r = 3 + 15r^2$

$\Rightarrow 15r^2 - 14r + 3 = 0 \quad \Rightarrow (3r-1)(5r-3) = 0$

$r = \frac{1}{3}, \frac{3}{5}.$

Only acceptable value is $r = \frac{1}{3}$, because

$r \in \left(0, \frac{1}{2}\right]$

$\therefore$ c. d $= 7b - 3a = 7ar - 3a = \frac{7}{3}a - 3a = -\frac{2}{3}a$

$\therefore$ 4th term $= 15\,c - \frac{2}{3}a = \frac{15}{9}a - \frac{2}{3}a = a$

19. The integral $\int_{\pi/6}^{\pi/3} \sec^{2/3} x \operatorname{cosec}^{4/3} x \, dx$ equal to :

(1) $3^{7/6} - 3^{5/6}$

(2) $3^{5/3} - 3^{1/3}$

(3) $3^{4/3} - 3^{1/3}$

(4) $3^{5/6} - 3^{2/3}$

Official Ans. by NTA (1)

Sol. $I = \int \frac{1}{\cos^{2/3} x \sin^{1/3} x . \sin x} dx$

$= \int \frac{\tan^{2/3} x}{\tan^2 x} . \sec^2 x . dx$

$= \int \frac{\sec^2 x}{\tan^{4/3} x} . dx \qquad \{\tan x = t, \sec^2 x dx = dt\}$

$= \int \frac{dt}{t^{4/3}} = \frac{t^{-1/3}}{-1/3} = -3\left(t^{-1/3}\right)$

$\Rightarrow I = -3\tan(x)^{-1/3}$

$\Rightarrow I = \left.\frac{3}{(\tan x)^{1/3}}\right|_{\pi/6}^{\pi/3} = -3\left(\frac{1}{\left(\sqrt{3}\right)^{1/3}} - \left(\sqrt{3}\right)^{1/3}\right)$

$= 3\left(3^{1/3} - \frac{1}{3^{1/6}}\right) = 3^{7/6} - 3^{5/6}$

20. Let y = y(x) be the solution of the differential equation, $\frac{dy}{dx} + y \tan x = 2x + x^2 \tan x$, $x \in \left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$, such that y(0) = 1. Then :

(1) $y'\left(\frac{\pi}{4}\right) + y'\left(\frac{-\pi}{4}\right) = -\sqrt{2}$

(2) $y'\left(\frac{\pi}{4}\right) - y'\left(\frac{-\pi}{4}\right) = \pi - \sqrt{2}$

(3) $y\left(\frac{\pi}{4}\right) - y\left(-\frac{\pi}{4}\right) = \sqrt{2}$

(4) $y\left(\frac{\pi}{4}\right) + y\left(-\frac{\pi}{4}\right) = \frac{\pi^2}{2} + 2$

Official Ans. by NTA (2)

Sol. $\frac{dy}{dx} + y(\tan x) = 2x + x^2 \tan x$

I.F = $e^{\int \tan x\, dx} = e^{\ln .\sec x} = \sec x$

$\therefore$ y . secx = $\int (2x + x^2 \tan x)\sec x.dx$

= $\int 2x \sec x\, dx + \int x^2 (\sec x.\tan x) dx$

y secx = x^2 sec x + λ

⇒ y = x^2 + λcos x

y(0) = 0 + λ = 1 ⇒ λ = 1

y = x^2 + cos x

$y\left(\frac{\pi}{4}\right) = \frac{\pi^2}{16} + \frac{1}{\sqrt{2}}$

$y\left(-\frac{\pi}{4}\right) = \frac{\pi^2}{16} + \frac{1}{\sqrt{2}}$

y'(x) = 2x – sinx

$y'\left(\frac{\pi}{4}\right) = \frac{\pi}{2} - \frac{1}{\sqrt{2}}$

$y'\left(\frac{-\pi}{4}\right) = \frac{-\pi}{2} + \frac{1}{\sqrt{2}}$

$y'\left(\frac{\pi}{4}\right) - y'\left(\frac{-\pi}{4}\right) = \pi - \sqrt{2}$

21. Let a_1, a_2, a_3,......be an A. P. with $a_6 = 2$. Then the common difference of this A. P., which maximises the produce $a_1a_4a_5$, is :

(1) $\frac{6}{5}$ (2) $\frac{8}{5}$

(3) $\frac{2}{3}$ (4) $\frac{3}{2}$

Official Ans. by NTA (2)

Sol. Let a is first term and d is common difference

then, a + 5d = 2 (given) ...(1)

f(d) = (2 – 5d) (2 – 2d) (2 – d)

f '(d) = 0 ⇒ d = $\frac{2}{3}, \frac{8}{5}$

f "(d) < 0 at d = 8/5

⇒ d = $\frac{8}{5}$

22. The angles A, B and C of a triangle ABC are in A.P. and a : b = 1 : $\sqrt{3}$. If c = 4 cm, then the area (in sq. cm) of this triangle is :

(1) $4\sqrt{3}$ (2) $\frac{2}{\sqrt{3}}$

(3) $2\sqrt{3}$ (4) $\frac{4}{\sqrt{3}}$

Official Ans. by NTA (3)

Sol. $\angle B = \frac{\pi}{3}$, by sine Rule

sin A = $\frac{1}{2}$

⇒ A = 30°, a = 2 , b = $2\sqrt{3}$, c = 4

Δ = $\frac{1}{2} \times 2\sqrt{3} \times 2$ = $2\sqrt{3}$ sq. cm

23. Minimum number of times a fair coin must be tossed so that the probability of getting at least one head is more than 99% is :

(1) 5 (2) 6

(3) 7 (4) 8

Official Ans. by NTA (3)

Sol. $1 - \left(\frac{1}{2}\right)^n > \frac{99}{100}$

⇒ $\left(\frac{1}{2}\right)^n < \frac{1}{100}$

⇒ n = 7.

24. Suppose that 20 pillars of the same height have been erected along the boundary of a circular stadium. If the top of each pillar has been connected by beams with the top of all its non-adjacent pillars, then the total number beams is :

(1) 210 (2) 190

(3) 170 (4) 180

Official Ans. by NTA (3)

Sol. Total cases = number of diagonals

= $^{20}C_2 - 20 = 170$

25. The sum of the real roots of the equatuion

$$\begin{vmatrix} x & -6 & -1 \\ 2 & -3x & x-3 \\ -3 & 2x & x+2 \end{vmatrix} = 0$$, is equal to :

(1) 6 (2) 1

(3) 0 (4) – 4

Official Ans. by NTA (3)

Sol. By expansion, we get

$-5x^3 + 30x - 30 + 5x = 0$

$\Rightarrow -5x^3 + 35x - 30 = 0$

$\Rightarrow x^3 - 7x + 6 = 0$, All roots are real

So, sum of roots = 0

26. Let $f(x) = \log_e(\sin x)$, $(0 < x < \pi)$ and $g(x) = \sin^{-1}(e^{-x})$, $(x \geq 0)$. If α is a positive real number such that $a = (fog)'(\alpha)$ and $b = (fog)(\alpha)$, then :

(1) $a\alpha^2 - b\alpha - a = 0$

(2) $a\alpha^2 + b\alpha - a = -2\alpha^2$

(3) $a\alpha^2 + b\alpha + a = 0$

(4) $a\alpha^2 - b\alpha - a = 1$

Official Ans. by NTA (4)

Sol. $fog(x) = (-x) \Rightarrow (fg(\alpha)) = -\alpha = b$

$(fg(x))' = -1 \Rightarrow (fg(\alpha))' = -1 = a$

27. If the tangent to the curve $y = \frac{x}{x^2 - 3}$, $x \in R$, $\left(x \neq \pm\sqrt{3}\right)$, at a point $(\alpha, \beta) \neq (0, 0)$ on it is parallel to the line $2x + 6y - 11 = 0$, then :

(1) $|6\alpha + 2\beta| = 19$

(2) $|2\alpha + 6\beta| = 11$

(3) $|6\alpha + 2\beta| = 9$

(4) $|2\alpha + 6\beta| = 19$

Official Ans. by NTA (1)

Sol. $$\left.\frac{dy}{dx}\right|_{(\alpha,\beta)} = \frac{-\alpha^2 - 3}{\left(\alpha^2 - 3\right)^2}$$

Given that :

$$\frac{-\alpha^2 - 3}{\left(\alpha^2 - 3\right)^2} = -\frac{1}{3}$$

$\Rightarrow \alpha = 0, \pm 3$ $(\alpha \neq 0)$

$\Rightarrow \beta = \pm \frac{1}{2}$. $(\beta \neq 0)$

$|6\alpha + 2\beta| = 19$

28. The number of real roots of the equation $5 + |2^x - 1| = 2^x(2^x - 2)$ is :

(1) 2 (2) 3

(3) 4 (4) 1

Official Ans. by NTA (4)

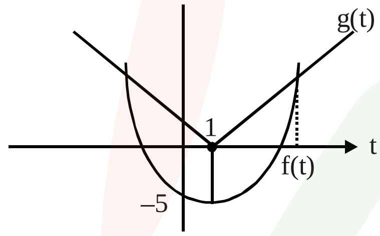
Sol. Let $2^x = t$

$5 + |t - 1| = t^2 - 2t$

$\Rightarrow |t - 1| = (t^2 - 2t - 5)$

g(t) f(t)

From the graph



$\because t > 0$

So, number of real root is 1.

29. If $\lim\limits_{x\to 1} \frac{x^2 - ax + b}{x - 1} = 5$, then a + b is equal to :-

(1) –7 (2) – 4

(3) 5 (4) 1

Official Ans. by NTA (1)

Sol. $$\lim_{x\to 1} \frac{x^2 - ax + b}{x - 1} = 5$$

$1 - a + b = 0$ ...(i)

$2 - a = 5$ ...(ii)

$\Rightarrow a + b = -7$.

30. The negation of the boolean expression $\sim s \vee (\sim r \wedge s)$ is equivalent to :

(1) r (2) $s \wedge r$

(3) $s \vee r$ (4) $\sim s \wedge \sim r$

Official Ans. by NTA (2)

Sol. $\sim(\sim s \vee (\sim r \wedge s))$

$s \wedge (r \vee \sim s)$

$(s \wedge r) \vee (s \wedge \sim s)$

$(s \wedge r) \vee (c)$

$(s \wedge r)$