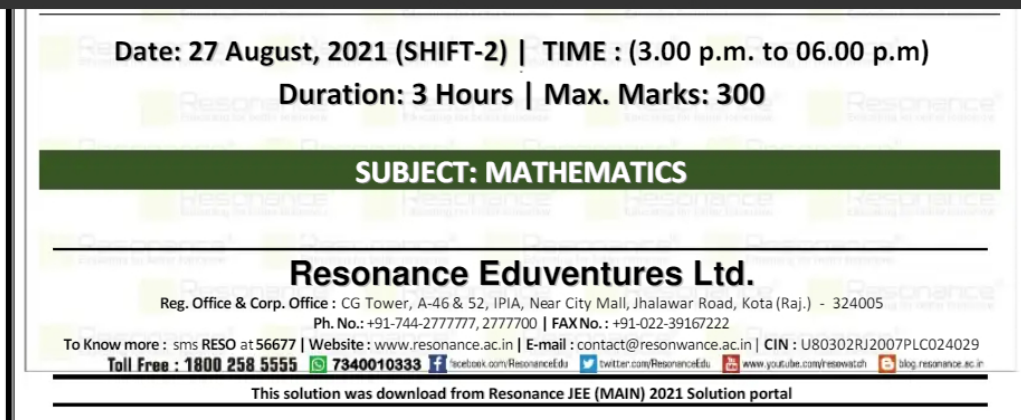




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in JEE (Advanced) 2020 from any Institute of Kota

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5 AIRs in TOP-50 in JEE (Adv.) 2020 from Classroom

				
AIR-2 (GEN-EWS)	Zonal Topper IIT-Kharagpur	2nd Rank in IIT-Kharagpur Zone		
AIR-15	AIR-25	AIR-29	AIR-30	AIR-41
DHANANJAY KEJRIWAL	SAMARTH AGARWAL	SANKALP PARASHAR	AARYAN K. GUPTA	UTKARSH P. SINGH
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4505	14755	2646
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PART : MATHEMATICS

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(1) $\frac{1}{4}$ (2) $\frac{1}{2}$ (3) 0 (4) $\frac{1}{8}$

Ans. (1)

Sol. $I = \int_0^1 \cot^{-1} \left(\frac{\sin \frac{x}{2} + \cos \frac{x}{2}}{\sin \frac{x}{2} - \cos \frac{x}{2}} \right) dx$

$$I = \int_0^1 \cot^{-1} \left(\frac{2 \cos \frac{x}{2}}{2 \sin \frac{x}{2}} \right) dx$$

$$I = \int_0^1 \frac{x}{2} dx = \frac{1}{4}$$

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of the given equation)

Ans. 2
 Sol. $1 - 2\sin^2 x \cos^2 x - \sin x \cos x = 0$
 $\sin x \cos x = -1, \frac{1}{2}$ ($\sin x \cos x = -1$ rejected)
 $\sin 2x = 1 \Rightarrow x = \frac{\pi}{4}$
 $s = \frac{\pi}{4}$
 $\Rightarrow \frac{8s}{\pi} = \frac{8\pi}{4\pi} = 2$

3. If $\lim_{x \rightarrow \infty} (\sqrt{x^2 - x + 1} - ax) = b$. Then the value of $2(a + b)$ is :

(1) 2

(2) 4

(3) 2

(4) 1

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Sol. $\lim_{x \rightarrow \infty} \sqrt{x^2 - x + 1} - ax = b$
 $\Rightarrow \lim_{x \rightarrow \infty} \sqrt{x^2 - x + 1} - ax \times \frac{\sqrt{x^2 - x + 1} + ax}{\sqrt{x^2 - x + 1} + ax} = b$

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$\Rightarrow \lim_{x \rightarrow \infty} \frac{(x^2 - x + 1) - (ax)^2}{\sqrt{x^2 - x + 1} + ax} = b$
 $\Rightarrow$ Limit exist only if $a^2 = 1$
 $\therefore a = 1, -1$
 $\Rightarrow \lim_{x \rightarrow \infty} \frac{-x + 1}{\sqrt{x^2 - x + 1} + ax} = b$
 $\Rightarrow \lim_{x \rightarrow \infty} \frac{-1 + \frac{1}{x}}{\sqrt{1 - \frac{1}{x} + \frac{1}{x^2}} + a} = b$
 $\Rightarrow \frac{-1}{1 + a} = b$

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$b = \frac{-1}{2}$
 Then $2(a + b) = 1$

4. Image of a point P (-1, 2, 3) in plane $x + y - z - 3 = 0$ is Q and S is a point on this plane whose co-ordinates are $(3, 2, \beta)$. Then the square of length segment QS is :

(1) $\sqrt{18}$ (2) 16 (3) 17 (4) 9

Ans. (3)
 Sol. $\frac{x+1}{1} = \frac{y-2}{1} = \frac{z-3}{-1} = \frac{-2(-1+2-3-3)}{1+1+1}$
 $\Rightarrow x = \frac{7}{3}, y = \frac{16}{3}, z = \frac{-1}{3}$
 $\therefore Q = \left(\frac{7}{3}, \frac{16}{3}, \frac{-1}{3}\right)$
 $S(3, 2, \beta)$ lies on plane

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$\Rightarrow S = (3, 2, 2)$
 $QS = \sqrt{17}$

5. Let a curve P : $(y - 2)^2 = x - 1$. If a tangent is drawn to the curve P at the point whose ordinate is 3 then the area between the tangent, curve and x-axis is

(1) 9 (2) 11 (3) $\frac{9}{2}$ (4) $\frac{11}{2}$

Ans. (1)
 Sol. Given $y = 3$
 $x = 2$
 so point is (2,3)
 Differentiate given equation w.r.t. x , we get
 $2(y - 2)y' = 1$

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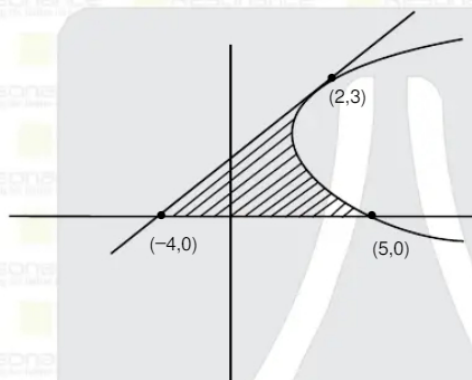
$$y' = \frac{1}{2(y-2)}$$

$$y'|_{(2,3)} = \frac{1}{2}$$

so equation of tangent is

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$$x - 2y + 4 = 0$$



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$$\begin{aligned} \text{Area} &= \int_0^3 [(y-2)^2 + 1 - (2y-4)^2] dy \\ \text{Area} &= \int_0^3 (y^2 - 6y + 9) dy \\ \text{Area} &= \left(\frac{y^3}{3} - 3y^2 + 9y \right)_0^3 = 9 \text{ sq. unit} \end{aligned}$$

6. Perpendicular tangents are drawn from an external point P to the parabola $y^2 = 16(x - 3)$. Then the locus of point P is :

- (1) $x = 1$ (2) $x = -1$ (3) $x = \frac{1}{2}$ (4) $x = 2$

Ans. (2)

Sol. Locus is directrix of parabola

$$X + A = 0$$

$$x - 3 + 4 = 0 \Rightarrow x + 1 = 0$$

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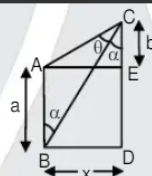
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7. $(p \wedge q) \rightarrow ((r \wedge q) \wedge p)$ is a
 (1) Tautology (2) Contradiction
 (3) neither contradiction nor tautology (4) None of these

Ans. (3)

Sol.

			I	II	
p	q	r	$p \wedge q$	$r \wedge q \wedge p$	$I \rightarrow II$
T	T	T	T	T	T
T	T	F	T	F	F
T	F	T	F	F	T
T	F	F	F	F	T
F	T	T	F	F	T
F	T	F	F	F	T
F	F	T	F	F	T
F	F	F	F	F	T



- (1) $x^2 - 2ax + ab + b^2 = 0$ (2) $x^2 - 2ax + ab + a^2 = 0$
 (3) $x^2 + 2ax - ab + b^2 = 0$ (4) $x^2 + 2ax + ab + b^2 = 0$

Ans. (1)

Sol. From Diagram $\tan(\theta + \alpha) = \frac{x}{b}$, $\tan \alpha = \frac{x}{a+b}$

$$\Rightarrow \frac{1 + \frac{x}{a+b}}{1 - \frac{x}{a+b}} = \frac{x}{b}$$

$$\Rightarrow ab + b^2 + 2bx = 2ax + 2bx - x^2$$

$$\Rightarrow x^2 - 2ax + ab + b^2 = 0$$

9. Let there be two non concentric circles having same radii of 5 cm touching each other at point P(1,2) and the common tangent of both the circles at P is $4x + 3y = 10$. If centres of two circles are $C_1(\alpha, \beta)$ and $C_2(\gamma, \delta)$, then the value of $|(\alpha + \beta)(\gamma + \delta)|$ is
 (1) 20 (2) 40 (3) 25 (4) 35

Ans. (2)

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Sol. $(x-1)^2 + (y-2)^2 + \lambda(4x+3y-10) = 0$

$$x^2 + y^2 + (2\lambda - 1)2x + \left(\frac{3}{2}\lambda - 2\right)2y + 5 - 10\lambda = 0$$

$$r = \sqrt{(2\lambda - 1)^2 + \left(\frac{3}{2}\lambda - 2\right)^2} - (5 - 10\lambda) = 5$$

$$4\lambda^2 + 1 - 4\lambda + \frac{9}{4}\lambda^2 + 4 - 6\lambda - 5 + 10\lambda = 25$$

$$\lambda = \pm 2$$

for $\lambda = 2$

$$x^2 + y^2 + 6x + 2y = 0 ; C_1(-3, -1)$$

for $\lambda = -2$

$$x^2 + y^2 - 10x - 10y + 25 = 0 ; C_2(5, 5)$$

$$|(\alpha + \beta)(\gamma + \delta)| = 40$$

10. If $(3x^2 + 4x + 3)^2 - (K + 1)(3x^2 + 4x + 2)(3x^2 + 4x + 3) + K(3x^2 + 4x + 2)^2 = 0$ has real roots then the value of K is

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

Ans. (2)

Sol. Let $t = (3x^2 + 4x + 2)$

$$\Rightarrow (t + 1)^2 - (K + 1)t(t + 1) + Kt^2 = 0$$

$$\Rightarrow t^2 + 1 + 2t - (K + 1)t(t + 1) + Kt^2 = 0$$

$$\Rightarrow t(1 - K) = -1$$

$$3x^2 + 4x + 2 = t = \frac{1}{K - 1}$$

For real roots, $D \geq 0$

$$\Rightarrow 16 - 4 \times 3 \times \left(2 - \frac{1}{K - 1}\right) \geq 0$$

$$\Rightarrow 4 \geq 6 - \frac{3}{K - 1} \Rightarrow \frac{3}{K - 1} \geq 2$$

$$\Rightarrow \frac{3 - 2K + 2}{K - 1} \geq 0$$

$$\Rightarrow \frac{(2K - 5)}{(K - 1)} \leq 0$$

$$K \in \left(1, \frac{5}{2}\right]$$

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11. Remainder when $3 \times 7^{22} + 2 \times 10^{22} - 44$ is divided by 18 is :

Sol. $3 \times (6 + 1)^{22} + 2 \times (9 + 1)^{22} - 44 = 18\lambda + 3 + 18\mu + 2 - 44$

$$= 18\delta - 39$$

$$= 18\beta + 15$$

12. The value of the integral $\int_0^1 \frac{\sqrt{x} dx}{(x+1)(3x+1)(x+3)}$ is :

(1) $\frac{\pi}{8} - \frac{\sqrt{3}\pi}{16}$ (2) $\frac{\pi}{8} + \frac{\sqrt{3}\pi}{16}$ (3) $\frac{\pi}{4} - \frac{\sqrt{3}\pi}{16}$ (4) 0

Ans. (1)

Sol. Let $\sqrt{x} = t$

$$= \int_0^1 \frac{2t^2 dt}{(t^2 + 1)(3t^2 + 1)(t^2 + 3)} = \int_0^1 \frac{(3t^2 + 1) - (t^2 + 1)}{(t^2 + 1)(3t^2 + 1)(t^2 + 3)} dt =$$

$$= \int_0^1 \left(\frac{1}{(t^2 + 3)(t^2 + 1)} - \frac{1}{(t^2 + 3)(3t^2 + 1)} \right) dt$$

$$= \int_0^1 \left(\frac{2(t^2 + 1) - 2(t^2 + 3) + 8t^2 + 1}{8(t^2 + 3)} \right) dt$$

$$= \int_0^1 \left(\frac{dt}{2(t^2 + 1)} - \frac{1}{8(3t^2 + 1)} - \frac{3}{8} \frac{dt}{(t^2 + 3)} \right)$$

$$= \left(\frac{1}{2} \tan^{-1} t - \frac{3\sqrt{3}}{8 \times 3} \tan^{-1} \sqrt{3}t - \frac{3}{8\sqrt{3}} \tan^{-1} \frac{t}{\sqrt{3}} \right)_0^1$$

$$= \frac{\pi}{8} - \frac{\sqrt{3}}{8} \times \frac{\pi}{3} - \frac{\sqrt{3}}{8} \frac{\pi}{6}$$

$$= \frac{\pi}{8} - \frac{\sqrt{3}\pi}{16}$$

13. When $0 < x < 1$, $y = \frac{1}{2}x^2 + \frac{2}{3}x^3 + \frac{3}{4}x^4 + \dots$ Then the value of e^{1-y} at $x = \frac{1}{2}$

Ans. (2)

$$= (x^2 + x^3 + x^4 + \dots) - \left(\frac{x^2}{2} + \frac{x^3}{3} + \frac{x^4}{4} + \dots \right)$$

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

$$= \frac{x}{1-x} + n(1-x)$$

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Put $x = \frac{1}{2} \Rightarrow y = 1 - \ln 2$

Then $e^{1-y} = e^{1-1+\ln 2} = 2$

14. If $\arg(z_1 - z_2) = \frac{\pi}{4}$, z_1 & z_2 satisfy $|z - 3| = \operatorname{Re}(z)$ Then sum of imaginary part of $(z_1 + z_2)$ is

Ans. (6)

Sol. Let $z_1 = x_1 + iy_1$, $z_2 = x_2 + iy_2$

$$z_1 - z_2 = (x_1 - x_2) + i(y_1 - y_2)$$

$$\therefore \arg(z_1 - z_2) = \frac{\pi}{4} \Rightarrow \tan^{-1} \left(\frac{y_1 - y_2}{x_1 - x_2} \right) = \frac{\pi}{4}$$

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$$|z_1 - 3| = \operatorname{Re}(z_1) \Rightarrow (x_1 - 3)^2 + y_1^2 = x_1^2$$

$$|z_2 - 3| = \operatorname{Re}(z_2) \Rightarrow (x_2 - 3)^2 + y_2^2 = x_2^2$$

$$\Rightarrow (x_1 - 3)^2 - (x_2 - 3)^2 + (y_1^2 - y_2^2) = x_1^2 - x_2^2$$

$$\Rightarrow (x_1 - x_2)(x_1 + x_2 - 6) + (y_1 - y_2)(y_1 + y_2) = (x_1 + x_2)(x_1 - x_2)$$

$$\Rightarrow x_1 + x_2 - 6 + y_1 + y_2 = x_1 + x_2$$

$$\Rightarrow y_1 + y_2 = 6$$

15. A plane which passes through the intersection of the planes $\vec{r} \cdot (2\hat{i} + 6\hat{j} + \hat{k}) = 4$ and $\vec{r} \cdot (2\hat{i} + 3\hat{j} + 6\hat{k}) = 2$ and also parallel to the y-axis is :

(1) $2x + 11z = 0$

(2) $4x + 11z = 0$

(3) $x + 9z = 0$

(4) $x + 11z = 0$

Ans. (1)

Sol. Equation of the plane $(2+2k)x + (6+3k)y + (1+6k)z = 4+2k$

$$0(2+2k) + 1(6+3k) + 0(1+6k) = 0 \Rightarrow k = -2$$

$$-2x - 11z = 0 \Rightarrow 2x + 11z = 0$$

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