

**Class – XII**  
**MATHEMATICS- 041**  
**SAMPLE QUESTION PAPER 2019-20**

**Time: 3 Hrs.**

**Maximum Marks: 80**

General Instructions:

- (i) All the questions are compulsory.
- (ii) The question paper consists of 36 questions divided into 4 sections A, B, C, and D.
- (iii) Section A comprises of 20 questions of 1 mark each. Section B comprises of 6 questions of 2 marks each. Section C comprises of 6 questions of 4 marks each. Section D comprises of 4 questions of 6 marks each.
- (iv) There is no overall choice. However, an internal choice has been provided in three questions of 1 mark each, two questions of 2 marks each, two questions of 4 marks each, and two questions of 6 marks each. You have to attempt only one of the alternatives in all such questions.
- (v) Use of calculators is not permitted.

<b>SECTION A</b>		
<b>Q1 - Q10 are multiple choice type questions. Select the correct option</b>		
1	If A is any square matrix of order $3 \times 3$ such that $ A  = 3$ , then the value of $ \text{adj}A $ is ? (a) 3 (b) $\frac{1}{3}$ (c) 9 (d) 27	1
2	Suppose P and Q are two different matrices of order $3 \times n$ and $n \times p$ , then the order of the matrix $P \times Q$ is? (a) $3 \times p$ (b) $p \times 3$ (c) $n \times n$ (d) $3 \times 3$	1
3	If $(2\hat{i} + 6\hat{j} + 27\hat{k}) \times (\hat{i} + p\hat{j} + q\hat{k}) = \vec{0}$ , then the values of p and q are ? (a) $p=6, q=27$ (b) $p=3, q=\frac{27}{2}$ (c) $p=6, q=\frac{27}{2}$ (d) $p=3, q=27$	1
4	If A and B are two events such that $P(A)=0.2$ , $P(B)=0.4$ and $P(A \cup B)=0.5$ , then value of $P(A/B)$ is ? (a) 0.1 (b) 0.25 (c) 0.5 (d) 0.08	1
5	The point which does not lie in the half plane $2x + 3y - 12 \leq 0$ is (a) (1,2) (b) (2,1) (c) (2,3) (d) (-3,2)	1
6	If $\sin^{-1} x + \sin^{-1} y = \frac{2\pi}{3}$ , then the value of $\cos^{-1} x + \cos^{-1} y$ is _____ (a) $\frac{2\pi}{3}$ (b) $\frac{\pi}{3}$ (c) $\frac{\pi}{2}$ (d) $\pi$	1

7	An urn contains 6 balls of which two are red and four are black. Two balls are drawn at random. Probability that they are of the different colours is  (a) $\frac{2}{5}$ (b) $\frac{1}{15}$ (c) $\frac{8}{15}$ (d) $\frac{4}{15}$	1
8	$\int \frac{dx}{\sqrt{9-25x^2}}$ (a) $\sin^{-1}\left(\frac{5x}{3}\right) + c$ (b) $\frac{1}{5}\sin^{-1}\left(\frac{5x}{3}\right) + c$ (c) $\frac{1}{6}\log\left(\frac{3+5x}{3-5x}\right) + c$ (d) $\frac{1}{30}\log\left(\frac{3+5x}{3-5x}\right) + c$	1
9	What is the distance(in units) between the two planes $3x + 5y + 7z = 3$ and $9x + 15y + 21z = 9$ ? (a) 0(b) 3(c) $\frac{6}{\sqrt{83}}$ (d) 6	1
10	The equation of the line in vector form passing through the point $(-1, 3, 5)$ and parallel to line $\frac{x-3}{2} = \frac{y-4}{3}, z = 2$ . is (a) $\vec{r} = (-\hat{i} + 3\hat{j} + 5\hat{k}) + \lambda(2\hat{i} + 3\hat{j} + \hat{k})$ . (b) $\vec{r} = (-\hat{i} + 3\hat{j} + 5\hat{k}) + \lambda(2\hat{i} + 3\hat{j})$ (c) $\vec{r} = (2\hat{i} + 3\hat{j} - 2\hat{k}) + \lambda(-\hat{i} + 3\hat{j} + 5\hat{k})$ (d) $\vec{r} = (2\hat{i} + 3\hat{j}) + \lambda(-\hat{i} + 3\hat{j} + 5\hat{k})$	1
<b>(Q11 - Q15) Fill in the blanks</b>		
11	If f be the greatest integer function defined as $f(x) = [x]$ and g be the modulus function defined as $g(x) =  x $ , then the value of g of $\left(-\frac{5}{4}\right)$ is _____	1
12	If the function $f(x) = \begin{cases} \frac{x^2-1}{x-1} & \text{when } x \neq 1 \\ k & \text{when } x = 1 \end{cases}$ is given to be continuous at $x = 1$ , then the value of k is _____	1
13	If $\begin{bmatrix} 1 & 2 \\ 2 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 5 \\ 4 \end{bmatrix}$ , then value of y is _____.	1
14	If tangent to the curve $y^2 + 3x - 7 = 0$ at the point $(h, k)$ is parallel to line $x - y = 4$ , then value of k is ____? <b>OR</b> For the curve $y = 5x - 2x^3$ , if x increases at the rate of 2units/sec, then at $x = 3$ the slope of the curve is changing at _____	1
15	The magnitude of projection of $(2\hat{i} - \hat{j} + \hat{k})$ on $(\hat{i} - 2\hat{j} + 2\hat{k})$ is _____ <b>OR</b> Vector of magnitude 5 units and in the direction opposite to $2\hat{i} + 3\hat{j} - 6\hat{k}$ is ____	1
<b>(Q16 - Q20) Answer the following questions</b>		
16	Check whether $(l + m + n)$ is a factor of the determinant $\begin{vmatrix} l+m & m+n & n+l \\ n & l & m \\ 2 & 2 & 2 \end{vmatrix}$ or not. Give reason.	1
17	Evaluate $\int_{-2}^2 (x^3 + 1) dx$ .	1
18	Find $\int \frac{3+3\cos x}{x+\sin x} dx$ .	1

	<b>OR</b>	
	Find $\int (\cos^2 2x - \sin^2 2x) dx$	
19	Find $\int xe^{(1+x^2)} dx$ .	1
20	Write the general solution of differential equation $\frac{dy}{dx} = e^{x+y}$	1
	<b>SECTION – B</b>	
21	Express $\sin^{-1} \left( \frac{\sin x + \cos x}{\sqrt{2}} \right)$ ; where $-\frac{\pi}{4} < x < \frac{\pi}{4}$ , in the simplest form.	2
	<b>OR</b>	
	Let R be the relation in the set Z of integers given by $R = \{(a, b) : 2 \text{ divides } a - b\}$ . Show that the relation R transitive? Write the equivalence class [0].	
22	If $y = ae^{2x} + be^{-x}$ , then show that $\frac{d^2y}{dx^2} - \frac{dy}{dx} - 2y = 0$ .	2
23	A particle moves along the curve $x^2 = 2y$ . At what point, ordinate increases at the same rate as abscissa increases?	2
24	For three non-zero vectors $\vec{a}, \vec{b}$ and $\vec{c}$ , prove that $[\vec{a} - \vec{b}, \vec{b} - \vec{c}, \vec{c} - \vec{a}] = 0$ .	2
	<b>OR</b>	
	If $\vec{a} + \vec{b} + \vec{c} = 0$ and $ \vec{a}  = 3,  \vec{b}  = 5,  \vec{c}  = 7$ , then find the value of $\vec{a} \cdot \vec{b} + \vec{b} \cdot \vec{c} + \vec{c} \cdot \vec{a}$ .	
25	Find the acute angle between the lines $\frac{x-4}{3} = \frac{y+3}{4} = \frac{z+1}{5}$ and $\frac{x-1}{4} = \frac{y+1}{-3} = \frac{z+10}{5}$	2
26	A speaks truth in 80% cases and B speaks truth in 90% cases. In what percentage of cases are they likely to agree with each other in stating the same fact?	2
	<b>SECTION – C</b>	
27	Let $f: A \rightarrow B$ be a function defined as $f(x) = \frac{2x+3}{x-3}$ , where $A = \mathbb{R} - \{3\}$ and $B = \mathbb{R} - \{2\}$ . Is the function f one –one and onto? Is f invertible? If yes, then find its inverse.	4
28	If $\sqrt{1-x^2} + \sqrt{1-y^2} = a(x-y)$ , then prove that $\frac{dy}{dx} = \frac{\sqrt{1-y^2}}{\sqrt{1-x^2}}$ .	4
	<b>OR</b>	
	If $x = a(\cos 2\theta + 2\theta \sin 2\theta)$ and $y = a(\sin 2\theta - 2\theta \cos 2\theta)$ , find $\frac{d^2y}{dx^2}$ at $\theta = \frac{\pi}{8}$ .	
29	Solve the differential equation $x dy - y dx = \sqrt{x^2 + y^2} dx$ .	4

30	Evaluate $\int_1^3  x^2 - 2x  dx$ .	4
31	Two numbers are selected at random (without replacement) from first 7 natural numbers. If X denotes the smaller of the two numbers obtained, find the probability distribution of X. Also, find mean of the distribution. <b>OR</b> There are three coins, one is a two headed coin (having head on both the faces), another is a biased coin that comes up heads 75% of the time and the third is an unbiased coin. One of the three coins is chosen at random and tossed. If It shows head. What is probability that it was the two headed coin ?	4
32	Two tailors A and B earn ₹150 and ₹200 per day respectively. A can stitch 6 shirts and 4 pants per day, while B can stitch 10 shirts and 4 pants per day. Form a L.P.P to minimize the labour cost to produce (stitch) at least 60 shirts and 32 pants and solve it graphically.	4
<b>SECTION D</b>		
33	Using the properties of determinants, prove that $\begin{vmatrix} (y+z)^2 & x^2 & x^2 \\ y^2 & (z+x)^2 & y^2 \\ z^2 & z^2 & (x+y)^2 \end{vmatrix} = 2xyz(x+y+z)^3.$ <b>OR</b> If $A = \begin{bmatrix} 2 & 3 & 4 \\ 1 & -1 & 0 \\ 0 & 1 & 2 \end{bmatrix}$ , find $A^{-1}$ . Hence, solve the system of equations $x - y = 3$ ; $2x + 3y + 4z = 17$ ; $y + 2z = 7$	6
34	Using integration, find the area of the region $\{(x, y) : x^2 + y^2 \leq 1, x + y \geq 1, x \geq 0, y \geq 0\}$	6
35	A given quantity of metal is to be cast into a solid half circular cylinder with a rectangular base and semi-circular ends. Show that in order that total surface area is minimum, the ratio of length of cylinder to the diameter of semi-circular ends is $\pi : \pi + 2$ . <b>OR</b> Show that the triangle of maximum area that can be inscribed in a given circle is an equilateral triangle.	6
36	Find the equation of a plane passing through the points $A(2,1,2)$ and $B(4, -2,1)$ and perpendicular to plane $\vec{r} \cdot (\hat{i} - 2\hat{k}) = 5$ . Also, find the coordinates of the point, where the line passing through the points $(3,4,1)$ and $(5,1,6)$ crosses the plane thus obtained.	6

**Class – XII**  
**MATHEMATICS (041)**  
**SQP Marking Scheme (2019-20)**

**TIME: 3 Hrs.**

**Maximum Marks: 80**

SECTION A		
1	(c) 9	1
2	(a) $3 \times p$	1
3	(b) $p=3, q=\frac{27}{2}$	1
4	(b) 0.25	1
5	(c) (2,3)	1
6	(b) $\frac{\pi}{3}$	1
7	(c) $\frac{8}{15}$	1
8	(b) $\frac{1}{5} \sin^{-1} \left( \frac{5x}{3} \right) + c$	1
9	(a) 0	1
10	(b) $\vec{r} = (-\hat{i} + 3\hat{j} + 5\hat{k}) + \lambda(2\hat{i} + 3\hat{j})$	1
11	$g \left( \left[ -\frac{5}{4} \right] \right) = g(-2) = 2$	1
12	2	1
13	$y = 2$	1
14	$\frac{-3}{2}$	1
OR		
decreasing at rate of 72 units/sec.		
15	2 units	1
OR		
$\frac{5}{7}(-2\hat{i} - 3\hat{j} + 6\hat{k})$		
16	Apply $R_1 \rightarrow R_1 + R_2$ $\begin{vmatrix} l+m+n & m+n+l & n+l+m \\ n & l & m \\ 1 & 2 & 2 \end{vmatrix}$ $= 2(l+m+n) \begin{vmatrix} 1 & 1 & 1 \\ n & l & m \\ 1 & 1 & 1 \end{vmatrix} \quad ; \text{ yes } (l+m+n) \text{ is a factor}$	1
17	$\int_{-2}^2 (x^3 + 1) dx = \int_{-2}^2 (x^3) dx + \int_{-2}^2 1 dx = I_1 + I_2$ $= 0 + [x]_{-2}^2 \quad (\text{As } I_1 \text{ is odd function})$ $= 2 + 2$ $= 4$	1

18	<p>Let <math>x + \sin x = t</math>  So <math>(1 + \cos x)dx = dt</math>  <math>I = 3 \int \frac{dt}{t} = 3 \log t  + c = 3 \log (x + \sin x)  + c</math>  or directly by writing formula</p> $\int \frac{f'(x)}{f(x)} dx = \log f(x)  + c$ <p style="text-align: center;"><b>OR</b></p> $\int \cos 4x dx = \frac{\sin 4x}{4} + c$	1	
19	<p>let <math>(1 + x^2) = t</math>  so <math>2x dx = dt</math>  <math>\Rightarrow I = \frac{1}{2} \int e^t dt = \frac{1}{2} e^t + c = \frac{1}{2} e^{(1+x^2)} + c</math></p>	1	
20	<p><math>\frac{dy}{dx} = e^x e^y</math>  <math>\Rightarrow \frac{dy}{e^y} = e^x dx</math>  integrating both sides  <math>\Rightarrow -e^{-y} + c = e^x</math>  <math>\Rightarrow e^x + e^{-y} = c</math></p>	1	
<b>SECTION B</b>			
21	<p><math>= \sin^{-1} \left( \frac{\sin x}{\sqrt{2}} + \frac{\cos x}{\sqrt{2}} \right)</math> if <math>-\frac{\pi}{4} &lt; x &lt; \frac{\pi}{4}</math>  <math>= \sin^{-1} \left( \sin x \cos \frac{\pi}{4} + \cos x \sin \frac{\pi}{4} \right)</math> if <math>-\frac{\pi}{4} + \frac{\pi}{4} &lt; x + \frac{\pi}{4} &lt; \frac{\pi}{4} + \frac{\pi}{4}</math>  <math>= \sin^{-1} \left( \sin \left( x + \frac{\pi}{4} \right) \right)</math> if <math>0 &lt; \left( x + \frac{\pi}{4} \right) &lt; \frac{\pi}{2}</math> i.e. principal values  <math>= \left( x + \frac{\pi}{4} \right)</math></p> <p style="text-align: center;"><b>OR</b></p> <p>Let 2 divides <math>(a - b)</math> and 2 divides <math>(b - c)</math> : where <math>a, b, c \in Z</math>  So 2 divides <math>[(a - b) + (b - c)]</math>  2 divides <math>(a - c)</math>: Yes relation R is transitive  <math>[0] = \{0, \pm 2, \pm 4, \pm 6, \dots\}</math></p>	1	
			1
			1
22	<p><math>y = ae^{2x} + be^{-x} \dots \dots \dots (1)</math>  <math>\frac{dy}{dx} = 2ae^{2x} - be^{-x} \dots \dots \dots (2)</math>  <math>\frac{d^2y}{dx^2} = 4ae^{2x} + be^{-x} \dots \dots \dots (3)</math>  putting values on LHS</p> $= \frac{d^2y}{dx^2} - \frac{dy}{dx} - 2y$ $= (4ae^{2x} + be^{-x}) - (2ae^{2x} - be^{-x}) - 2(ae^{2x} + be^{-x})$ $= 4ae^{2x} + be^{-x} - 2ae^{2x} + be^{-x} - 2ae^{2x} - 2be^{-x}$ $= 0$	1	
			1



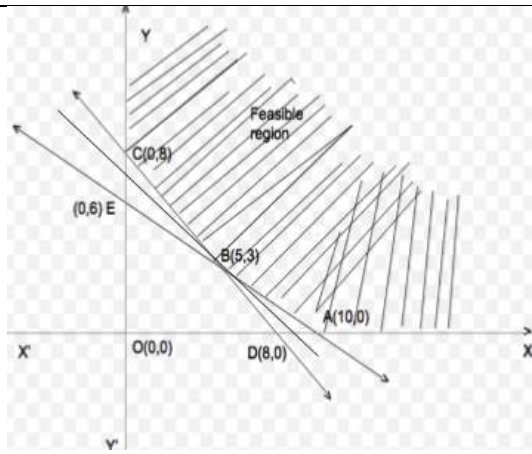
	$= P(A)P(B) \text{ or } P(\bar{A})P(\bar{B})$ $= \left(\frac{4}{5}\right)\left(\frac{9}{10}\right) + \left(\frac{1}{5}\right)\left(\frac{1}{10}\right)$ $= \frac{36+1}{50} = \frac{37}{50}$ $= \frac{74}{100} = 74\%$	1
	<b>SECTION C</b>	
27	<p>Let <math>y = f(x) = \frac{2x+3}{x-3}</math> .....(1)</p> <p>Let <math>x_1, x_2 \in A = \mathbb{R} - \{3\}</math></p> <p>Let <math>f(x_1) = f(x_2)</math></p> $\Rightarrow \frac{2x_1 + 3}{x_1 - 3} = \frac{2x_2 + 3}{x_2 - 3}$ $\Rightarrow (2x_1 + 3)(x_2 - 3) = (2x_2 + 3)(x_1 - 3)$ $\Rightarrow (2x_1x_2 - 6x_1 + 3x_2 - 9) = (2x_1x_2 - 6x_2 + 3x_1 - 9)$ $\Rightarrow -6x_1 + 3x_2 = -6x_2 + 3x_1$ $\Rightarrow 9x_1 = 9x_2$ $\Rightarrow x_1 = x_2$ <p>Now <math>f(x_1) = f(x_2) \Rightarrow x_1 = x_2</math></p> <p>so <math>f(x)</math> is one-one</p> <p>For onto</p> $y = \frac{2x + 3}{x - 3}$ $\Rightarrow xy - 3y = 2x + 3$ $\Rightarrow xy - 2x = 3y + 3$ $\Rightarrow x(y - 2) = 3(y + 1)$ $\Rightarrow x = \frac{3(y+1)}{(y-2)} \dots\dots\dots(2)$ <p>equation (2) is defined for all real values of y except 2 i.e <math>y \in \mathbb{R} - \{2\}</math> which is same as given set <math>B = \mathbb{R} - \{2\}</math> (co-domain=range)</p> <p>Also <math>y = f(x)</math></p> $f(x) = f\left(\frac{3(y+1)}{(y-2)}\right)$ $= \frac{2\left[\frac{3(y+1)}{(y-2)}\right] + 3}{\frac{3(y+1)}{(y-2)} - 3} \left(\text{since } f(x) = \frac{2x + 3}{x - 3}\right)$ $\frac{2(3y + 3) + 3(y - 2)}{3y + 3 - 3y + 6} = \frac{9y}{9} = y$ <p>Thus for every <math>y \in B</math>, there exists <math>x \in A</math> such that <math>f(x) = y</math></p> <p>Thus function is onto.</p> <p>Since <math>f(x)</math> is one-one and onto so <math>f(x)</math> is invertible.</p> <p>Inverse is given by <math>x = f^{-1}(y) = \frac{3(y+1)}{(y-2)}</math></p>	<p><math>\frac{1}{2}</math></p> <p>1</p> <p><math>\frac{1}{2}</math></p> <p>1</p>
28	$\sqrt{1-x^2} + \sqrt{1-y^2} = a(x-y)$ <p>Let <math>x = \sin A</math> , <math>y = \sin B</math></p> $\sqrt{1-\sin^2 A} + \sqrt{1-\sin^2 B} = a(\sin A - \sin B)$ $\cos A + \cos B = a(\sin A - \sin B)$ $\Rightarrow 2 \cos\left(\frac{A+B}{2}\right) \cos\left(\frac{A-B}{2}\right) = 2a \cos\left(\frac{A+B}{2}\right) \sin\left(\frac{A-B}{2}\right)$ $\Rightarrow \cos\left(\frac{A-B}{2}\right) = a \sin\left(\frac{A-B}{2}\right)$	<p><math>\frac{1}{2}</math></p> <p>1</p>



	$\Rightarrow \cot\left(\frac{A-B}{2}\right) = a$ $\Rightarrow \frac{A-B}{2} = \cot^{-1} a$ $\Rightarrow A-B = 2 \cot^{-1} a$ $\Rightarrow \sin^{-1} x - \sin^{-1} y = 2 \cot^{-1} a$ <p>differentiating w.r.t. x</p> $\Rightarrow \frac{1}{\sqrt{1-x^2}} - \frac{1}{\sqrt{1-y^2}} \frac{dy}{dx} = 0$ $\Rightarrow \frac{dy}{dx} = \frac{\sqrt{1-y^2}}{\sqrt{1-x^2}}$ <p style="text-align: center;"><b>OR</b></p>	<p>1</p> <p>1</p> <p><math>\frac{1}{2}</math></p>
	$x = a(\cos 2\theta + 2\theta \sin 2\theta)$ $\Rightarrow \frac{dx}{d\theta} = a(-2 \sin 2\theta + 2 \sin 2\theta + 4\theta \cos 2\theta)$ $\Rightarrow \frac{dx}{d\theta} = a(4\theta \cos 2\theta) \dots \dots \dots (1)$ $y = a(\sin 2\theta - 2\theta \cos 2\theta)$ $\Rightarrow \frac{dy}{d\theta} = a(2 \cos 2\theta + 4\theta \sin 2\theta - 2 \cos 2\theta)$ $\Rightarrow \frac{dy}{d\theta} = a(4\theta \sin 2\theta) \dots \dots \dots (2)$ <p>using (1) and (2)</p> $\Rightarrow \frac{dy}{dx} = \frac{a(4\theta \sin 2\theta)}{a(4\theta \cos 2\theta)}$ $\Rightarrow \frac{dy}{dx} = \frac{\sin 2\theta}{\cos 2\theta} = \tan 2\theta$ <p>Differentiating again with respect to x, we get</p> $\Rightarrow \frac{d^2y}{dx^2} = 2 \sec^2 2\theta \cdot \frac{d\theta}{dx}$ $\Rightarrow \frac{d^2y}{dx^2} = 2 \sec^2 2\theta \cdot \frac{1}{a(4\theta \cos 2\theta)}$ $\left. \frac{d^2y}{dx^2} \right _{\theta=\frac{\pi}{8}} = 2 \sec^2 \frac{\pi}{4} \cdot \frac{1}{a\left(4 \frac{\pi}{8} \cos \frac{\pi}{4}\right)}$ $= \frac{8\sqrt{2}}{\pi a}$	<p>1</p> <p>1</p> <p><math>\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p> <p>1</p>
29	$x \frac{dy}{dx} - y = \sqrt{x^2 + y^2}$ $\Rightarrow x \frac{dy}{dx} = y + \sqrt{x^2 + y^2}$ $\Rightarrow \frac{dy}{dx} = \frac{y + \sqrt{x^2 + y^2}}{x} \dots \dots \dots (1)$ <p style="text-align: right;">let <math>y = vx</math></p> <p>differentiating with w.r.t. x</p> $\Rightarrow \frac{dy}{dx} = v + x \frac{dv}{dx}$ <p>put in (1)</p>	<p>1</p>

	$\Rightarrow v + x \frac{dv}{dx} = \frac{vx + \sqrt{x^2 + v^2 x^2}}{x}$ $\Rightarrow v + x \frac{dv}{dx} = \frac{x(v + \sqrt{1 + v^2})}{x}$ $\Rightarrow x \frac{dv}{dx} = v + \sqrt{1 + v^2} - v$ $\Rightarrow x \frac{dv}{dx} = \sqrt{1 + v^2}$ $\Rightarrow \frac{dv}{\sqrt{1 + v^2}} = \frac{dx}{x}$ <p>integrating both sides</p> $\Rightarrow \int \frac{dv}{\sqrt{1 + v^2}} = \int \frac{dx}{x}$ $\Rightarrow \log(v + \sqrt{1 + v^2}) = \log x + \log c$ $\Rightarrow \log(v + \sqrt{1 + v^2}) = \log cx$ $\Rightarrow (v + \sqrt{1 + v^2}) = cx$ $\Rightarrow \left( \frac{y}{x} + \sqrt{1 + \left( \frac{y}{x} \right)^2} \right) = cx$ $\Rightarrow y + \sqrt{x^2 + y^2} = cx^2$	<p>1</p> <p><math>1\frac{1}{2}</math></p> <p><math>\frac{1}{2}</math></p>							
30	<p>Consider <math>I = \int_1^3  x^2 - 2x  dx</math></p> $ x^2 - 2x  = \begin{cases} -(x^2 - 2x) & \text{when } 1 \leq x < 2 \\ (x^2 - 2x) & \text{when } 2 \leq x \leq 3 \end{cases}$ $I = \int_1^2  x^2 - 2x  dx + \int_2^3  x^2 - 2x  dx$ $I = \int_1^2 -(x^2 - 2x) dx + \int_2^3 (x^2 - 2x) dx$ $I = -\left[ \frac{x^3}{3} - x^2 \right]_1^2 + \left[ \frac{x^3}{3} - x^2 \right]_2^3$ $I = -\left( -\frac{4}{3} + \frac{2}{3} \right) + \left( \frac{4}{3} \right)$ $I = \frac{6}{3} = 2$	<p>1</p> <p>1</p> <p>1</p> <p>1</p>							
31	<p>Let X denotes the smaller of the two numbers obtained So X can take values 1,2,3,4,5,6 P(X=1 is smaller number)</p> $P(X=1) = \frac{6}{7C_2} = \frac{6}{21} = \frac{2}{7}$ <p>(Total cases when two numbers can be selected from first 7 numbers are <math>7C_2</math>)</p> $P(X=2) = \frac{5}{7C_2} = \frac{5}{21}$ $P(X=3) = \frac{4}{7C_2} = \frac{4}{21}$ $P(X=4) = \frac{3}{7C_2} = \frac{3}{21} = \frac{1}{7}$ $P(X=5) = \frac{2}{7C_2} = \frac{2}{21}$ $P(X=6) = \frac{1}{7C_2} = \frac{1}{21}$ <table border="1" style="width: 100%; text-align: center;"> <tr> <td><math>x_i</math></td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> <td>6</td> </tr> </table>	$x_i$	1	2	3	4	5	6	<p><math>\frac{1}{2}</math></p> <p>2</p>
$x_i$	1	2	3	4	5	6			

	<table border="1"> <tbody> <tr> <td><math>p_i</math></td> <td><math>\frac{6}{21}</math></td> <td><math>\frac{5}{21}</math></td> <td><math>\frac{4}{21}</math></td> <td><math>\frac{3}{21}</math></td> <td><math>\frac{2}{21}</math></td> <td><math>\frac{1}{21}</math></td> </tr> <tr> <td><math>p_i x_i</math></td> <td><math>\frac{6}{21}</math></td> <td><math>\frac{10}{21}</math></td> <td><math>\frac{12}{21}</math></td> <td><math>\frac{12}{21}</math></td> <td><math>\frac{10}{21}</math></td> <td><math>\frac{6}{21}</math></td> </tr> </tbody> </table> <p>Mean <math>= \sum p_i x_i = \frac{6}{21} + \frac{10}{21} + \frac{12}{21} + \frac{12}{21} + \frac{10}{21} + \frac{6}{21} = \frac{56}{21} = \frac{8}{3}</math></p> <p style="text-align: center;"><b>OR</b></p>	$p_i$	$\frac{6}{21}$	$\frac{5}{21}$	$\frac{4}{21}$	$\frac{3}{21}$	$\frac{2}{21}$	$\frac{1}{21}$	$p_i x_i$	$\frac{6}{21}$	$\frac{10}{21}$	$\frac{12}{21}$	$\frac{12}{21}$	$\frac{10}{21}$	$\frac{6}{21}$	$\frac{1}{2}$ 1
$p_i$	$\frac{6}{21}$	$\frac{5}{21}$	$\frac{4}{21}$	$\frac{3}{21}$	$\frac{2}{21}$	$\frac{1}{21}$										
$p_i x_i$	$\frac{6}{21}$	$\frac{10}{21}$	$\frac{12}{21}$	$\frac{12}{21}$	$\frac{10}{21}$	$\frac{6}{21}$										
	<p>Let <math>E_1</math> = event of selecting a two headed coin  <math>E_2</math> = event of selecting a biased coin, which shows 75% times Head  <math>E_3</math> = event of selecting an unbiased coin.  A = event that tossed coin shows head.</p> <p style="text-align: center;"><math>\therefore P(E_1) = P(E_2) = P(E_3) = \frac{1}{3}</math></p> <p><math>P(A/E_1) = P(\text{coin showing head given that it is two headed coin})</math>  <math>= 1</math></p> <p><math>P(A/E_2) = P(\text{coin showing head given that it is a biased coin})</math>  <math>= \frac{75}{100} = \frac{3}{4}</math></p> <p><math>P(A/E_3) = P(\text{coin showing head given that it is unbiased coin})</math>  <math>= \frac{1}{2}</math></p> <p>By Bayes theorem  P(getting two headed coin when it is known that it shows Head)</p> $P(E_1/A) = \frac{P(E_1)P(A/E_1)}{P(E_1)P(A/E_1) + P(E_2)P(A/E_2) + P(E_3)P(A/E_3)}$ $= \frac{\frac{1}{3} \times 1}{\frac{1}{3} \times 1 + \frac{1}{3} \times \frac{3}{4} + \frac{1}{3} \times \frac{1}{2}} = \frac{\frac{1}{3} \times 1}{\frac{1}{3} \left(1 + \frac{3}{4} + \frac{1}{2}\right)} = \frac{\frac{1}{3} \times 1}{\frac{1}{3} \times \frac{9}{4}} = \frac{4}{9}$ <p>Required probability <math>= \frac{4}{9}</math></p>	1 $\frac{1}{2}$ 1 $\frac{1}{2}$														
32	<p>Let tailor A works for <math>x</math> days and tailor B works for <math>y</math> days  Objective function :  To minimize labour cost <math>Z = 150x + 200y</math> (in ₹)  Subject to constraints  <math>6x + 10y \geq 60</math> i.e. <math>3x + 5y \geq 30</math>  <math>4x + 4y \geq 32</math> i.e. <math>x + y \geq 8</math>  <math>x \geq 0, y \geq 0</math>  consider equations to draw the graph and then we will shade feasible region</p> $3x + 5y = 30$ $x + y = 8$	$\frac{1}{2}$ $\frac{1}{2}$														



corner points of feasible region are A(10,0), B(5,3) and C(0,8)  
Value of Z at these corner points

Point	$Z = 150x + 200y$ (in ₹)
A(10,0)	$=1500+0=1500$
B(5,3)	$=750+600=1350$ (minimum)
C(0,8)	$=0+1600=1600$

So minimum value of Z is ₹1350 when tailor A works for 5 days and tailor B works for 3 days.

To check draw  $150x + 200y < 1350$  i.e  $3x + 4y < 27$

As there is no region common with feasible region so minimum value is ₹1350

### SECTION D

33

$$\text{LHS} = \begin{vmatrix} (y+z)^2 & x^2 & x^2 \\ y^2 & (z+x)^2 & y^2 \\ z^2 & z^2 & (x+y)^2 \end{vmatrix}$$

Apply  $C_2 \rightarrow C_2 - C_1$ ,  $C_3 \rightarrow C_3 - C_1$

$$= \begin{vmatrix} (y+z)^2 & x^2 - (y+z)^2 & x^2 - (y+z)^2 \\ y^2 & (z+x)^2 - y^2 & 0 \\ z^2 & 0 & (x+y)^2 - z^2 \end{vmatrix}$$

$$= \begin{vmatrix} (y+z)^2 & (x+y+z)(x-y-z) & (x+y+z)(x-y-z) \\ y^2 & (z+x+y)(z+x-y) & 0 \\ z^2 & 0 & (x+y+z)(x+y-z) \end{vmatrix}$$

Taking  $(x+y+z)$  common from  $C_2$  as well as  $C_3$

$$= (x+y+z)^2 \begin{vmatrix} (y+z)^2 & (x-y-z) & (x-y-z) \\ y^2 & (z+x-y) & 0 \\ z^2 & 0 & (x+y-z) \end{vmatrix}$$

Apply  $R_1 \rightarrow R_1 - R_2 - R_3$

$$= (x+y+z)^2 \begin{vmatrix} 2yz & -2z & -2y \\ y^2 & (z+x-y) & 0 \\ z^2 & 0 & (x+y-z) \end{vmatrix}$$

1

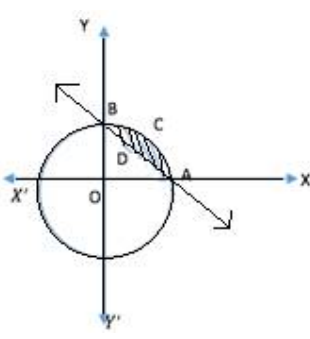
1

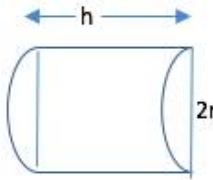
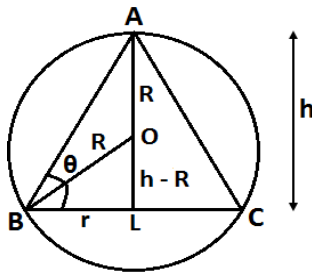
1

1

1

	<p>Apply <math>C_2 \rightarrow y C_2</math> and <math>C_3 \rightarrow z C_3</math></p> $= \frac{(x+y+z)^2}{yz} \begin{vmatrix} 2yz & -2yz & -2yz \\ y^2 & (yz + yx - y^2) & 0 \\ z^2 & 0 & (zx + zy - z^2) \end{vmatrix}$ <p>Apply <math>C_2 \rightarrow C_2 + C_1</math> and <math>C_3 \rightarrow C_3 + C_1</math></p> $= \frac{(x+y+z)^2}{yz} \begin{vmatrix} 2yz & 0 & 0 \\ y^2 & (yz + yx) & y^2 \\ z^2 & z^2 & (zx + zy) \end{vmatrix}$ <p>expanding along <math>R_1</math></p> $= \left(\frac{(x+y+z)^2}{yz}\right) 2yz[(yz + yx)(zx + zy) - y^2 z^2]$ $= 2(x + y + z)^2 [xyz^2 + x^2 yz + xy^2 z + y^2 z^2 - y^2 z^2]$ $= 2xyz(x + y + z)^2 (x + y + z)$ $= 2xyz(x + y + z)^3$ <p style="text-align: center;"><b>OR</b></p>	<p style="text-align: center;"><u>1</u></p> <p style="text-align: center;"><u>1</u></p> <p style="text-align: center;"><u>1</u></p>
	<p>** <math>A = \begin{bmatrix} 2 &amp; 3 &amp; 4 \\ 1 &amp; -1 &amp; 0 \\ 0 &amp; 1 &amp; 2 \end{bmatrix}</math></p> $ A  = 2(-2) - 3(2 - 0) + 4(1 - 0) = -6 \neq 0$ <p style="text-align: center;"><math>\therefore A^{-1}</math> exists</p> <p>Cofactors</p> $A_{11} = -2 \quad A_{12} = -2 \quad A_{13} = 1$ $A_{21} = 2 \quad A_{22} = 4 \quad A_{23} = -2$ $A_{31} = 4 \quad A_{32} = 4 \quad A_{33} = -5$ $Adj A = \begin{bmatrix} -2 & -2 & 1 \\ -2 & 4 & -2 \\ 4 & 4 & -5 \end{bmatrix}'$ $Adj A = \begin{bmatrix} -2 & -2 & 4 \\ -2 & 4 & 4 \\ 1 & -2 & -5 \end{bmatrix}$ $A^{-1} = \frac{Adj A}{ A } = \frac{1}{-6} \begin{bmatrix} -2 & -2 & 4 \\ -2 & 4 & 4 \\ 1 & -2 & -5 \end{bmatrix}$ <p>System of equations can be written as <math>AX = B</math></p> <p>Where <math>A = \begin{bmatrix} 2 &amp; 3 &amp; 4 \\ 1 &amp; -1 &amp; 0 \\ 0 &amp; 1 &amp; 2 \end{bmatrix}</math>, <math>X = \begin{bmatrix} x \\ y \\ z \end{bmatrix}</math>, <math>B = \begin{bmatrix} 17 \\ 3 \\ 7 \end{bmatrix}</math></p> <p>Now <math>AX = B</math></p> $\Rightarrow X = A^{-1}B$ $\Rightarrow X = \frac{1}{-6} \begin{bmatrix} -2 & -2 & 4 \\ -2 & 4 & 4 \\ 1 & -2 & -5 \end{bmatrix} \begin{bmatrix} 17 \\ 3 \\ 7 \end{bmatrix}$	<p style="text-align: center;">1</p> <p style="text-align: center;">2</p> <p style="text-align: center;">1</p> <p style="text-align: center;"><math>\frac{1}{2}</math></p>

	$\Rightarrow X = \frac{1}{-6} \begin{bmatrix} -34 - 6 + 28 \\ -34 + 12 + 28 \\ 17 - 6 - 35 \end{bmatrix}$ $\Rightarrow X = \frac{1}{-6} \begin{bmatrix} -12 \\ 6 \\ -24 \end{bmatrix}$ $\Rightarrow X = \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 2 \\ -1 \\ 4 \end{bmatrix}$ $\Rightarrow x = 2, \quad y = -1, \quad z = 4$	$1\frac{1}{2}$
34	<p> <math>x^2 + y^2 = 1</math>.....(1)  <math>x + y = 1</math>.....(2)  solving (1) and(2)  <math>x^2 + (1 - x)^2 = 1</math>  <math>x^2 + x^2 - 2x + 1 = 1</math>  <math>2x^2 - 2x = 0</math>  <math>2x(x - 1) = 0</math>  <math>x = 0</math> or <math>x = 1</math> </p>  <p> Required area = shaded area ACBDA  = area(OACBO) – area(OADBO)  <math>= \int_0^1 (y_{circle} - y_{line}) dx</math>  <math>= \int_0^1 \sqrt{1 - x^2} dx - \int_0^1 (1 - x) dx</math>  <math>= \left[ \frac{x\sqrt{1-x^2}}{2} + \frac{1}{2} \sin^{-1} x \right]_0^1 - \left[ x - \frac{x^2}{2} \right]_0^1</math>  <math>= \left[ \left( 0 + \frac{1}{2} \cdot \frac{\pi}{2} \right) - 0 \right] - \left[ \left( 1 - \frac{1}{2} \right) \right]</math>  <math>\left( \frac{\pi}{4} - \frac{1}{2} \right)</math> square units </p>	<p>1</p> <p>1</p> <p>1</p> <p><math>1\frac{1}{2}</math></p> <p><math>1\frac{1}{2}</math></p>
35	<p>Let <math>r</math> be the radius and <math>h</math> be the height of half cylinder</p> <p>Volume <math>= \frac{1}{2} \pi r^2 h = V(\text{constant})</math>.....(1)</p>	$\frac{1}{2} (fig)$

	<div style="text-align: center;">  </div> <p>Total surface area of half cylinder is</p> $S = 2\left(\frac{1}{2}\pi r^2\right) + \pi r h + 2rh \dots\dots\dots(2)$ <p>From (1) put the value of <math>h</math> in (2)</p> $S = (\pi r^2) + \pi r \left(\frac{2V}{\pi r^2}\right) + 2r \left(\frac{2V}{\pi r^2}\right)$ $S = (\pi r^2) + \left(\frac{1}{r}\right) \left[\frac{4V}{\pi} + 2V\right]$ $\frac{ds}{dr} = (2\pi r) + \left(\frac{-1}{r^2}\right) \left[\frac{4V}{\pi} + 2V\right] \dots\dots\dots(3)$ <p>For maxima/minima <math>\frac{ds}{dr} = 0</math></p> $\Rightarrow (2\pi r) + \left(\frac{-1}{r^2}\right) \left[\frac{4V}{\pi} + 2V\right] = 0$ $\Rightarrow (2\pi r) = \left(\frac{1}{r^2}\right) \left[\frac{4V + 2V\pi}{\pi}\right]$ $\Rightarrow \pi r^3 = V \left[\frac{2 + \pi}{\pi}\right]$ $\Rightarrow V = \frac{\pi^2 r^3}{\pi + 2} \dots\dots\dots(4)$ <p>From (1) and (4)</p> $\Rightarrow \frac{1}{2}\pi r^2 h = \frac{\pi^2 r^3}{\pi + 2}$ $\Rightarrow \frac{h}{2r} = \frac{\pi}{\pi + 2}$ $\Rightarrow \text{height: diameter} = \pi : \pi + 2$ <p>Differentiating (3) with respect to <math>r</math></p> $\frac{d^2s}{dr^2} = (2\pi) + \left(\frac{2}{r^3}\right) \left[\frac{4V}{\pi} + 2V\right] = \text{positive (as all quantities are +ve)}$ <p>so <math>S</math> is minimum when</p> $\text{height: diameter} = \pi : \pi + 2$ <p>OR</p>	<p><math>1 \frac{1}{2}</math></p> <p>1</p> <p>1</p> <p>1</p> <p>1</p>
	<p>Let <math>2r</math> be the base and <math>h</math> be the height of triangle, which is inscribed in a circle of radius <math>R</math></p> <p>Area of triangle = <math>\frac{1}{2}(\text{base})(\text{height})</math></p> $A = \frac{1}{2}(2r)(h) = rh \dots\dots\dots(1)$ <div style="text-align: center;">  </div> <p>Area being positive quantity, <math>A</math> will be maximum or minimum if <math>A^2</math> is</p>	<p>1</p> <p><math>\frac{1}{2}</math> (fig)</p>

	<p>maximum or minimum.</p> $Z = A^2 = r^2 h^2 \dots \dots \dots (2)$ <p>Now In triangle OLB <math>BL^2 = OB^2 - OL^2</math>  In <math>\triangle OBD</math>  <math>Z = A^2 = r^2 h^2 \quad r^2 = R^2 - (h - R)^2 \Rightarrow r^2 = 2hR - h^2</math>  <span style="margin-left: 300px;">put in (2)</span></p> $Z = h^2(2hR - h^2)$ $\Rightarrow Z = (2h^3R - h^4)$ $\Rightarrow \frac{dZ}{dh} = 6h^2R - 4h^3 \dots \dots \dots (3)$ <p>For maxima/minima <math>\frac{dZ}{dh} = 0</math>  <math>\Rightarrow 6h^2R - 4h^3 = 0</math>  <math>\Rightarrow 6R = 4h(h \neq 0)</math></p> $\Rightarrow h = \frac{3R}{2}$ <p>differentiating (3) w.r.t. h</p> $\Rightarrow \frac{d^2Z}{dh^2} = 12hR - 12h^2$ $\Rightarrow \left. \frac{d^2Z}{dh^2} \right _{h=\frac{3R}{2}} = 12\left(\frac{3R}{2}\right)R - 12\left(\frac{3R}{2}\right)^2$ $= 18R^2 - 27R^2 = -ve$ <p>so <math>Z=A^2</math> is maximum when <math>h = \frac{3R}{2}</math>  <math>\Rightarrow A</math> is maximum when <math>h = \frac{3R}{2}</math></p> <p>when <math>h = \frac{3R}{2}, r^2 = 2hR - h^2 = 2R \cdot \frac{3R}{2} - \left(\frac{3R}{2}\right)^2</math></p> $r^2 = \frac{3R^2}{4}$ $r = \frac{\sqrt{3}R}{2}$ $\tan \theta = \frac{h}{r} = \frac{\frac{3R}{2}}{\frac{\sqrt{3}R}{2}} = \sqrt{3} \Rightarrow \theta = \frac{\pi}{3}$ <p>Triangle ABC is equilateral triangle</p>	<p style="text-align: center;">1 2</p> <p style="text-align: center;">1</p> <p style="text-align: center;">1</p> <p style="text-align: center;">1</p> <p style="text-align: center;">1</p> <p style="text-align: center;">1</p>
36	<p>Let <math>P(x, y, z)</math> be any point on the plane in which <math>A(2, 1, 2)</math> and <math>B(4, -2, 1)</math> lie.  <math>\therefore \vec{AP}</math> and <math>\vec{AB}</math> lie on required plane.</p> <p>Also required plane is perpendicular to given plane <math>\vec{r} \cdot (\hat{i} - 2\hat{k}) = 5</math>  <math>\therefore</math> normal to given plane <math>\vec{n}_1 = (\hat{i} - 2\hat{k})</math> lie on required plane.</p> <p><math>\Rightarrow \vec{AP}, \vec{AB}</math> and <math>\vec{n}_1</math> are coplanar.</p> <p>Where <math>\vec{AP} = (x - 2)\hat{i} + (y - 1)\hat{j} + (z - 2)\hat{k}</math>  <math>\vec{AB} = 2\hat{i} - 3\hat{j} - \hat{k}</math>  <math>\Rightarrow</math> Scaler triple product <math>[\vec{AP} \quad \vec{AB} \quad \vec{n}_1] = 0</math></p>	<p style="text-align: center;">1</p> <p style="text-align: center;">1</p> <p style="text-align: center;">1</p>



	$\Rightarrow \begin{vmatrix} x-2 & y-1 & z-2 \\ 2 & -3 & -1 \\ 1 & 0 & -2 \end{vmatrix} = 0$ $\Rightarrow (x-2)(6-0) - (y-1)(-4+1) + (z-2)(0+3) = 0$ $\Rightarrow 6x - 12 + 3y - 3 + 3z - 6 = 0$ $\Rightarrow 2x + y + z = 7 \dots \dots \dots (1)$ <p>Line passing through points <math>L(3,4,1)</math> and <math>M(5,1,6)</math> is</p> $\Rightarrow \frac{x-3}{2} = \frac{y-4}{-3} = \frac{z-1}{5} = \lambda \dots \dots \dots (2)$ <p><math>\Rightarrow</math> General point on the line is <math>Q(2\lambda + 3, -3\lambda + 4, 5\lambda + 1)</math></p> <p>As line (2) crosses plane (1) so point Q should satisfy equation(1)</p> $\therefore 2(2\lambda + 3) + (-3\lambda + 4) + (5\lambda + 1) = 7$ $4\lambda + 6 - 3\lambda + 4 + 5\lambda + 1 = 7$ $6\lambda = -4$ $\lambda = -\frac{2}{3}$ $Q\left(-\frac{4}{3} + 3, 2 + 4, -\frac{10}{3} + 1\right) = Q\left(\frac{5}{3}, 6, -\frac{7}{3}\right)$	<p>1</p> <p>1</p> <p>1</p>
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