ANSWER KEY

SECOND YEAR HIGHER SECONDARY EXAMINATION MARCH 2022

PART-I/II/III

SUBJECT: MATHEMATICS (S) 60

CODE NO: SY 27 VERSION: ____

60 SCORES 2 HOURS

Qn. No	Sub Qns	Answer Key/Value Points	Score	Total Score
	A	Part I		
1		(a) $\{(1,1),(2,2),(3,3)\}$	1	
2		(a) $\frac{1}{2}$	1	
3		(b) $\lvert A\rvert^2$	1	
4		$P(E/F) = \frac{P(E \cap F)}{P(F)} = \frac{1}{2}$	½ + ½	
5		$\int_a^b y\,dx$ or $\int_0^2 2x\,dx = 4$	½ + ½	
6		$\frac{dy}{dx} = 2x$, Slope = 4	½ + ½	
7		$\overrightarrow{AB} = \overrightarrow{OB} - \overrightarrow{OA}$, $\overrightarrow{AB} = 3\hat{i} - 3\hat{k}$	½ + ½	
8		(c) (2, 1, -2)	1	
9		1	1	9
	B			
10		$\frac{\pi}{4}$ or 45^0	1	
11		(b) 2	1	
12		$\frac{3}{\sqrt{38}}, \frac{-2}{\sqrt{38}}, \frac{5}{\sqrt{38}}$	1	
		Remark: 1. direction ratios = 3, -2, 5 give ½ Score 2. $\lvert\vec{r}\rvert = \sqrt{38}$ give ½ Score 3. $\frac{a}{\sqrt{a^2+b^2+c^2}}, \frac{b}{\sqrt{a^2+b^2+c^2}}, \frac{c}{\sqrt{a^2+b^2+c^2}}$ give ½ Score		

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13		$\frac{3x^2}{x^3}$ or $\frac{3}{x}$	1	4
	A	Part II		
14		$x+y=5,\ 5+x=6$ $x=1,\ y=4$	½+½ ½+½	2
15		$\frac{dx}{dt}=4,\ \frac{dy}{dt}=-5$ $A=xy$ $\frac{dA}{dt}=x\frac{dy}{dt}+y\frac{dx}{dt}=10x-5+5x4$ $=-30$	½+½ ½ ½	2
16		$f'(x)=3x^2+3$ $f'(x)>0$ Therefore $f(x)$ is strictly increasing on R	1 1	2
17		$y^2dy=2x\,dx$ $\int y^2dy=\int 2x\,dx$ $\frac{y^3}{3}=x^2+C$	1 ½ ½	2
18		$\begin{vmatrix}1&-1&1\\3&1&2\\1&\lambda&-3\end{vmatrix}=0$ $1(-3-2\lambda)+1(-9-2)+1(3\lambda-1)=0$ (Remark: $[\vec{a},\vec{b},\vec{c}]=0$ give ½ score) $\lambda=15$	1 ½ ½	2
19		$\log y=\log(x^{\sin x})$ $\log y=\sin x\log x$ $\frac{1}{y}\frac{dy}{dx}=\frac{\sin x}{x}+\log x\cos x$ $\frac{dy}{dx}=x^{\sin x}\left[\frac{\sin x}{x}+\log x\cos x\right]$	1 1	2

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20		$\frac{dy}{dx} - \frac{y}{x} = 2x$	½	
		$IF = e^{\int p dx}$	1	
		$= e^{-\log x}$	½	2
		$= e^{\log(\frac{1}{x})} = \frac{1}{x}$		
21	A	PART - III		
		$A' = \begin{bmatrix} 3 & -2 & -4 \\ 3 & -2 & -5 \\ -1 & 1 & 2 \end{bmatrix}$	½	
		$P = \frac{1}{2}(A + A') = \frac{1}{2}\begin{bmatrix} 6 & 1 & -5 \\ 1 & -4 & -4 \\ -5 & -4 & 4 \end{bmatrix}$	1	
		$Q = \frac{1}{2}(A - A') = \frac{1}{2}\begin{bmatrix} 0 & 5 & 3 \\ -5 & 0 & 6 \\ -3 & 6 & 0 \end{bmatrix}$	1	
		Therefore $A = P + Q$	½	3
22		$x - x = 0$, integer	½	
		$(x, x) \in R$, R is reflexive	½	
		$x - y$ integer $\Rightarrow y - x$ integer	½	
		$(x, y) \in R \Rightarrow (y, x) \in R$, Symmetric	½	
		$x - y$ integer, $y - z$ integer $\Rightarrow x - z$ integer	½	
		$(x, y) \in R, (y, z) \in R \Rightarrow (x, z) \in R$, transitive	½	3
		$\therefore$ R is an equivalence relation (Using example give 3 score)		
23		$P(E_1) = \frac{1}{2}$, $P(E_2) = \frac{1}{2}$	1	
		$P(A/E_1) = \frac{5}{8}$, $P(A/E_2) = \frac{3}{10}$	1	
		$P(E_2/A) = \frac{P(E_2)\,P(A/E_2)}{P(E_1)\,P(A/E_1) + P(E_2)P(A/E_2)}$	½	

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		$= \dfrac{\frac{1}{2} \times \frac{3}{10}}{\frac{1}{2} \times \frac{5}{8} + \frac{1}{2} \times \frac{3}{10}}$ $= \dfrac{12}{37}$	½	3
24	(a)	$\vec{a} \times \vec{b} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & 1 & 1 \\ 1 & 1 & 1 \end{vmatrix}$	1	
		$= \hat{i}(1-1) - \hat{j}(2-1) + \hat{k}(2-1)$	½	
		$= -\hat{j} + \hat{k}$	½	
	(b)	Unit vector $= \dfrac{\vec{a} \times \vec{b}}{\lvert\vec{a} \times \vec{b}\rvert} = \dfrac{-\hat{j} + \hat{k}}{\sqrt{2}}$	½ + ½	3
		Remark 1 For any $\vec{a} \times \vec{b}$, correct unit vector give 1 score.		
		Remark 2 $\hat{a} = \dfrac{\vec{a}}{\lvert\vec{a}\rvert}$ give ½ score		
25	B	$A = IA$	1	
		$\begin{bmatrix} 1 & 3 \\ 2 & 7 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} A$	½	
		$\begin{bmatrix} 1 & 3 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ -2 & 1 \end{bmatrix} A$, $R_2 \to R_2 - 2R_1$	1	
		$\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 7 & -3 \\ -2 & 1 \end{bmatrix} A$, $R_1 \to R_1 - 3R_2$	½	3
		$A^{-1} = \begin{bmatrix} 7 & -3 \\ -2 & 1 \end{bmatrix}$		
		Remark Using the formula $A^{-1} = \dfrac{Adj\,A}{\lvert A\rvert} = \begin{bmatrix} 7 & -3 \\ -2 & 1 \end{bmatrix}$ give 3 Score		

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26	(a)	$a * e = a$	½	
		$\frac{ae}{3} = a$, $e = 3$	½	
	(b)	$3 * b = e$	1	
		$\frac{3b}{3} = 3$	½	
		$b = 3$	½	3
27		$f(x) = x^2$, $a = 0$, $b = 2$, $nh = 2$	1	
		$\int_a^b f(x)\,dx = \lim_{h \to 0} h\left[f(a) + f(a+h) + \cdots + f(a+(n-1)h)\right]$	1	
		$\int_0^2 x^2\,dx = \lim_{h \to 0} h\left[0 + h^2 + 2^2h^2 + \cdots + (n-1)^2h^2\right]$	½	
		$= \lim_{h \to 0} h^3 \frac{n(n-1)(2n-1)}{6}$.		
		$= \frac{8}{3}$	½	3
		Remark $\int_0^2 x^2\,dx = \left[\frac{x^3}{3}\right]_0^2 = \frac{8}{3}$, give 2 Score		
28	A	PART – IV		
		$2\tan^{-1}\left(\frac{1}{2}\right) = \tan^{-1}\left(\frac{2 \times \frac{1}{2}}{1 - \frac{1}{4}}\right) = \tan^{-1}\left(\frac{4}{3}\right)$	1	
		$2\tan^{-1}\frac{1}{2} + \tan^{-1}\frac{1}{7} = \tan^{-1}\left(\frac{4}{3}\right) + \tan^{-1}\left(\frac{1}{7}\right)$	½	
		$= \tan^{-1}\left(\frac{\frac{4}{3} + \frac{1}{7}}{1 - \frac{4}{3} \times \frac{1}{7}}\right)$	2	
		$= \tan^{-1}\left(\frac{31}{17}\right)$	½	4
		Remark1 For alternative method give 4 Score Remark 2. $2\tan^{-1}x = \tan^{-1}\left(\frac{2x}{1-x^2}\right)$ give ½ score Remark 3. $\tan^{-1}x + \tan^{-1}y = \tan^{-1}\left(\frac{x+y}{1-xy}\right) \rightarrow 1$ score		

Qn. No	Sub Qns	Answer Key/Value Points	Score	Total Score
29		$\text{Area} = \int_a^b y\,dx = \int_2^4 3\sqrt{x}\,dx$	2	
		$= 3\left[\frac{x^{\frac{3}{2}}}{\frac{3}{2}}\right]_2^4$	1	
		$= \frac{6}{3}\left[4^{\frac{3}{2}} - 2^{\frac{3}{2}}\right]$	1	4
		$= 2\left[8 - 2\sqrt{2}\right]$		
		Remarks 1 Rough sketch of the region give 1 Score		
		Remark 2 $\int_a^b y\,dx$ = Area give 1 Score		
30	(a)	$LHL = \lim_{x \to 3^-}(3x+1) = 10$	½+½	
		$RHL = \lim_{x \to 3^+}(x^2+1) = 10$	½+½	
		LHL = RHL, f(x) is continuous		
		Remark 1 Concept of continuity give 1 Score		
		Remark 2 LHL = RHL give 1 Score		
	(b)	f(x) is continuous in [2, 4]	½	
		f(x) is differentiable in (2, 4)	½	
		$f(a) = f(2) = -15$, $f(b) = f(4) = -15$	½	
		$f'(c) = 0$, $4c - 12 = 0$, $c = 3 \in (2,4)$	½	4
		Remark: $f'(x) = 4x - 12$ give 1 Score		
31	(a)	$\frac{x-x_1}{x_2-x_1} = \frac{y-y_1}{y_2-y_1} = \frac{z-z_1}{z_2-z_1}$ or $\frac{x-x_1}{a} = \frac{y-y_1}{b} = \frac{z-z_1}{c}$	1	
		$\frac{x-2}{2} = \frac{y-1}{3} = \frac{z}{3}$	1	
		Remark Vector method give 2 Score		
	(b)	$A(x-x_1) + B(y-y_1) + C(z-z_1) = 0$	1	
		$2(x-1) + 3(y-1) + 3(z-2) = 0$	½	4
		$2x + 3y + 3z - 11 = 0$ (or vector method)	½	

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32	B	<table><tr><td>X</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td></td></tr><tr><td>P(X)</td><td>$\frac{1}{6}$</td><td>$\frac{1}{6}$</td><td>$\frac{1}{6}$</td><td>$\frac{1}{6}$</td><td>$\frac{1}{6}$</td><td>$\frac{1}{6}$</td><td></td></tr><tr><td>X P(X)</td><td>$\frac{1}{6}$</td><td>$\frac{2}{6}$</td><td>$\frac{3}{6}$</td><td>$\frac{4}{6}$</td><td>$\frac{5}{6}$</td><td>$\frac{6}{6}$</td><td>$\Sigma=\frac{21}{6}$</td></tr></table>	3	4
		$\text{Mean} = \sum X\,P(X) = 1\times\frac{1}{6}+2\times\frac{1}{6}+3\times\frac{1}{6}+4\times\frac{1}{6}+5\times\frac{1}{6}+6\times\frac{1}{6}$	1	
		$= \frac{21}{6}$		
		Remark 1 $S=\{1,2,3,4,5,6\}$ give 1 score		
		Remark 2 $P(E)=\frac{1}{6}$ give ½ score		
33	(a)	$a_1, b_1, c_1 = 3,-2,1$; $a_2, b_2, c_2 = 2,1,2$	½	
		$\cos\theta = \frac{a_1a_2+b_1b_2+c_1c_2}{\sqrt{a_1^2+b_1^2+c_1^2}\sqrt{a_2^2+b_2^2+c_2^2}}$	1	
		$= \frac{6}{3\sqrt{14}} = \frac{2}{\sqrt{14}}$	1	
		Remark 1 $a_1, b_1, c_1 = 3,-2,1$; $a_2, b_2, c_2 = 2,1,2$ give 1 score		
		Remark 2 Using vector formula give 2 score		
	(b)	$(3x-2y+z+6)+k(2x+y+2z-6)=0$	1	4
		$k=1$	½	
		$5x-y+3z=0$	½	
		Remark: Using vector method give 2 score		
34		PART V		
		$A=\begin{bmatrix}1&-1&2\\0&2&-3\\3&-2&4\end{bmatrix}$ $X=\begin{bmatrix}x\\y\\z\end{bmatrix}$ $B=\begin{bmatrix}1\\1\\2\end{bmatrix}$	1	
		$\lvert A\rvert = -1$	1	
		$\text{Adj } A = \begin{bmatrix}2&0&-1\\-9&-2&3\\-6&-1&2\end{bmatrix}$	2	
		$A^{-1} = \frac{\text{Adj } A}{\lvert A\rvert} = \frac{1}{-1}\begin{bmatrix}2&0&-1\\-9&-2&3\\-6&-1&2\end{bmatrix}$	½+½	
		$X = A^{-1}B$	½	

Qn. No	Sub Qns	Answer Key/Value Points	Score	Total Score
		$X = \begin{bmatrix} 0 \\ 5 \\ 3 \end{bmatrix}$ $x=0,\ y=5,\ z=3$	$\frac{1}{2}$	6
35	(a)	$\frac{x}{(x+1)(x+2)} = \frac{A}{x+1} + \frac{B}{x+2}$	1	
		$A=-1,\ B=2$	1	
		$\int \frac{x}{(x+1)(x+2)}dx = \int \frac{-1}{x+1}dx + \int \frac{2}{x+2}dx$	$\frac{1}{2}$	
		$= -\log\lvert x+1\rvert + 2\log\lvert x+2\rvert + C$	$\frac{1}{2}$	
	(b)	$I = \int_0^{\frac{\pi}{2}} \frac{\sin^4 x}{\sin^4 x + \cos^4 x}dx$ —— ①		
		$= \int_0^{\frac{\pi}{2}} \frac{\sin^4(\frac{\pi}{2}-x)}{\sin^4(\frac{\pi}{2}-x) + \cos^4(\frac{\pi}{2}-x)}dx$	1	
		$I = \int_0^{\frac{\pi}{2}} \frac{\cos^4 x}{\cos^4 x + \sin^4 x}dx$ —— ②	$\frac{1}{2}$	
		$2I = \int_0^{\frac{\pi}{2}} \frac{\sin^4 x + \cos^4 x}{\sin^4 x + \cos^4 x}dx$	$\frac{1}{2}$	
		$= \int_0^{\frac{\pi}{2}} 1\,dx = \frac{\pi}{2}$	$\frac{1}{2}$	6
		$I = \frac{\pi}{4}$	$\frac{1}{2}$	
		Remark 1: $\int_0^a f(x)dx = \int_0^a f(a-x)dx$ give 1 score		
		Remark 2: $\sin(\frac{\pi}{2}-x) = \cos x$ give $\frac{1}{2}$ score		
36		$x+2y=10$: x: 0, 10 y: 5, 0 $3x+y=15$: x: 0, 5 y: 15, 0	$\frac{1}{2}+\frac{1}{2}$	

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		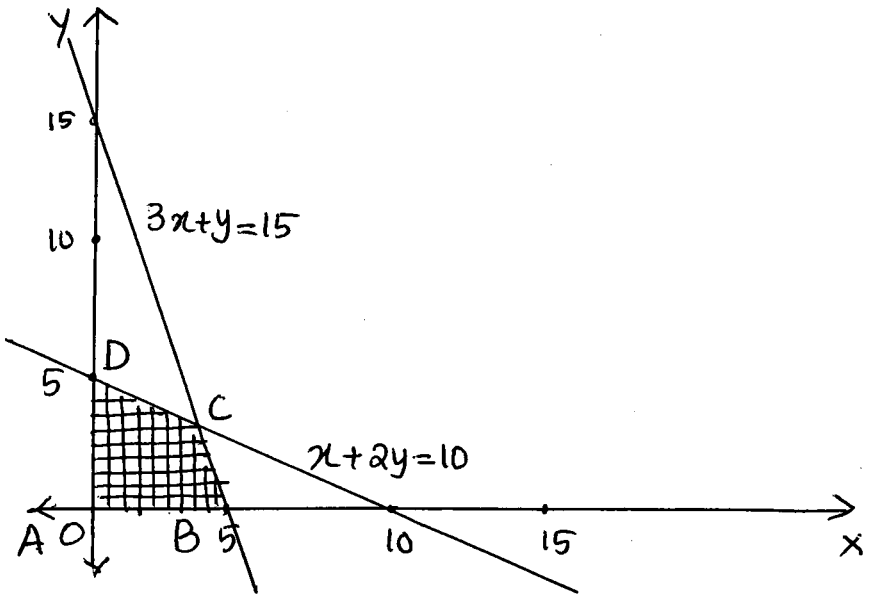	3	
		Corner points A(0,0), B(5,0), C(4,3), D(0,5)	1	
		Maximum value of Z = 18	1	6
		Remark 1 Another feasible region give 2½ score Remark 2 Each correct line give 1 score Remark 3 Only drawing X, Y axes give 1 score		

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