

**DIRECTORATE OF GOVERNMENT EXAMINATION, CHENNAI-6**  
**HSE SECOND YEAR EXAMINATIONS MARCH / APRIL 2023**  
**BUSINESS MATHEMATICS AND STATISTICS - ANSWER KEY**

**Maximum Marks – 90**

**General Instructions :**

1. Answers written only in **BLACK** or **BLUE** should be evaluated.
2. For objective type questions, award 1 mark for "writing the correct option's code and the corresponding option's answer".
3. Award "0 marks" for one who wrote both "option's code" and "option's answer" with one of them is not correct.
4. Marks should be awarded for suitable alternative method also.
5. Mark(s) should not be reduced for the correct answer / stage, if it is written without formula / properties also, 2\* means award one mark for the formula.
6. Award full mark directly, if the solution is arrived with no mistakes without giving weightage for the stages.
7. The stage mark is essential, only if the part of the solution is incorrect.
8. Award marks, if the answer is in decimal value and also approximately equal to the key answer

9. **Important Note for Part II, Part III and Part IV**

For a particular stage in which the stage mark is greater than 1 and one who begins with correct step but reaches with incorrect solution, for such suitable credits should be given by breaking the stage marks.

## PART - I

- i. Answer all the questions  
 ii. Choose the most appropriate from the given Four alternatives and write the option code and the corresponding answer

Q.No	Option	Answer	20×1=20
1	(d)	1	1
2	(a)	6	1
3	(b)	$\sin x + c$	1
4	(d)	$2\sqrt{e^x} + c$	1
5	(b)	$MC - MR = 0$	1
6	(b)	$100 - 3x^2$	1
7	(c)	$y_2 + 4y_1 + 5 = 0$	1
8	(d)	$xe^{2x}$	1
9	(b)	$1 + \Delta$	1
10	(a)	$y_2$	1
11	(a)	0	1
12	(a)	1	1
13	(d)	De-Moivre	1
14	(b)	poisson	1
15	(b)	a sample	1
16	(b)	Population parameter	1
17	(b)	Geometric mean	1
18	(d)	a year	1
19	(b)	Total supply $\neq$ Total demand	1
20	(b)	top left corner	1

<b>PART – II</b>			
Q. No.	<b>Answer any <u>Seven</u> questions. Question no. 30 is compulsory.</b>	<b>7×2=14</b>	
21	$ A  = 6 \neq 0$	1	2
	$\rho(A) = 3$	1	
22	$\int (-5x^2 - 13x + 6) dx$	1	2
	$= \frac{-5x^3}{3} - \frac{13x^2}{2} + 6x + c$	1	
23	$A = \int_a^b y dx$ (or) $\int_1^4 (4x + 3) dx$	1	2
	$= 39$ sq.units	1	
24	$\Delta(\log ax) = \log a(x+h) - \log ax$	1	2
	$= \log \left(1 + \frac{h}{x}\right)$	1	
25	$E(X) = \frac{9}{22} + \frac{2}{22}$		2
	$= \frac{11}{22}$ (or) $\frac{1}{2}$	2*	
26	A Random variable 'X' is said to follow binomial distribution with parameter 'n' and 'p' if it assumes only non-negative value and its probability mass function is given by	1	2
	$P(X=x) = p(x) = \begin{cases} nC_x p^x q^{n-x}, & x = 0, 1, 2, \dots, n, q = 1 - p \\ 0, & \text{otherwise} \end{cases}$	1	
27	i. Personal bias is completely eliminated. ii. It is economical as it saves time, money and labour. iii. The method requires minimum knowledge about the population in advance. <b>( Any 2 points)</b>		2
28	$\frac{dy}{dx} = (x + 1)(y + 1)$	1	2
	$\log(y+1) = \frac{x^2}{2} + x + c$	1	
29	Minimize $z = \sum_{i=1}^m \sum_{j=1}^n C_{ij} x_{ij}$	1	2
	Subject to the constraints $\sum_{i=1}^n x_{ij} = 1, j = 1, 2, \dots, n$ $\sum_{j=1}^n x_{ij} = 1, i = 1, 2, \dots, n$ and $x_{ij} = 0$ (or) 1 for all (i,j)	1	

30	<b>Compulsory :</b> $C.L.I = \frac{\sum p_1 q_0}{\sum p_0 q_0} \times 100 = \frac{3140}{1974} \times 100$	1	2
	= 159.07	1	

Q. No.	PART - III		
	<b>Answer any seven questions.</b>		
	<b>Question number 40 is compulsory.</b>		<b>7×3=21</b>
31	$[A, B] = \begin{bmatrix} 1 & 2 & -3 & -2 \\ 3 & -1 & -2 & 1 \\ 2 & 3 & -5 & k \end{bmatrix}$	1	3
	$[A, B] \sim \begin{bmatrix} 1 & 2 & -3 & -2 \\ 0 & -7 & 7 & 7 \\ 0 & -1 & 1 & 4+K \end{bmatrix} \begin{matrix} R_2 \rightarrow R_2 - 3R_1 \\ R_3 \rightarrow R_3 - 2R_1 \end{matrix}$		
	$\sim \begin{bmatrix} 1 & 2 & -3 & -2 \\ 0 & -7 & 7 & 7 \\ 0 & 0 & 0 & 21+7K \end{bmatrix} R_3 \rightarrow 7R_3 - R_2$	1	
	$K = -3$	1	
32	$R = \int MR dx + k$ (or) $R = \int (20 - 5x + 3x^2) dx + k$	1	3
	$R = 20x - \frac{5x^2}{2} + \frac{3x^3}{3} + k$	1	
	$R = 20x - \frac{5x^2}{2} + x^3$	1	
33	A.E. is $9m^2 - 12m + 4 = 0$	1	3
	$m = \frac{2}{3}, \frac{2}{3}$	1	
	$y = (Ax + B)e^{\frac{2x}{3}}$	1	
34	$\Delta^4 y_0 = 0$ (or) $(E - 1)^4 y_0 = 0$	1	3
	$y_4 - 4y_3 + 6y_2 - 4y_1 + y_0 = 0$	1	
	$y_3 = 31$ (Any alternative method)	1	

35	$E(X) = \frac{4}{5}$						2*	3
	$E(X^2) = \frac{2}{3}$							
	$V(X) = \frac{2}{75}$						1	
36	$\lambda = \frac{390}{520} = 0.75$						1	3
	$P(X=0) = e^{-0.75}$							
	$(P(X=0))^5 = e^{-3.75}$						2*	
37	$\sigma = 10, \text{S.E } \bar{X} = 3$						1	3
	$\text{S.E.} = \frac{\sigma}{\sqrt{n}} = 3$						1	
	Sample size $n = 11$						1	
38	Commodities	Price $p_0$ 2007	$p_1$ 2011	Weights (V)	$P = \frac{p_1}{p_0} \times 100$	PV		3
	A	350	400	40	114.286	4571.44		
	B	175	250	35	142.857	4999.995		
	C	100	115	15	115	1725	1	
	D	75	105	20	140	2800		
	E	60	80	25	133.333	3333.325		
				$\Sigma V = 135$		$\Sigma PV =$ 17429.76		
Cost of living Index no. $= \frac{\Sigma PV}{\Sigma V}$						1		
$= 129.1093$						1		
39	Maxmin = Max (5,7,9,8) = 9 $\rightarrow A_3$						1	3
	Minmax = Min (14,11,11,13) = 11 $\rightarrow A_2 \& A_3$						2	
40	<b>Compulsory:</b>						1	3
	$\int \frac{1}{\sqrt{x+2} - \sqrt{x+3}} \times \frac{\sqrt{x+2} + \sqrt{x+3}}{\sqrt{x+2} + \sqrt{x+3}} dx$							
	$= \int \frac{\sqrt{x+2} + \sqrt{x+3}}{-1} dx$						1	
$= - \left[ \frac{(x+2)^{\frac{3}{2}}}{\frac{3}{2}} + \frac{(x+3)^{\frac{3}{2}}}{\frac{3}{2}} \right] + C$						1		
(or) $-\frac{2}{3} \left( (x+2)^{\frac{3}{2}} + (x+3)^{\frac{3}{2}} \right) + c$								

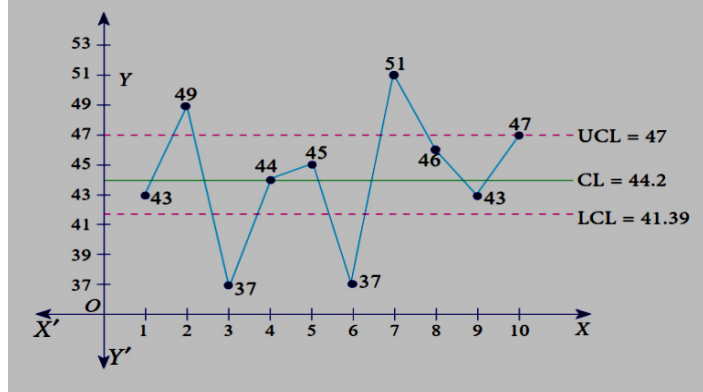
Q. No.	PART - IV		7×5=35																																																																																				
41	<b>Answer all the questions.</b>																																																																																						
(a)	$\Delta = \begin{vmatrix} 1 & 1 & 1 \\ 2 & -1 & 3 \\ 3 & 2 & -1 \end{vmatrix} = 13 \neq 0$	1	5																																																																																				
	$\Delta_x = \begin{vmatrix} 4 & 1 & 1 \\ 1 & -1 & 3 \\ 1 & 2 & -1 \end{vmatrix} = -13$	1																																																																																					
	$\Delta_y = \begin{vmatrix} 1 & 4 & 1 \\ 2 & 1 & 3 \\ 3 & 1 & -1 \end{vmatrix} = 39$	1																																																																																					
	$\Delta_z = \begin{vmatrix} 1 & 1 & 4 \\ 2 & -1 & 1 \\ 3 & 2 & 1 \end{vmatrix} = 26$	1																																																																																					
	$x = -1, y = 3, z = 2$	1																																																																																					
<b>(OR)</b>																																																																																							
41	$n = \frac{1946-1941}{10} = 0.5$	1																																																																																					
(b)	<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <thead> <tr> <th>x</th> <th>y</th> <th><math>\Delta y</math></th> <th><math>\Delta^2 y</math></th> <th><math>\Delta^3 y</math></th> <th><math>\Delta^4 y</math></th> <th><math>\Delta^5 y</math></th> </tr> </thead> <tbody> <tr> <td>1941</td> <td>20</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td>4</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>1951</td> <td>24</td> <td></td> <td>1</td> <td></td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td>5</td> <td></td> <td>1</td> <td></td> <td></td> </tr> <tr> <td>1961</td> <td>29</td> <td></td> <td>2</td> <td></td> <td>0</td> <td></td> </tr> <tr> <td></td> <td></td> <td>7</td> <td></td> <td>1</td> <td></td> <td>-9</td> </tr> <tr> <td>1971</td> <td>36</td> <td></td> <td>3</td> <td></td> <td>-9</td> <td></td> </tr> <tr> <td></td> <td></td> <td>10</td> <td></td> <td>-8</td> <td></td> <td></td> </tr> <tr> <td>1981</td> <td>46</td> <td></td> <td>-5</td> <td></td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td>5</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>1991</td> <td>51</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>	x	y	$\Delta y$	$\Delta^2 y$	$\Delta^3 y$	$\Delta^4 y$	$\Delta^5 y$	1941	20								4					1951	24		1						5		1			1961	29		2		0				7		1		-9	1971	36		3		-9				10		-8			1981	46		-5						5					1991	51						2	
x	y	$\Delta y$	$\Delta^2 y$	$\Delta^3 y$	$\Delta^4 y$	$\Delta^5 y$																																																																																	
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	$y = y_0 + \frac{n}{1!} \Delta y_0 + \frac{n(n-1)}{2!} \Delta^2 y_0 + \frac{n(n-1)(n-2)}{3!} \Delta^3 y_0 + \frac{n(n-1)(n-2)(n-3)}{4!} \Delta^4 y_0 + \frac{n(n-1)(n-2)(n-3)(n-4)}{5!} \Delta^5 y_0$ $= 20 + 2 - 0.125 + 0.0625 - 0.24609$																																																																																						
	= 21.69 lakhs	2*																																																																																					

42 (a)	$\int_a^b f(x)dx = \lim_{h \rightarrow 0} \sum_{r=1}^n h f(a+rh)$	1	5
	$a=1, b=2, h=\frac{b-a}{n} = \frac{2-1}{n} = \frac{1}{n}$	1	
	$f(a+rh) = 2 + \frac{2r}{n} + 1 = 3 + \frac{2r}{n}$	1	
	$= \lim_{n \rightarrow \infty} \left[ \frac{3}{n} \sum_{r=1}^n (1) + \frac{2}{n^2} \sum_{r=1}^n (r) \right]$	1	
	$\int_1^2 (2x+1)dx = 4$ <b>(OR)</b>	1	
42 (b)	$P = q = \frac{1}{2}$	1	5
	$P(x \geq 6) = P(6) + P(7) + P(8) + P(9) + P(10)$	1	
	$P(x \geq 6) = \left(\frac{1}{2}\right)^{10} [10C_6 + 10C_7 + 10C_8 + 10C_9 + 10C_{10}]$	2*	
	$= \frac{193}{512}$	1	
43 (a)	At equilibrium, $P_d = P_s$	1	5
	$C S = \int_0^{x_0} f(x)dx - x_0 P_0 = 24$ units	2*	
	$P S = x_0 P_0 - \int_0^{x_0} g(x)dx = 16$ units <b>(OR)</b>	2*	
43 (b)	$Z = \frac{x-\mu}{\sigma} = \frac{20-12}{4} = 2$	2*	5
	$P(X \leq 20) = P(Z \leq 2) = 0.9772$	1	
	if $x = 0$ $Z = \frac{0-12}{4} = -3$ , if $x = 12$ $Z = \frac{12-12}{4} = 0$	1	
	$P(0 \leq X \leq 12) = P(-3 \leq Z \leq 0) = 0.4987$	1	

44 (a)	Auxiliary equation : $m^2 - 2m + 1 = 0$	1	5	
	C.F = $(Ax + B)e^x$	1		
	$P.I_1 = \frac{e^{2x}}{D^2 - 2D + 1} = e^{2x}$	1		
	$P.I_2 = \frac{e^x}{D^2 - 2D + 1} = \frac{e^x}{(D-1)^2} = \frac{x^2}{2} e^x$	1		
	$Y = (Ax + B)e^x + e^{2x} + \frac{x^2}{2} e^x$ (OR)	1		
44 (b)	$n = 50, \sigma = 1.6, \bar{X} = 9.3, \mu = 8.9$	1	5	
	$H_0 : \mu = 8.9$ ( Null hypothesis ) $H_1 : \mu \neq 8.9$ ( Alternative hypothesis )	1		
	$ Z  = 1.7676$	2*		
	$ Z  < 1.96$ , Null hypothesis, $H_0$ is accepted.	1		
45 (a)	$x_0 = 5, x_1 = 6, x_2 = 9, x_3 = 11$ $y_0 = 12, y_1 = 13, y_2 = 14, y_3 = 16$	3*	5	
	$y = 12 \left[ \frac{(10-6)(10-9)(10-11)}{(5-6)(5-9)(5-11)} \right] + 13 \left[ \frac{(10-5)(10-9)(10-11)}{(6-5)(6-9)(6-11)} \right] +$ $14 \left[ \frac{(10-5)(10-6)(10-11)}{(9-5)(9-6)(9-11)} \right] + 16 \left[ \frac{(10-5)(10-6)(10-9)}{(11-5)(11-6)(11-9)} \right]$			
	$y = 2 - 4.333 + 11.667 + 5.333$			1
	$y = 14.667$ (OR)			1
45 (b)	$P = \frac{1}{x}, Q = x^3$	1	5	
	I.F = $x$	1		
	$yx = \int x^4 dx + c$	2*		
	$yx = \frac{x^5}{5} + c$	1		



46 (a)	Co mm oditi es	$p_0$	$p_1$	$q_0$	$q_1$	$p_0q_0$	$p_0q_1$	$p_1q_0$	$p_1q_1$			
	A	12	14	18	16	216	192	252	224			
	B	15	16	20	15	300	225	320	240			
	C	14	15	24	20	336	280	360	300			
	D	12	12	29	23	348	276	348	276			
						1200	973	1280	1040			
	$\sum p_0q_0 = 1200, \sum p_0q_1 = 973,$ $\sum p_1q_0 = 1280, \sum p_1q_1 = 1040$										2	
	i. Laspeyre's index no. $P_{01}^L = \frac{\sum p_1q_0}{\sum p_0q_0} \times 100 = 106.67$										1	
	ii. Paasche's index no. $P_{01}^P = \frac{\sum p_1q_1}{\sum p_0q_1} \times 100 = 106.89$										1	
	iii. Fisher's index no. $P_{01}^F = \sqrt{P_{01}^L \times P_{01}^P} = 106.78$										1	
(OR)											5	
46 (b)	(i) $P(X \leq 0) = \frac{1}{2}$										1	
	(ii) $P(X < 0) = \frac{1}{4}$										1	
	(iii) $P( X  \leq 2) = P(-2 \leq X \leq 2) = \frac{1}{2}$										2	
	(iv) $P(0 \leq X \leq 10) = \frac{3}{4}$										1	

<p>47 (a)</p>	<p><math>\bar{X} = 44.2, \bar{R} = 5.8</math></p> <p> <math display="block">\left. \begin{aligned} \text{UCL} &amp;= \bar{X} + A_2\bar{R} = 47.00 \\ \text{CL} &amp;= \bar{X} = 44.2 \\ \text{LCL} &amp;= \bar{X} - A_2\bar{R} = 41.39 \end{aligned} \right\}</math> </p>	<p>1</p> <p>1</p>																																					
		<p>2</p>																																					
	<p>Four points falls out of the control limits. The process is out of control.</p> <p style="text-align: center;"><b>(OR)</b></p>	<p>1</p>	<p>5</p>																																				
<p>47 (b)</p>	<p>Total Availability = Total Requirement = 80, This is a balanced transportation.</p> <p><b>Final distribution:</b></p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td></td> <td>I</td> <td>II</td> <td>III</td> <td>IV</td> <td><math>a_i</math></td> </tr> <tr> <td>A</td> <td>(6) 5</td> <td>(6) 1</td> <td>(17) 3</td> <td>(5) 3</td> <td>34</td> </tr> <tr> <td>B</td> <td>(15) 3</td> <td>3</td> <td>5</td> <td>4</td> <td>15</td> </tr> <tr> <td>C</td> <td>6</td> <td>4</td> <td>4</td> <td>(12) 3</td> <td>12</td> </tr> <tr> <td>D</td> <td>4</td> <td>(19) 1</td> <td>4</td> <td>5</td> <td>19</td> </tr> <tr> <td><math>b_j</math></td> <td>21</td> <td>25</td> <td>17</td> <td>17</td> <td></td> </tr> </table>		I	II	III	IV	$a_i$	A	(6) 5	(6) 1	(17) 3	(5) 3	34	B	(15) 3	3	5	4	15	C	6	4	4	(12) 3	12	D	4	(19) 1	4	5	19	$b_j$	21	25	17	17		<p>1</p> <p>2</p>	
	I	II	III	IV	$a_i$																																		
A	(6) 5	(6) 1	(17) 3	(5) 3	34																																		
B	(15) 3	3	5	4	15																																		
C	6	4	4	(12) 3	12																																		
D	4	(19) 1	4	5	19																																		
$b_j$	21	25	17	17																																			
	<p>Total Transportation cost =</p> <p style="text-align: center;"> <math>(6 \times 5) + (6 \times 1) + (17 \times 3) + (5 \times 3) + (15 \times 3)</math>  <math>+ (12 \times 3) + (19 \times 1)</math>  <math>= ₹ 202</math> </p>	<p>2</p>																																					