

2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV CERTIFIED PUBLIC ACCOUNT FOUNDATION LEVEL 1 EXAMINATIO

F1.1: BUSINESS MATHEMATICS AND QUANTITATIVE METHODS DAY: THURSDAY, 01 DECEMBER 2022 MARKING GUIDE AND MODEL ANSWER

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Marking guide
            criteria
           Award 0.5 Marks for the Mean and standard deviation formula
           Award 0.5 Marks for the correct answer of Mean and standard deviation
           Award 0.5 Marks for the Mean and variance formula<sup>221</sup>
            Award 0.5 Marks for the correct answer of variance
           Award 1 Mark for the correct answer of \sum y^2
                                                                                          202
           Award 0.5 Marks for the correct answer of Total number of errors
            Award 1 Mark for the correct answer of combined mean
            Award 1 Mark for the correct answer of combined variance
           Award 1 Mark for the correct answer of combined standard devi
 Sub-total A
           Award 0.5 Marks for the Q1, Median (Q2) and Q3 formula
           Award 0.5 Marks for the correct answer of Q1, Median (Q2) and Q3
            Award 1 Mark for the correct answer of Quartile coefficient of skewne
           Award 1 Mark for mode of grouped data formula v202210
            Award 1 Mark for the correct answer of mode of grouped data
            Award 1 Mark for the correct answer of mean of grouped data
           Award 1 Mark for the correct answer of standard deviation of grouped
           data 0V20221CPARNOV20221C
            Award 1 Mark for the correct total of f_i * x_i^2 of grouped date
     c. iii Award 1 Mark for the correct answer of the coefficient of variati
            grouped data
 Sub-total B
Model Answer
Solution A
i) Given: \sum x =
Mean = \bar{x} =
  920 - 4
                                                                                  Page 2 of
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$$= \sqrt{\frac{5032}{200}} - (4.6)^2 = \sqrt{4} = 2$$
(i) Let assume that the error on the further 50 pages is y
$$Mean = \overline{y} = \frac{5y}{h}$$

$$\sum y = \overline{y} + n = 4.4 + n = 4.4 + 50 = 220$$

$$\sigma = 2.2$$

$$\Rightarrow (2.2)^2 = Variance = \frac{5y^2}{n} - 9^2$$

$$(2.2)^2 = \frac{5y^2}{25n} - (4.4)^2$$

$$\sum y^2 = 50 + ((2.2)^2 + (4.4)^2) = 1210$$
Combining the two sets of 250 pages.
Total number of errors =  $\sum x + \sum y = 920 + 220 = 1140$ 
Let  $x_{12}$  be the combined mean and  $\sigma_{12}$  combined standard deviation
$$Variance = \sigma_{120}^2 = \frac{52x^2 + 2x^2}{n + n_2} - \kappa_{12}^2$$

$$= \frac{502x + 220}{280} - (4.56)^2 = 4.1744$$
Therefore, the standard deviation is  $\sigma_{12} = \sqrt{\sigma_{12}} = \sqrt{4.1744} = 2.04$ 
Solution B
Let  $Q_1$  and  $Q_2$  be quartile 1 and quartile 3 respectively
(1) Number of observation n is odd
Therefore,  $Q_1 = (\frac{1}{4}X_{n+1})^{(n)}$  value  $= X_{12+1}^{(n)}$ 

$$Q_2 = (\frac{1}{4}X_{n+1})^{(n)}$$
 value  $= X_{12+1}^{(n)}$ 
Arranging the results in order:

RNOV2022ICPA	RNOV2022	ICPARN	IOV20221	CPARNO	OV20221	CPARNO	V2022IC	PARNON	/2022ICI	PARNON	/2022IC	PARNON	2022IC	PARNO	V2022IC
RNOV2022ICPA	RNOV2022	NCPARN	IOV20221	CPARNO	3V20221	CPARNO	V20221C	PARNON	/2022ICI	PARNON	/2022IC	PARNON	2022IC	PARNO	V2022IC
RNOV2022ICPA	RNOV2022	NCPARN	IOV20221	CPARNO	OV20221	CPARNO	V20221C	PARNON	/2022ICI	PARNON	/2022IC	PARNON	2022IC	PARNO	V2022IC
RNOV2022ICPA	RNOV2022	ICPARN	IOV20221	CPARN	OV20221	CPARNO	V20221C	PARNON	/2022ICI	PARNON	/2022IC	PARNON	2022IC	PARNO	V20221C
RNOV2022ICPA	RNOV2022	PICPARN	IOV20221	CPARN	OV20221	CPARNO	V20221C	PARNOV	/2022ICI	PARNON	/2022IC	PARNON	2022IC	PARNO	V2022IC
RNOV2022ICPA	RN23/2022	2126ARN	( <b>29</b> )0221	(30.RN)	0310221	CI31RNO	V <b>37</b> 221C	P37NOV	/2 <b>38</b> 21CI	A38101	/2/41/21C	PARNON	2022IC	PARNO	V2022IC
RNOV2022ICPA	RNQV2022	216 PARN	10/20221	CPARNO	0120221	CPARNO	V2822IC	PABNOV	/2832ICI	PARNOV	/202210	PARNOV	2022IC	PARNO	V2022IC
RNOV2022ICPA	44 RNOV2022	44 2ICPARN	40 IOV20221	40 CPARNO	48 0V20221	CPARNO	49 V2022IC	PARNOV	/2022ICI	PARNOV	<b>38</b> /2022IC	PARNOV	2022IC	PARNO	V2022IC
RNOV2022ICPA	RN592022	$2161_{ARN}$	6120221	61ARNO	$563_{0221}$	CP70RNO	v <b>7</b> 5221C	PZ6NOV	/2 <b>85</b> 21CI	PARNOV	/2022IC	PARNOV	2022IC	PARNO	V2022IC
RNOV2022ICPA	RNOV2022	2ICPARN	IOV20221	CPARNO	OV2022I	CPARNO	V2022IC	PARNOV	/2022ICI	PARNOV	/2022IC	PARNOV	2022IC	PARNO	V2022IC
RNOV2022ICPA	RNOV2022	2ICPARN	IOV20221	CPARNO	OV2022I	CPARNO	V2022IC	PARNOV	/2022ICI	PARNOV	/2022IC	PARNOV	2022IC	PARNO	V2022IC
RNOV2022ICPA	$O_1 = X_{\circ}^{th}$	$n = 8^{th}$	value =	-37RN	OV2022I	CPARNO	V2022IC	PARNOV	/2022ICI	PARNOV	/2022IC	PARNOV	2022IC	PARNO	V2022IC
RNOV2022ICPA	RNOV2022	2ICPARN	IOV2022]	CPARNO	OV2022I	CPARNO	V2022IC	PARNOV	/2022ICI	PARNOV	/2022IC	PARNOV	/2022IC	PARNO	V2022IC
RNOV2022ICPA	$0_2 = X_{24}^{th}$	$_{1}^{2} = 24^{t}$	<sup>h</sup> value	= 61	OV2022I	CPARNO	V2022IC	PARNOV	/2022ICI	PARNOV	/2022IC	PARNOV	/2022IC	PARNO	V2022IC
RNOV2022ICPA	RNOV2022	ICPARN	IOV20221	CPARNO	OV2022I	CPARNO	V2022IC	PARNOV	/2022ICI	PARNOV	/2022IC	PARNOV	2022IC	PARNO	V2022IC
RNOV2022ICPA	$O_2 = X_n^{th}$	UCPA 16	5 <sup>th</sup> value	2 = 48	OV2022I	CPARNO	V2022IC	PARNOV	/2022ICI	PARNOV	/2022IC	PARNOV	2022IC	PARNO	V2022IC
RNOV2022ICPA	$RNOV20\frac{1}{2}$	TCPARN	IOV20221	CPARNO	OV2022I	CPARNO	V2022IC	PARNOV	/2022ICI	PARNOV	/2022IC	PARNOV	2022IC	PARNO	V2022IC
RNOV2022ICPA	RNOV2022	2ICPARN	IOV20221	CPARNO	OV2022I	CPARNO	V2022IC	PARNOV	/2022ICI	PARNOV	/2022IC	PARNOV	2022IC	PARNO	V2022IC
RNOV2022ICPA	New $Q_3$	$+Q_2 =$	= 612 <del>-2</del> 4	8 = 13	DV2022I	CPARNO	V2022IC	PARNOV	/2022ICI	PARNOV	/2022IC	PARNOV	2022IC	PARNO	V2022IC
RNOV2022ICPA	RNOV2022	2ICPARN	IOV20221	CPARN(	OV2022I	CPARNO	V2022IC	PARNOV	/2022ICI	PARNOV	/2022IC	PARNOV	2022IC	PARNO	V2022IC
RNOV2022ICPA	$Q_2 - Q_1$	= 48 -	-372≡2I	<b>D</b> PARNO	OV20221	CPARNO	V20221C	PARNOV	/2022ICI	PARNOV	/2022IC	PARNOV	/2022IC	PARNO	V20221C
RNOV2022ICPA	RNOV2022	2ICPARN	OV20221	CPARNO	OV20221	CPARNO	V20221C	PARNOV	/2022ICI	PARNOV	/2022IC	PARNO	2022IC	PARNO	V20221C
RNOV2022ICPA	Since, $Q_3$	$_{3}-Q_{2}$	$> Q_2 -$	$Q_1$ the	distribu	tion is p	ositivel	y skewe	ed.0221C1	PARNOV	/2022IC	PARNOV	2022IC	PARNO	V2022IC
RNOV2022ICPA	KNOV2022			CPARN	OV20221	CPARNO	V20221C	PARNON	/2022ICI	ARNO	/2022IC	PARNON	2022IC	PARNO	V2022IC
RNOV2022ICPA	Quartile	coeme	lent of s	skewne	SS/20221	CPARNO CDA DNO	V2022IC	PAKNUN	/2022ICI	ARNO	/202210	PAKNUN	2022IC	PARNO	V 2022IC
RNOV2022ICPA	RNOV2022	=(0 - 0)	$\frac{10}{20221}$	(CPARINO (2+01) - (2+0) - (2+0) - (2+0) - (2+0) - (2+0) - (2+0)	(2MD) at	CDARNO	V2022IC	PAKNOV	/2022ICI	ARNOV	/2022IC	PARNUN DA DNOS	202210	PARNO	V 2022IC
NNOV2022ICFA	$=$ $\frac{(\sqrt{2})}{\sqrt{2}}$		- or $-$			CPARNO	V20221C	DADNON	/2022ICI	DADNO	/202210	PARNON DA DNOS	2022IC	PARNO	V2022IC
RNOV2022ICIA	PNOV2003	ICDARN	IOV20221	CDA PNI	1V20221	CPARNO	V20221C	DARNOV	720221CI		72022IC	DADNON	2022IC		V2022IC
RNOV2022ICIA	13-11		OV20221	CPARNO	OV20221	CPARNO	V20221C	PARNON	/20221CI	DARNON	/2022IC	PARNON	2022IC	PARNO	V2022IC
RNOV2022ICIA	61-37		IOV20221	CPARNI	OV20221	CPARNO	V20221C	PARNON	/2022ICI	PARNON	/2022IC	PARNON	2022IC	PARNO	V20221C
RNOV2022ICPA	PNOV2022	ICPARN	IOV20221	CPARNO	OV20221	CPARNO	V2022IC	PARNON	/2022ICI	PARNON	/2022IC	PARNON	2022IC	PARNO	V2022IC
RNOV2022ICPA	This indi	cates a	positive	skewne	ess.	CPARNO	V2022IC	PARNOV	/2022ICI	PARNOV	/2022IC	PARNOV	2022IC	PARNO	V2022IC

PA] pai	Length	Frequency	Cumulative	Class point	$x_i^2$	$f_i * x_i$	$f_i * x_i^2$	CPARNOV2022I
PAI		$(f_i)$	Frequency	$(x_i)$				CPARNOV2022I
PA1	20 - 30	3	3	25	625	75	1875	CPARNOV2022I
PAI PAI	30 - 40	7	10	35	1225	245	8575	PARNOV20221 PARNOV20221
PAI	40 - 50	8	18	45	2025	360	16200	CPARNOV2022I
PA]	50 - 60	5	23	55	3025	275	15125	CPARNOV2022I
PAI PAI	60 - 70	4	27	65	4225	260	16900	CPARNOV20221 CPARNOV20221
PAJ	70 - 80	3	30	75	5625	225	16875	CPARNOV2022I
PA1	80 - 90	1	31	85	7225	85	7225	CPARNOV2022I
PA1	Total	31				1525	82775	CPARNOV20221

RNOV2022ICPAP

Draw a frequency distribution table

 $\frac{1529}{1529} = \frac{1529}{1529} = \frac{1529}{1529$ 

RNOV20221CPAI<mark>F1:1</mark>/20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CIP<mark>Page 4 of 20</mark>CPARNOV20221C RNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV202

nd frequency  $D_2$ : is the difference between h: is the class width.  $L_o = 40, D_1 = 8 - 7 = 1, D_2$ ±3,  $Mode = L_o + \frac{D_1}{D_1 + D_2} * h = 40 + \frac{1}{1+3} * 10 = 40 + \frac{10}{4}$ 40 + 2 5 Mode = 42.5**iii**) Standard deviation =  $\sqrt{\frac{\sum f_i * x_i^2}{\sum f_i}}$  $\sum f_i * x_i$ 1525  $\sum f_i * x_i^2$ 1525 82775 Standard deviation 31 31  $\Sigma f_i$ Coefficient of variat 15.82 49. **QUESTION TWO** Marking Guide criteria Award 1 Mark for the correct answer of probability of success Award 1 Mark for the correct answer of probability of failure  $V^{2}$ Award 1 mark for identification of the model to be used (independence a binomial model) v20221CPARNOV20221CPA Award 1 mark for formula of probability of success when x=2 Award 1 mark for correct answer of probability that 2 customers will pay with credit card Award 1 mark for formula of probability that more than 7 cu will pay by credit cards. Award 2 marks for correct answer of probability that more than customers will pay with credit card O22ICPAR Award 1 mark for the correct answer of the mean and Sub\_total Page

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Award 1 Mark for formulation of Null hypothesis Ho
               Award 1 Mark for formulation of Alternative hypothesis H<sub>1</sub>
               Award 1 mark for formula of probability that 11 patients have been
              positively impacted by the vaccine P(X \le 11) V2022IC PAR
               Award 2 Marks for the correct answer from the test
               Award 1 Mark for mentioning that boundary for the critical region wil
               be to the left of x = 11
               Award 2 Marks for the correct decision (Ho will not be rejected)
               Award 2 Marks for the correct reasons mentioned by the student
 b.ii
                                                                                                  2
 Sub-tota
Model Answe
Solution A
Let x be the number of the customers in a sample of ten cu
                                                              stomers who pay by c
Let paying by credit card be the probability of success.
Let q be the probability of failure, 1-P=c
       -0.6 = 0.4 be the probability of fa
 Assuming independence a binomial \beta model
 herefore, X \sim \beta(10,6)
     P(X = 2) = C_2^{10} * P^k * q^{n-k} = C_2^{10} * P^2 * q^8
      \frac{10!}{2!(10-2)!} * (0.6)<sup>2</sup> * (0.4)<sup>8</sup>
     = 45 * (0.6)^2 * (0.4)^8 = 0.011
     P(X > 7) = P(X = 8) + P(X = 9) + P(X = 10)
      C_8^{10} * P^8 * q^2 + C_9^{10} * P^9 q^1 + C_{10}^{10} * P^{10} q^0
    = 45 * (0.6)^8 * (0.4)^2 + 10 * (0.6)^9 * (0.4)^1 + (0.6)^8
        The mean = E(x) = n * p = 10 * (0.6) = 6 and
    The standard deviation
                                  =\sqrt{\sigma^2}=\sqrt{n*p*q}=
                                                                            (0.4)
Solution B
                                                                                          Page 6
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ne number of patients in 15 whose pander relieved by the vac RNOV202210 e that the effect of vaccine on patient is independent of the other pat X can be modeled by a binomial distribution Where,  $X \sim \beta(15, p)$  $H_o: P = 0.9$  (the success  $H_1: P < 0.9$ If  $H_o$  is True, then,  $X \sim \beta(15,0.9)$ Since the alternative hypothesis is P < 0.9, The critical region is in the lower tail of the distri % level. The test value, x, will lie in the critical re Reject  $H_0$  if  $P(X \le x) \le 5\%$ Among 15 patients 11 react on their pandemic symptom  $P(X \le 11 \setminus P = 0.9) = P(X \ge 4 \setminus P = 0.1)$  $= 1 - P(X \le 3)$ = 1 - 0.9444 = 0.0556 ≅ 5.6 %  $P(X \le 11) = 1 - P(X \ge 12)$  $= 1 - \left[ \mathcal{C}_{12}^{15} * (0.9)^{12} * (0.1)^3 + \mathcal{C}_{13}^{15} * (0.9)^{13} * (0.1)^2 + \mathcal{C}_{14}^{15} * (0.9)^{14} * (0.1)^1 + \mathcal{C}_{15}^{15} \right]$ (0.9)15]  $= 1 - 0.944 = 0.0556 \cong 5.6 \%$  $P(X \le 11)$  is greater than 5 %. This means that boundary for the critical region will of x = 11. PAR Therefore, Ho is not rejected and the vaccine company's claim of a 90 % succ rate is uphe ii) V20 With safety in mind, it would be wise to suggest that the doctor errors on the side of caution of vaccine and carry out further tests before accepting that the success rate is 90 %, since this can have a direct effect on life. Page 7

QUESTIC	DNTHREE21CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV202021CPARNOV202021CPARNOV202021CPARNOV202021CPARNOV202021CPARNOV202021CPARNOV202020	OV20221 OV20221
Marking	CPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNO Guide 0V2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV	OV20221 OV20221
RNOV202210 RNOV202210	CPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNO Critéria 2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV202	OV2022I Marksi
RNOV202210	Award 1 Mark for the correct meaning of population <sup>221CPARNOV20221CPARNOV</sup>	OV <b>1</b> 022I
RNOV202210 RNOV <b>2</b> 02 <b>11</b>	Award 1 Mark for the correct meaning of sampling frame	⊃V2022I ⊖V <b>1</b> 022I
RNOV602210	PAward 1 Mark for correct answer on each case NOV20221CPARNOV20221CPARNOV	OV <b>2</b> 022I
RNOV202210 RNOV202210	Award 1 Mark for mentioning that every $k^{th}$ member should be chosen	OV20221 OV20221
RNOV202210	Award 1 Mark for formula of how to obtain K value 221CPARNOV20221CPARNO	OV2022I
RNOV202210 RNOV202210	Award 1 Mark for example of 8 members selected from a list of 300	OV <b>1</b> 022I OV2022I
<b>d.i</b> RNOV202210	Award 1 Mark for each correct line in Leontief matrix	OV2022I
RNOV202210 RNOV <b>d.ii</b> 210	Ward 1 Mark for the correct answer of $det(I - A)$ 2022[CPARNOV2022]CPARNOV2022[CPARNOV2022]CPARNOV202[NARNOV202]CPARNOV202[NARNOV202]CPARNOV202[NARNOV202[NARNOV202[NARNOV202]CPARNOV202[NARNOV202]CPARNOV202[NARNOV202]CPARNOV202[NARNOV202[NARNOV202[NARNOV202]CPARNOV202[NARNOV202[NARNOV202]CPARNOV202[NARNOV202[NARNOV202[NARNOV202[NARNOV202[NARNOV202[NARNOV202[NARNOV202[NARNOV202[NARNOV202[NARNOV202[NARNOV202[NARNOV202[NARNOV202[NARNOV202[NARNOV202[NARNOV20[NARNOV202[NARNOV202[NARNOV202[NARNOV20[NARNOV20[NARNOV20[NARNOV20[NARNOV20[NARNOV2[NARNOV20[NARNOV20[NARNOV20[NARNOV20[NARNOV[NARNOV20	)v20221 0V <b>1</b> 0221
RNOV2022I	Award 3 Marks for calculation of output 1 $(x_1)$ OV20221CPARNOV20221CPARNOV	OV <b>3</b> 022I
RNOV202210	Award 3 Marks for calculation of output 2 $(x_2)$	OV20221
RNOV2022I	Award 3 Marks for calculation of output 3 $(x_3)$ NOV20221CPARNOV20221CPARNOV	DV <b>3</b> 022I
Nov20221	Swer <sup>NOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV202021CPARNOV202021CPARNOV202021CPARNOV202021CPARNOV202021CPARNOV202021CPARNOV202021CPARNOV202020</sup>	OV20221
Solution A	<sup>-</sup> PARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNO CPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNO	OV2022I OV2022I
i) A pop	ulation is a particular group of individuals or items. <sup>V2022ICPARNOV2022ICPARNO</sup>	OV2022I
ii) One o called	f individual members of a population have been numbered to form a list, thi a sampling frame.	i <mark>s list is</mark> 0V20221 0V20221
Solution <b>E</b>	CPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNO CPARNOV2022ICPARNOV202	OV2022I OV2022I
The suitab cooperativ from infor	le sampling frame for the case One is the list of registered owners as kept by Yeg e in Kigali city. Whereas the suitable sampling frame for the case Two is a list co mation provided by the Ministry of Health/RBC.	o Carbs ompilec
Solution (	CPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARN( PARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARN(	OV2022I OV2022I
To choose	a systematic sample of 8 members from a list of 300 you can proceed as follow	OV20221 UV20221
✓ Since y	you are going to choose every $k^{th}$ member, you need to find a suitable value of	∋∨20221 <b>k</b> √20221
✓ To cho	ose so, choose a convenient value close to $\frac{N}{n}$ .	OV20221 OV20221 OV20221
✓ Where	N is a population size and n is the sample size.	OV2022I OV2022I
NOV20221 ✓ In this	CPAR NOV 300 ICPARNOV 2022 ICPARNOV 202 IC	OV2022I OV2022I
rNOV202210 ✓ Then w	CPARNOV2022ICPARNOV202	OV20221 OV20221
KNOV202210	LPAKNOVZUZZICPAK	JV20221

Take the first member of the sample as 87 and then add 40 each time. The other member is 127.  
167. 207. 247. 287. 27, and 67. Then you can arrange  
Solution D  
Given 
$$A = \begin{pmatrix} 0.3 & 0.5 & 0.2 \\ 0.2 & 0.0 & 0.5 \\ 0.1 & 0.3 & 0.1 \end{pmatrix}$$
  
(i) The Leonief matrix  $-1 - A = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 1 \end{pmatrix} - \begin{pmatrix} 0.3 & 0.5 & 0.2 \\ 0.2 & 0 & 0.5 \\ 0.1 & 0.3 & 0.1 \end{pmatrix} = \begin{pmatrix} 0.7 & -0.5 & -0.2 \\ -0.2 & 1 & -0.5 \\ -0.1 & -0.3 & 0.5 \end{pmatrix}$   
(ii) Let  $X^T = (x_1, x_2, x_3) = \begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix}$   
Now  $\begin{pmatrix} x_1 \\ x_3 \\ x_5 \end{pmatrix} = (1 - A)^{-1} + D$   
 $= \begin{pmatrix} 0.7 & -0.5 & -0.2 \\ -0.2 & 1 & -0.5 \\ -0.1 & -0.3 & 0.5 \end{pmatrix}^{-1} + \begin{pmatrix} 100 \\ 40 \\ 50 \end{pmatrix}$   
 $(1 - A)^{-1} = \frac{1}{4\pi (1 - 4)} + cof actor matrix$   
det $(1 - A) = 0.401$   
Therefore,  $\begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix} = \frac{1}{0.5\pi +} \begin{pmatrix} 0.75 & 0.42 & 0.40 \\ 0.23 & 0.61 & 0.39 \\ 0.25 & 0.62 \end{pmatrix} + \begin{pmatrix} 100 \\ 40 \\ 50 \end{pmatrix}$   
 $x_1 = \frac{1}{4\pi (1 - 5)} + (0.75 + (100) + 0.42 + (40) + 0.40 + (50))]$   
 $x_1 = 270$   
 $x_2 = \frac{1}{0.5\pi +} (0.15 + (100) + 0.25 + (40) + 0.40 + (50))]$   
 $x_2 = 167$   
 $x_3 = \frac{1}{0.5\pi +} (0.16 + (100) + 0.25 + (40) + 0.62 + (50))]$   
 $x_3 = 147$   
Therefore, the output matrix is:  
 $\begin{pmatrix} x_1 \\ x_2 \\ x_1 \end{pmatrix} = \begin{pmatrix} 270 \\ 167 \\ 147 \end{pmatrix}$   
Therefore, the output matrix is:  
 $\begin{pmatrix} x_1 \\ x_2 \\ x_1 \end{pmatrix} = \begin{pmatrix} 270 \\ 167 \\ 147 \end{pmatrix}$ 

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OUESTION FOU
Marking Guide
a) 1 Mark for each correct alternative on the tree Maximum 3
   1 Mark for calculation of EMV on each alternative Maximum
   1 Marks for correct decision
  Subtotal
b. (i) Develop objective function V2022ICPARNOV2022ICPAR
  Develop constraint function (1 for demand constraint and 1 for supply constraint
  Maximum
                                                                                          3
b. ii) 0.5 Marks for each Correct allocation using NWC (Maximum 2.5)
                                                                                         2.5
 1.5 Marks for calculation of total cost using NWC CPARNOV2022IC
                                                                                        125
                                                                                        2.5
  0.5 Marks for each Correct allocation using LCM (Maximum 2.5)
  1.5 Marks for calculation of total cost using LCM
                                                                                         1.5
                                                                                        0.5
  0.5 Marks for correct decision
b.iii) 0.5 Marks for ea
                                       the transportation problem
                                                                                         125
Total
                                                                                         20
Model Answer
Solution A
The tree diagram is
                                                                               Page 10
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$x_{11} + x_{12} + x_{12}$	$_{3} + x_{14}$	20_20≤	22ICPARNOV20	22ICPARNOV202	22ICPARNOV20	22ICPARNOV202
$x_{21} + x_{22} + x_2$	$_{3} + x_{24}$	≤ 700 }Sι	pply constrain	tsICPARNOV202	22ICPARNOV20	22ICPARNOV202 22ICPARNOV202
$x_{31} + x_{32} + x_3$	$_{3} + x_{34}$	<u>≤ 900</u> )	22ICPARNOV20. 22ICPARNOV20.	221CPARNOV202	22ICPARNOV20.	22ICPARNOV202 22ICPARNOV202
$x_{11} + x_{21} + x_3$	<sub>1</sub> ≥ 900	ICRARNOV20. ICPARNOV20:	22ICPARNOV20. 22ICPARNOV20.	221CPARNOV20. 221CPARNOV202	221CPARNOV20. 221CPARNOV202	221CPARNOV202 221CPARNOV202
$x_{12} + x_{22} + x_{33}$	$_{2} \geq 800$	$\mathbb{CP}^{\mathbb{R}}$ Dema	nd constraints	22ICPARNOV202 22ICPARNOV202	22ICPARNOV202 22ICPARNOV202	22ICPARNOV202 22ICPARNOV202
$x_{12} + x_{22} + x_{23}$	> 500	ICPARNOV202 ICPARNOV202	22ICPARNOV202 22ICPARNOV202	22ICPARNOV202 22ICPARNOV202	22ICPARNOV202 22ICPARNOV202	22ICPARNOV202 22ICPARNOV202
v = 13 + 223 + 233 v = 2221 CPAR v = 221 CPAR	> 400	ICPARNOV20 ICPARNOV20	22ICPARNOV202 22ICPARNOV202	22ICPARNOV202 22ICPARNOV202	22ICPARNOV202 22ICPARNOV202	22ICPARNOV202 22ICPARNOV202
$\begin{array}{c} \mathbf{\lambda}_{14} + \mathbf{\lambda}_{24} \pm \mathbf{\lambda}_{3} \\ \mathbf{\lambda}_{22} \\ \mathbf{\lambda}_{14} + \mathbf{\lambda}_{24} \pm \mathbf{\lambda}_{3} \\ \mathbf{\lambda}_{14} + \mathbf{\lambda}_{14} \pm \mathbf{\lambda}_{3} \\ \mathbf{\lambda}_{14} + \mathbf{\lambda}_{14} \pm \mathbf{\lambda}_{3} \\ \mathbf{\lambda}_{14} + \mathbf{\lambda}_{14} \pm \mathbf{\lambda}_{14} \pm \mathbf{\lambda}_{14} \\ \mathbf{\lambda}_{14} + \mathbf{\lambda}_{14}$		ICPARNOV20	22ICPARNOV20 22ICPARNOV20	21CPARNOV202	22ICPARNOV202 22ICPARNOV202	22ICPARNOV202 22ICPARNOV202
n)		Can be sumn	arrized in the t	able below:	22ICPARNOV20	22ICPARNOV202
NOV2022ICPAR	NDX2022	ICPARNOV2	221CPARNOV20 221CPARNOV20	221CPARNOV202	21CD KNOV 201 22ICPARNOV 201	Supply
CAOV2022ICPAR	ND <b>Q</b> 2022	ICPARNOV29	22ICPARNOV202 22ICPARNOV202	29CPARNOV202	21C <sup>4</sup> ARNOV202 21C <b>5</b> Arnov202	221CPA <b>1000</b> /202
a ovacal chi a	NOV2022	ICDA DNOV20		er er ner to the	file of file	00 + 202
$(\mathbf{Z})^{\sqrt{20221}CPAR}$	1052022	10PARNOV26	22ICPARNOV20	22 <mark>7</mark> CPARNOV202	22ICBARNOV202	$221CPA_{900} \times 202$
Z Demand North West Co Destination/so	5 900 orner M ources	ICPARNOV26         ICPARNOV28         ICPARNOV20	221CPARNOV20: 221CPARNOV20: 221CPARNOV20: 221CPARNOV20: 21CPARNOV20: 21CPARNOV20: 221CPARNOV20: 221CPARNOV20: 221CPARNOV20: 29CPARNOV20: 20100000000000000000000000000000000000	227CPARNOV202 221CPARNOV202 221CPARNOV202 221CPARNOV202 221CPARNOV202 221CPARNOV202 221CPARNOV202 221CPARNOV202 221CPARNOV202 221CPARNOV202	22108ARNOV202 2210PARNOV202 2210PARNOV202 2210PARNOV202 2210PARNOV202 2210PARNOV202 2210PARNOV202 2210PARNOV202 2210PARNOV202 2210PARNOV202	221CPA 900 221CPA 800 202 221CPA 800 202
Z Demand North West Co Destination/so X	5 900 orner M	CPARNOV26         ICPARNOV28         ICPARNOV20         ethod (NWC         CPARNOV20         ICPARNOV20	221CPARNOV20: 221CPARNOV20: 221CPARNOV20: 221CPARNOV20: 21CPARNOV20:	227CPARNOV202 221CPARNOV202 21CPARNOV2	22108 22109 22100 2010000000000	221CPA 900 221CPARNO 202 221CPARNO 202 21CPARNO 202
Z Demand North West Co Destination/so X Y	5 900 orner M	ICPARNOV26         ICPARNOV20         ICPARNOV20         ethod (NWC         ICPARNOV20	221CPARNOV20: 201CPARNOV20: 221CPARNOV20: 221CPARNOV20: 211CPA	227CPARNOV202 221CPARNOV202 221CPARNOV202 221CPARNOV202 221CPARNOV202 221CPARNOV202 221CPARNOV202 221CPARNOV202 221CPARNOV202 21CPARN	22108ARNOV202 2210PARNOV202 2210PARNOV202 2210PARNOV202 2210PARNOV202 2210PARNOV202 2210PARNOV202 2210PARNOV202 2210PARNOV202 2210PARNOV202 2210PARNOV202 2210PARNOV202 2210PARNOV202 2210PARNOV202	900 2600 21CPARNO 202 21CPARNO
Z Demand North West Co Destination/so X Y Z	5 900 orner M	CPARNOV26         ICPARNOV20         ICPARNOV20         ethod (NWC         ICPARNOV20	221CPARNOV20: 201CPARNOV20: 221CPARNOV20: 221CPARNOV20: 211CPARNOV20: 211CPARNOV20: 211CPARNOV20: 211CPARNOV20: 211CPARNOV20: B PARNOV20: B PARNOV20: 6 PARNOV20: 7 PARNOV20:	27 CPARNOV202 20 CPARNOV202 21 CPARNOV202 22 CPARNOV202 22 CPARNOV202 22 CPARNOV202 22 CPARNOV202 22 CPARNOV202 22 CPARNOV202 22 CPARNOV202 23 CPARNOV202 24 CPARNOV202 24 CPARNOV202 25 CPARNOV202 26 DARNOV202 27 DARNOV202 20	22108ARNOV202 2210ARNOV202 2210PARNOV202 22100PARNOV202 2210PARNOV202 2210PARNOV202 22	900 2600 21CPARNOV202 21CPARNOV
Z Demand North West Co Destination/so X Y Z Demand	5 900 0rner M 0222 022 022 022 022 022 022 022 022 0	6         1CPARNOV20         1CPARNOV20         ethod (NWC         1CPARNOV20         4         5         900         4         5         200         0         1CPARNOV20	221CPARNOV20 200 PARNOV20 221CPARNOV20 221CPARNOV20 221CPARNOV20 221CPARNOV20 221CPARNOV20 221CPARNOV20 221CPARNOV20 <b>B</b> PARNOV20 <b>B</b> PARNOV20 <b>6</b> A 100 <b>2</b> PARNOV20 <b>6</b> PARNOV20 <b>6</b> PARNOV20 <b>6</b> PARNOV20 <b>6</b> PARNOV20 <b>6</b> PARNOV20 <b>6</b> PARNOV20 <b>700</b>	27 CPARNOV20 20 CPARNOV20 21 CPARNOV20 22 CPARNOV20 22 CPARNOV20 22 CPARNOV20 22 CPARNOV20 22 CPARNOV20 6 PARNOV20 6 PARNOV20 7 500 500 0 20 CPARNOV20 20 CPA	22108 22108 22109 22	900 2600 21CPARNOV202 21CPARNOV202 21CPARNOV202 21CPARNOV202 21CPARNOV202 21CPARNOV202 21CPARNOV202 21CPARNOV202 2000 2000 0 2000 0 2000 0 2000 2000
Z Demand North West Co Destination/so X Y Z Demand $x_{11} = 900$ $x_{12} = 100$ $x_{22} = 700$ $x_{33} = 500$ $x_{34} = 400$ The optimum is $Z = 5400 \pm 60$	$   \begin{bmatrix}     5 \\     900   \end{bmatrix}   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $ $     0 < 202   $	ICPARNOV26         ICPARNOV20         ICPARNOV20         ethod (NWC         ICPARNOV20         ICPARNOV20         ICPARNOV20         ICPARNOV20         ICPARNOV20         ICPARNOV20         ACPARNOV20         ACPARNOV20         ICPARNOV20	221CPARNOV20 200 PARNOV20 221CPARNOV20 221CPARNOV20 221CPARNOV20 221CPARNOV20 221CPARNOV20 221CPARNOV20 21CPARNOV20 6 PARNOV20 6 PARNOV20 6 PARNOV20 21CPARNOV20	27       CPARNOV20         200       RNOV20         200       RNOV20         200       RNOV20         201       CPARNOV20         201	22108 22109 22	221CPA 900 221CPA 800 221CPA 800 221CPA 800 221CPA 800 221CPA 800 221CPA 800 221CPA 800 221CPA 800 221CPA 800 200 200 200 200 200 200 200
Z Demand North West Co Destination/so X Y Z Demand $x_{11} = 900$ $x_{12} = 100$ $x_{22} = 700$ $x_{33} = 500$ $x_{34} = 400$ The optimum is Z = 5400 + 60	$     \begin{bmatrix}       5 \\       900       \\       900  $	6       6         1CPARNOV20         ethod (NWC         1CPARNOV20         ethod (NWC         1CPARNOV20         1CPARNOV20         1CPARNOV20         1CPARNOV20         4         5       900         4         5       900         4       0         5       900         4       0         5       900         4       0         5       900         4       0         5       0         10       10         10       4         10       4         10       4         10       4         10       4         10       4         10       4         10       4         10       4         10       4         10       4         10       4         10       4         10       4         10       4         10       4         10       4         10 <td< td=""><td>221CPARNOV20 200 PARNOV20 21CPARNOV20 21CPARNOV20 21CPARNOV20 21CPARNOV20 21CPARNOV20 21CPARNOV20 21CPARNOV20 6 PARNOV20 6 PARNOV20 6 PARNOV20 21CPAR</td><td>27 CPARNOV20 20 CPARNOV20 21 CPARNOV20 21</td><td>22108 22109 22</td><td>221CPA 900 221CPA 800 221CPA 800 221CPA 800 221CPA 800 221CPA 800 221CPA 800 221CPA 800 221CPA 800 221CPA 800 200 1000 100 1000 100 0 2008 00 2008 00</td></td<>	221CPARNOV20 200 PARNOV20 21CPARNOV20 21CPARNOV20 21CPARNOV20 21CPARNOV20 21CPARNOV20 21CPARNOV20 21CPARNOV20 6 PARNOV20 6 PARNOV20 6 PARNOV20 21CPAR	27 CPARNOV20 20 CPARNOV20 21	22108 22109 22	221CPA 900 221CPA 800 221CPA 800 221CPA 800 221CPA 800 221CPA 800 221CPA 800 221CPA 800 221CPA 800 221CPA 800 200 1000 100 1000 100 0 2008 00 2008 00

Using Least Cost Methods (LCM Supply Destination/Sources A B CARNOV D 6 1000 600 0 6 4 500 ø 400 Х 100 X 5 700 2. p. .700 0 Y X 5 PAR 900 6 1 900 Z 8 0 900 0 Demand 800 100 0 500 0 400 0  $x_{12} = 100$  $x_{13} = 500$ RNOV20  $x_{14} = 40$  $x_{22} = 700$  $x_{31} = 900$ The optimum is Z =6 \* (100) + 6 \* (500) + 4 \* (400)Z = 600 + 3000 + 1600 + 1400 + 4500*Z* = 11,100 The best method is Least cost method since it gives the minimum cost. iii) A transportation problem is characterized by three elements 1. Supply points 2. Demand points 3. Cost of transport **QUESTION FIVE** Marking Guide Marks Draw network (0.5Marks for each correct drawn activity, maximum 7) Identify critical (0.5 for each activity on CP) Calculation of mean and the variance (2 Mark for mean and 3 marks for 5 Explanation for the concept of crashing of a project Explanation for the criteria for selecting of an activity for crashing (0.5 for each criteria) Page 13 of



RNOV2022ICPAI	NOV2022ICPARN	JOV2022ICPARN	OV2022ICPA	RNOV202	2ICPARNOV2022ICPARNO	V2022ICPARNOV2022I	TP/
RNOV2022ICPAI	BOV2022ICPARM	2V2022ICPARN	0V2 <b>3:5</b> 1CPA	R <b>8</b> IOV202	24 CPARNOV 2022 ICPARNO	V1022ICPARNOV2022I	CP/
RNOV2022ICPAI	COV2022ICPARN	6V2022ICPARN	OV2092ICPA	R18 <sup>V202</sup>	210 <sup>0</sup> ARNOV2022ICPARNO	V4022ICPARNOV2022I	CP/
RNOV20221CPA1 RNOV20221CPA1	$\mathbf{P}_{OV20221CPAR}$	iov20221CPARN 14v20221CPARN	оv 2022 ICPA	$10^{10}$	21CPARNOV20221CPARNO 2 <b>6</b> PARNOV20221CPARNO	V20221CPARNOV20221 V20221CPARNOV202210	CP/
RNOV2022ICPAI	RIEOV2022ICPARI	QV2022ICPARN	OV24.5ICPA	R510V202	24CPARNOV2022ICPARNO	V2022ICPA4RNOV2022I	CP/
RNOV2022ICPAI	RNOV2022ICPAR	IOV2022ICPARN	OV2022ICPA	RNOV202	2ICPARNOV2022ICPARNO	V2022ICPAGRNOV2022I	CP/
RNOV2022ICPAI	FOV2022ICPARI	4	0V20221CPA 0V20221CPA	$10^{10}$	21CPARNOV2022ICPARNO	V 2022ICPARNO V 2022IO V 2022ICPARNO V 2022IO	CP/
RNOV2022ICPAI	CGDV2022ICPARM	5V2022ICPARN	OV2 <b>6.5</b> 1CPA	R <b>N</b> OV202	2 <b>7</b> CPARNOV2022ICPARNO	1022ICPARNOV2022I	CPA
RNOV2022ICPAI	NPV2022ICPARN	SV2022ICPARN	DV20821CPA	$R_{17}^{PV202}$	29 PARNOV 2022 ICPARNO	V 2022ICPARNOV 2022I	CP/
RNOV2022ICPAI RNOV2022ICPAI	NOV2022ICPARI	3V2022ICPARN	$0V_20221CPA$	<b>8</b> 10V202	21CPARNOV20221CPARNO 21CPARNOV20221CPARNO	$\sqrt{20221CPARNO}\sqrt{202210}$	CP/
RNOV2022ICPAI	NOV2022ICPARN	3V2022ICPARN	0V20 <b>9</b> 2ICPA	R <b>9</b> IOV202	2 <b>8</b> CPARNOV2022ICPARNO	V1022ICPARNOV2022I	CP/
RNOV2022ICPAI	KOV2022ICPART	4V2022ICPARN	$\frac{0.0020221CPA}{4}$	RNOV202	2JCPARNOV2022ICPARNO	V 0221CPARNOV20221	CP/
RNOV2022ICPAI	ULOV2022ICPAR	dv20221CPARN	0V2 <b>5.5</b> 1CPA	R710V202	25 PARNOV 2022IC PARNO	v <b>1</b> 0221CPARNOV202210	CP/

NOV20

9

2CPARNOV2022ICPARNO

6 PARNOV20221CPARNO

3022ICPARNOV2022

4

9 NOV

RNOV20221CPARNO

 $V202^{2ICP}$ 

5.5

MV2022ICPAR

NOV2022ICPAR

2022ICPARN

 $5_{\rm V}$ 

20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV2022 20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV202 20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV202 20221CPARNOV20021CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20 The variance  $\sigma^2 = \frac{1}{9} + 1 + 4 + 1 + 1 + 4 + 3 + \frac{4}{9} = 14.5556$ 

iv) The process of shortening the time to complete a project is called crashing and is usually achieved by putting into service additional labor or machines to one activity or more activities. Crashing involves more costs to speed up a project by spending extra cost as possible. Project crashing seeks to minimize the extra cost for completion of a project before the stipulated time.

v) The criteria for the selection of an activity to be crashed is as follows:

select the activity on the critical path with smallest crash cost per unit time. Crash this activity to the maximum units of time as may be permissible by the given data.

Crashing an activity requires extra amount to be spent. We have to select an activity with less crash

cost. 2022 CPARNO 2022 CPARNO

20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV2022 20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV2022 20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV2022 20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV2022 20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV2022 20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20222 20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20222 20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20222 20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20222 20221CPARNOV20221

OV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV202 OV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20202 OV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV202 OV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV202 OV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV202 OV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV2022 OV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV2022 OV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV2022 OV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV2022 OV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV20221CPARNOV2022 OV20221CPARNOV20221CPAR

WIGHT Allswei	NOV2022ICPARNO	V2022ICPARNOV	2022ICPARNOV2	022ICPARNOV202	2ICPARNOV2022
RNOV2022ICPARN Solution A PARN	NOV2022ICPARNO NOV2022ICPARNO	)V2022ICPARNOV )V2022ICPARNOV	2022ICPARNOV2( 2022ICPARNOV2)	022ICPARNOV202 022ICPARNOV202	2ICPARNOV2022 2ICPARNOV2022
i) The least-so for a given $X = c + dY wh$ $\sum x 327$	quare line of regiveled value of Y. ere $c = \bar{x} - d\bar{y}$	ression of X on and $d = \frac{s_{xy}}{s_{yy}}$ 1661	Y: This equation 20221CPARNOV2 20221CPARNOV2 20221CPARNOV2 20221CPARNOV2 20221CPARNOV2 20221CPARNOV2	n is used to estim 022ICPARNOV202 022ICPARNOV202 022ICPARNOV202 022ICPARNOV202 022ICPARNOV202 022ICPARNOV202	tate a value of 2 21CPARNOV2022 21CPARNOV2022 21CPARNOV2022 21CPARNOV2022 21CPARNOV2022 21CPARNOV2022
$\bar{x} = \frac{2}{n_{221CP}} = \frac{1}{6}$	and $\bar{y} = \frac{-z}{n} = \frac{1}{n}$	V2022ICPARNOV	20221CPARNOV2 20221CPARNOV2	022ICPARNOV202 022ICPARNOV202	2ICPARNOV2022 2ICPARNOV2022
KNOV2022ICPARM	X 2022ICPARNO	<b>Y</b> 022ICPARNOV	x^2	<b>y^2</b>	TCPARNOV2022
RNOV20221CPARN	10V20221CPARNC	V2022ICPARNOV	20221CPAR <b>1764</b>	221CPAR 20449	ICPARNO 6006
RNOV2022ICPA2	OV2022ICPAI50	V2022ICPAR179	2022ICPAR 2500	221CPAR 320412	ICPARNO 8950
RNOV2022ICPARA RNOV2022ICPARA	IOV20221CPARNO	V20221CPAR V20221CPAR 197	20221CPAR 2209	38809	9259
RNOV2022ICPA4	10V2022ICPAI <b>58</b> C	V2022ICPAR <b>335</b> V	2022ICPAR 3364	221CPAR <b>112225</b> 2	21CPARN (19430
RNOV2022ICPA <b>5</b> . RNOV2022ICPAR	VOV2022ICPAI <b>57</b> VOV2022ICPAR <u>N</u> C	V2022ICPAR384	3249	147456	21888
RNOV2022ICPAR	NOV2022ICPAR73C	V2022ICPAR423	2022ICPAR 53292	178929 <sub>2</sub>	ICPARN 30879
$s_{xy} = \frac{1}{n} \sum xy - \frac{1}{n} \sum $	$\overline{x}\overline{y} = \frac{1}{6} * 96412$	V2022ICPARNOV V2022ICPARNOV V2022ICPARNOV V2062I*P46NOV V2022ICPARNOV V2022ICPARNOV	2022ICPARNOV20 2022ICPARNOV20 2022ICPARNOV20 2022ICPARNOV20 2022ICPARNOV20 2022ICPARNOV20	022ICPARNOV202 022ICPARNOV202 022ICPARNOV202 022ICPARNOV202 022ICPARNOV202 022ICPARNOV202	2ICPARNOV2022 2ICPARNOV2022 2ICPARNOV2022 2ICPARNOV2022 2ICPARNOV2022 2ICPARNOV2022
$s_{xy} = \frac{1}{n} \sum xy -$ $s_{xy} = 981.25$ $s_{yy} = \frac{1}{n} \sum y^2 -$ $d = \frac{s_{xy}}{s_{yy}} = \frac{981.2}{11681}$ Calculate c $c = \bar{x} - d\bar{y} = \frac{3}{2}$	$\bar{x}\bar{y} = \frac{1}{6} * 96412$ $\bar{y}^2 = \frac{1}{6} * 52990$ $\frac{25}{.47} = 0.084$ $\frac{25}{.47} = 0.084$	$9 \frac{327}{6} \times \frac{1661}{6}$ $9 \frac{2}{7} \left(\frac{1661}{6}\right)^2 = 1$ $20221CPARNOV$	20221CPARNOV2 20221CPARNOV2	0221CPARNOV202 0221CPARNOV202 0221CPARNOV202 0221CPARNOV202 0221CPARNOV202 0221CPARNOV202 0221CPARNOV202 0221CPARNOV202 0221CPARNOV202 0221CPARNOV202 0221CPARNOV202 0221CPARNOV202 0221CPARNOV202 0221CPARNOV202 0221CPARNOV202 0221CPARNOV202 0221CPARNOV202	2ICPARNOV2022 2ICPARNOV2022 2ICPARNOV2022 2ICPARNOV2022 2ICPARNOV2022 2ICPARNOV2022 2ICPARNOV2022 2ICPARNOV2022 2ICPARNOV2022 2ICPARNOV2022 2ICPARNOV2022 2ICPARNOV2022 2ICPARNOV2022 2ICPARNOV2022 2ICPARNOV2022 2ICPARNOV2022 2ICPARNOV2022 2ICPARNOV2022 2ICPARNOV2022
$s_{xy} = \frac{1}{n} \sum xy -$ $s_{xy} = 981.25$ $s_{yy} = \frac{1}{n} \sum y^2 -$ $d = \frac{s_{xy}}{s_{yy}} = \frac{981.2}{11681}$ Calculate c $c = \bar{x} - d\bar{y} = \frac{3}{2}$ The equation o	$\bar{x}\bar{y} = \frac{1}{6} * 96412$ $\bar{y}^2 = \frac{1}{6} * 52990$ $\frac{25}{.47} = 0.084$ $\frac{25}{.47} = 0.084 * \frac{166}{.6}$ of regression line	$9 - \frac{327}{6} * \frac{1661}{6}$ $9 - \frac{1661}{6}^{2} = 1$ $20221CPARNOV$ $2000 CPACNOV$ $2000 CPACNOV$ $200 CPACNOV$ $200 CPACNOV$ $200 CPACNOV$	20221CPARNOV20 $20221CPARNOV20$	0221CPARNOV202 0221CPARNOV202	2ICPARNOV2022 2ICPARNOV2022
$s_{xy} = \frac{1}{n} \sum xy -$ $s_{xy} = 981.25$ $s_{yy} = \frac{1}{n} \sum y^2 -$ $d = \frac{s_{xy}}{s_{yy}} = \frac{981.2}{11681}$ Calculate c $c = \bar{x} - d\bar{y} = \frac{3}{1}$ The equation o Note: This alter	$\bar{x}\bar{y} = \frac{1}{6} * 96412$ $\bar{y}^2 = \frac{1}{6} * 52990$ $\frac{25}{.47} = 0.084$ $\frac{227}{6} - 0.084 * \frac{166}{6}$ of regression line rnative approace	$9 - \left(\frac{1661}{6}\right)^2 = 1$ $9 - \left(\frac{1661}{6}\right)^2 = 1$ $20221CPARNOV$ $20221CPARN$	20221CPARNOV20 $20221CPARNOV20$ $2020$	0221CPARNOV202         0221CP	2ICPARNOV2022 2ICPARNOV2022
$s_{xy} = \frac{1}{n} \sum xy -$ $s_{xy} = 981.25$ $s_{yy} = \frac{1}{n} \sum y^2 -$ $d = \frac{s_{xy}}{s_{yy}} = \frac{981.2}{11681}$ Calculate c $c = \bar{x} - d\bar{y} = \frac{3}{10}$ The equation o Note: This alter $b_{xy} = \text{Slope of th}$	$\bar{x}\bar{y} = \frac{1}{6} * 96412$ $\bar{y}^2 = \frac{1}{6} * 52990$ $\frac{25}{.47} = 0.084$ $\frac{27}{6} - 0.084 * \frac{166}{6}$ of regression line rnative approace the line of regression	$9 - \left(\frac{1661}{6}\right)^2 = 1$ $9 - \left(\frac{1661}{6}\right)^2 = 1$ $20221CPARNOV 20221CPARNOV 2$	20221CPARNOV2 20221	0221CPARNOV202           0221CPARNOV202	2ICPARNOV2022 2ICPARNOV2022

of regression c		(X - C + UI) ICPARNOV202	2ICPARNOV202	22ICPARNOV20	22ICPARNOV20	221CPARNOV2022
$X-\overline{X}=b_{XY}(Y$	- <b>Y</b> ) 2022	ICPARNOV202. ICPARNOV202.	2ICPARNOV202 2ICPARNOV202	221CPARNOV20 221CPARNOV20	22ICPARNOV20 22ICPARNOV20	221CPARNOV2022 221CPARNOV2022
ii) From the Therefore	equation, Mathew i	when $y = 58$ is 80 years old	2, <i>x</i> = 31.2 +	- 0.084 * 582	2 <u>2</u> 1800 2 <u>2</u> 1800 22100 20100 20100000000	)221CPARNOV2022 )221CPARNOV2022 )221CPARNOV2022 )221CPARNOV2022
Solution B PAT	RNOV2022 RNOV2022	ICPARNOV2022 ICPARNOV2022	2ICPARNOV202 2ICPARNOV202	22ICPARNOV20 22ICPARNOV20	22ICPARNOV20 22ICPARNOV20	)22ICPARNOV2022 )22ICPARNOV2022
i) Let comput	e the min	for each row	and the max f	or each colum	22ICPARNOV20 D2ICPARNOV20	)22ICPARNOV2022 )22ICPARNOV2022
Strategy	RNOV2022 RNOV2022	Player 2	CICPARNOV202 CPARNOV202	22ICPARNOV20 22ICPARNOV20	22ICPARNOV20 22ICPARNOV20	221CPARNOV2022 221CPARN <b>Min</b> 022
RNOV2022ICPAI	RNOV2022	ICPARNOV202	2ICPAI2NOV202	22ICPA3NOV20	22ICPARNOV20	221CPARNOV2022
Player 1	RNOV2022: RNOV2022	ICPARNOV202: ICPARNOV202	21CP/RNOV202 21CP/RNOV202	221CPARNOV20 221CPARNOV20	22ICPARNOV20 22ICPARNOV20	)2210PARNOV2022 )2210PA2RNOV2022
RNOV2022ICPAI	RN <b>2</b> DV2022	ICPAR <b>5</b> IOV202	2ICPAI <mark>4</mark> NOV202	22ICPAF310V20	22ICPA <b>5</b> RNOV20	221CPA3RNOV2022
RNOV2022ICPAI	30V2022	ICPAR2OV202.	21CPARNOV202	221CPAR40V20	221CPARNOV20	221CPARNOV2022
RNOV20221 Max	NOV2022	ICPAR <sup>5</sup> OV202	2ICPARNOV202	221CPA2NOV20	221CPARNOV20	22ICPARNOV2022
Using of     Strategy	addle poir	nt. ICPARNOV202 I strategies tec ICPARNOV202 CPARNOV202 ICPARNOV202	21CPARNOV202 21CPARNOV202 21CPARNOV202 21CPARNOV202 21CPARNOV202 21CPARNOV202 11	221CPARNOV20 minate rows an 222222222222222222222222222222222222	221CPARNOV20 221CPARNOV20 nd / or column 221CPARNOV20 221CPARNOV20 221CPARNOV20 221CPARNOV20	221CPARNOV2022 )221CPARNOV2022 ) <b>we get:</b> NOV2022 )221CPARNOV2022 )221CPARNOV2022 )221CPARNOV2022
There is no sa ii) Using o Strategy Player 1	addle poir	nt. CPARNOV202 I strategies teo CPARNOV202 CPARNOV202 CPARNOV202	21CPARNOV202	221CPARNOV20 minate rows an Player 2	221CPARNOV20 221CPARNOV20 ad / or column 221CPARNOV20 221CPARNOV20 221CPARNOV20 221CPARNOV20 221CPARNOV20	221CPARNOV2022 221CPARNOV2022 we get: NOV2022 221CPARNOV2022 221CPARNOV2022 221CPARNOV2022 221CPARNOV2022 221CPARNOV2022 221CPARNOV2022
There is no sa ii) Using of Strategy Player 1	nddle poir RNOV2022 dominatec RNOV2022 RNOV2022 RNOV2022 RNOV2022 RNOV2022 RNOV2022 RNOV2022 RNOV2022	nt. CPARNOV202 I strategies tec CPARNOV202 CPARNOV202 CPARNOV202 BARNOV202 ICPARNOV202 ICPARNOV202	21CPARNOV202	221CPARNOV20 221CPARNOV20 221CPARNOV20 210PARNOV20 211CPARNOV20 221CPARNOV20 221CPARNOV20 221CPARNOV20 221CPARNOV20 221CPARNOV20	221CPARNOV20 221CPARNOV20 221CPARNOV20 221CPARNOV20 221CPARNOV20 221CPARNOV20 221CPARNOV20 221CPARNOV20 221CPARNOV20 221CPARNOV20	221CPARNOV2022 221CPARNOV2022 221CPARNOV2022 221CPARNOV2022 221CPARNOV2022 221CPARNOV2022 221CPARNOV2022 221CPARNOV2022 221CPARNOV2022 221CPARNOV2022 221CPARNOV2022 221CPARNOV2022 221CPARNOV2022 221CPARNOV2022 221CPARNOV2022 221CPARNOV2022 221CPARNOV2022
There is no sa ii) Using a Strategy Player 1 iii) Algebr $P = \frac{3-(-4)}{8} = \frac{2}{8}$ $q = \frac{3-1}{8} = \frac{2}{8}$ $V = \frac{6+4}{8} = \frac{10}{8}$ Therefore, the	and 1 $\frac{5}{4}$	ht. PARNOV202 I strategies teo PARNOV202	21CPARNOV202         21CPARNOV202	221CPARNOV20 221CPARNOV20 minate rows an 221CPARNOV20 121CPARNOV20 221CPARNOV20	221CPARNOV20 221CPARNOV20	221CPARNOV2022         221CPA

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DUESTION SEVE
Marking Guide
a.i) 0.5 Marks for each forecasted number (Maximum 2)
a.ii) 0.5 Marks for each forecasted number (Maximum 2.5)
a.iii) 1 Mark for mean squared deviation of moving average
1 Mark for mean squared deviation of exponential smoothing
b. i) 0.5 Mark for formula of each index (Maximum 1.5 Marks)
2 Marks for calculation of each index (Maximum 6 Marks)
b.ii) 0.5 for each desirable properties of the base period in index number (Maximum 2)
1 for each explained desirable properties of the base period in index number (Max
Total
Model Answer
Solution A
    The two mon
m_2 = \frac{13+17}{2} = 15
m_3 = \frac{17+19}{2} = 18
       \frac{19+23}{2} = 21
m_5 = \frac{23+24}{2} = 23.5
The forecast for month six is just the moving average for the month before that.
average for month 5 = m_5 = FRW23,500
ii) Applying exponential smoothing with a smooth constant 0.9 we get
m_1 = y_1 = 13
m_2 = 0.9 * y_2 + 0.1 * m_1 = (0.9 * 17) + (0.1 * 13) = 16.60
m_3 = 0.9 * y_3 + 0.1 * m_2 = (0.9 * 19) + (0.1 * 16.60) = 18.76
m_4 = 0.9 * y_3 + 0.1 * m_4 = (0.9 * 23) + (0.1 * 18.76) = 22.58
m_5 = 0.9 * y_5 + 0.1 * m_4 = (0.9 * 24) + (0.1 * 22.58) = 23.86
As before the forecast for month six is just the average for month 5
                                                                                  Page 18
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 $MSD = \frac{[(15-19)^2 + (18-23)^2 + (21-24)^2]}{3} = 16.67$ For the exponential,  $MSD = \frac{[(13-17)^2 + (16.60-19)^2 + (18.76-23)^2 + (22.58-24)^2]}{4}$   $MSD = \frac{[(13-17)^2 + (16.60-19)^2 + (18.76-23)^2 + (22.58-24)^2]}{4}$ Since the exponential smoothing appears to give the best one month ahead as it has a lower MSD,

PAIwe prefer the forecast of FRWFR23,860 produced by exponential smoothing. 2022ICPARNOV2022ICPARN PARNOV2022ICPARNOV2002ICPARNOV2002

(CPA i) OV2 Before calculation of the indexes, let us start from the table below: OV

Commodity	NOVE	ase	NO Cu	rrent	NOV2022ICPA	RNOV2022ICP	RNOV2022IC	PARNOV2022I	
NOV2022ICPAI	Pov	022ICPAR	$P_{1V2}$	Q1CPAR	NOV2022ICPA	RNOV2022ICP	RNOV2022IC	PARNOV20221	
Irish <sup>2022ICPAI</sup>	NOV2	022ICPAR	NOV2	022ICPAR	NOV2022ICPA	RNOV2022ICP	ARNOV2022IC	PARNOV2022I	
potatoes kinigi	45 0	5,000	50 0	5,400	2,250,000	2,500,000	2,430,000	2,700,000	
Casava 21CPAI	26 2	022ICPAR	NOV2 N <b>30</b> 2	022ICPAR 022ICPAR	NOV2022ICPA NOV2022ICPA	RNOV2022ICP RNOV2022ICP RNOV2022ICP	ARNOV2022IC ARNOV2022IC	PARNOV20221 PARNOV20221 PARNOV20221	
NOV2022ICPAI	RNO <b>0</b> 2	02 <b>1,000</b> R	NO <b>0</b> 2	02 <b>1,100</b> R	260,000	300,000	RN 286,000	PAR 330,000	
Sweet <sub>221CPA1</sub>	23 0	15,00 0	NOV2 N34 <sup>2</sup> 0 <sup>2</sup>	13,00 0	3,450,000	5,100,000	2,990,000	4,420,000	
NOV2022ICPAI Vam2022ICPAI NOV2022ICPAI	NOV2 N31/2	0221CPAR 0221CPAR 0221CPAR 0221 <b>500</b> R	NOV2 N322 NO02	0221CPAR 0221CPAR 0221CPAR 0221( <b>500</b> R	NOV2022ICPA NOV2022ICPA NOV1 <b>55:000</b>	RNOV2022ICP RNOV2022ICP RNOV2022ICP	ARNOV20221C ARNOV20221C ARN0V20221C	PARNOV 20221 PARNOV 20221 PARNOV 20221 PARN <b>160,000</b> 1	
Matoke	20 0	0221CPAR 0221CPAR 0221CPAR 0221CPAR	26 0	022ICPAR 022ICPAR 022ICPAR 022ICPAR 6,800	1,400,000	1,820,000	1,360,000	ARNOV20221 ARNOV20221 1,768,000	
RNOV2022ICPAE RNOV2022ICPAE RNOV2022ICPAE	NOV2	022ICPAR 022ICPAR	NOV2 NOV2	022ICPAR 022ICPAR 022ICPAR	NOV2022ICPA 7,515,000	9,880,000	7,221,000	9,378,000	

- Laspeyres Formula In/0=  $\frac{\sum P1 \cdot Q0}{\sum P0 \cdot Q0} *100$
- 2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022IC 2022ICPA Therefore, Laspeyres index  $= \frac{9,880,000}{7,515,000} * 100 = 131.47$ 2022ICPARNOV202ICPARNOV2022ICPARNOV2022ICPARNOV202ICPARNOV202ICPARNOV202ICP
- $\frac{\Sigma P1 \cdot Q1}{\Sigma P0 \cdot Q1} + \frac{2}{2} \frac{\Sigma P1 \cdot Q1}{\Sigma P0 \cdot Q1} + \frac{100}{2} \frac{100}{\Sigma P0 \cdot Q1} + \frac{100}{2} \frac{100}{\Sigma P0 \cdot Q1} + \frac{100}{2} \frac{10$

ICPARTOV

Therefore, Paasche index  $\frac{9,378,000}{7,221,000}$ \*100=129.9

ARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2020 ARNOV2022ICPARNOV20202ICPARNOV200202ICPARNOV20202ICPARNOV200202ICPARNOV20202ICPARNOV200202ICPARNOV200202ICPARNOV200202ICPARNOV200202ICPARNOV2002020CPARNOV200202ICPARNOV20020ICPARNOV20020ICPARNOV20020ICPARNOV20020ICPARNOV20020ICPARNOV20020ICPARNOV20020ICPARNOV20020ICPARNOV20020ICPARNOV200202ICPARNOV20020ICPARNOV20020ICPARNOV20020ICPARNOV20020ICPARNOV20020ICPARNOV20020ICPARNOV20020ICPARNOV20020ICPARNOV20020ICPARNOV20020ICPARNOV20020ICPARNOV20020ICPARNOV20020ICPARNOV20020ICPARNOV20020ICPARNOV20020ICPARNOV20020ICPARNOV20020ICPARNOV Fisher Ideal Formula =  $\sqrt{\frac{\Sigma P1 \cdot Q0}{\Sigma P0 \cdot Q0}} * \frac{\Sigma P1 \cdot Q1}{\Sigma P0 \cdot Q1} * 100$ Therefore, Fisher ideal index =  $\sqrt{\frac{9,880,000}{7,515,000}} * \frac{9,378,000}{7,221,000} * 100=$ 

i) Desirable properties of the base period in index number are:

 The base year should not be either too short or too long: It should not be either less than a month or more than a year for calculation purpose
 The base year should not belong to too near or too far: This means that comparison of current year's conditions with the conditions in the base year. It means if the base year is too near to the current year, then comparison fail to capture the changes. Thus, in order to conduct a meaningful comparison, the base year should not be either too far or to near to the current year
 The base year should be so selected that the data for the same should be available:

The data for a year should be available in order to regard that particular year to be the base year.
This enables one to draw conclusions, inferences and for making comparisons **4.** The base year period should be constantly updated: The base year should be constantly

updated due to the changes in taste, preferences and fashion otherwise; the comparison becomes misleading or inconclusive

2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV20 2022ICPAI<mark>F1:1</mark>22022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2020 2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2020 2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2020 2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2020 2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV2022ICPARNOV20202ICPARNOV20020