

# CERTIFIED PUBLIC ACCOUNTANT FOUNDATION LEVEL 1 EXAMINATION F1.1: BUSINESS MATHEMATICS AND QUANTITATIVE METHODS

## DATE: THURSDAY,27 APRIL 2023

## MARKING GUIDE AND MODEL ANSWERS

LogarApril2023 [cparApril2023 [cparApr

## **QUESTION ONE**

## **Marking Guide**

Kigali Ltd (KL) a) (i) Allocation on the table (1 Mark each, max 6 Optimal transportation schedule (ii) Minimum transportation cost Maximum marks b) (i) Linear programming model Stating the decision variables Describing the objective function Defining the constraints (0.5 Marks, max 1.5) **Maximum marks** (ii) Solution of the linear problem using simplex method Insertion of slack variables into the constraints Insertion of slack variables in the objective function Drawing simplex tables (1 Mark each, max 5) Decision on the number of carpets produced **Maximum marks** (iii) Application of linear programming (1 Mark each, max 2) **Total marks** 

### **Model Answers**

a) i)Vogel's Approximation Method

Step 1: Identify the two lowest costs in each row and column of the given cost matrix and then write the absolute row and column difference. These differences are called penalties.

Marks

0.5

15

I

5

0.5

0.5

Step 2: Identify the row or column with the maximum penalty and assign the corresponding cell's min (supply, demand). If two or more columns or rows have the same maximum penalty, then we can choose one among them as per our convenience.

Step 3: If the assignment in the previous satisfies the supply at the origin, delete the corresponding row. If it satisfies the demand at that destination, delete the corresponding column.

Step 4: Stop the procedure if supply at each origin is 0, i.e., every supply is exhausted, and demand at each destination is 0, i.e., every demand is satisfying. If not, repeat the above steps, i.e., from step 1.

023 IcpurApril2023	Custom	il2023 IcparApril20			
Branches	ArApril	$202^{\mathbf{B}}$ IcparAp	ril202C IcparApr	ril202 DicparApr	Availability
Musanze (M) 2023	1,300	2(_1,100Ap	12021,500 Apr	1202 <b>2,000</b> Apr	il202 <b>300</b> parApril20
Nyagatare (N) 023	1,700	1,400	ril2(21,200 rAp)	il2021,300 Apr	il202400parApril20
Huye (H)	1,800	1,800	1,500	1,200	il202200parApril20
Requirements	200	300	300	100	900 April 20

<sup>(23</sup> Icpard of i) Table 1 Calculation of penalty and first allocation

023 IcnarApril2	Customers	023 Icnar	Availability	Penalty		
Branches	A Icnar Anril?	Binner	C2023	Dur April202	3 Icnar Anril 202	Icnar Anril?
M3 Icnar April2	1,300 (200)	1,100	1,500	2,000	300/100	200
N3 Icnar April2	1,700	1,400	1,200	1,300	3 400 Anni 1202	100
H3 Icnar April2	1,800	1,800	1,500	1,200	3 200 April 202	300
Requirements	200/0	300	300	100 mil202	3 Icnar April 2023	R Icnar April 20
Penalty	400/0	300	300	100	3 Icnar April 2023	Icnar April 21

Highest penalty is 400 and Customer A are satisfied and only 100 computers remain in Branch M.

Branches	Customers	2023 IcparAp	ril2023 IcparAp	Availability	Penalty	2023 Icparz
	$\mathbf{B}^{3}$ IcparApril	2 C IcparAp	ril20 $\mathbf{\hat{D}}$ IcparAp	ril2023 IcparApril2	023 IcparApril2023 Icp	
M <sup>3</sup> IcparApril2	1,100(100)	2 1,500	2,000	ril2(2100parApril2)	400 ar April	2023 Icpar
N <sup>3</sup> IcparApril2	1,400	2 1,200	1,300	ril2 400 parApril2	2100 ar April	2023 Icpar
${ m \hat{H}^{3}}$ IcparApril2	1,800	1,500	1,200	ril20200 parApril2	300 ar April	2023 Icpar
Requirements	300/200	2 <b>300</b> parAp	ril2 <b>100</b> parAp	ril2023 IcparApril2	023 IcparApril.	2023 Icpar/
Penalty	300 par April	2 300 parAp	ril2 100 parAp	ril2023 IcparApril2	023 IcparApril	2023 Icpar

Table 2 Calculation of new penalty and Second allocation

Highest penalty is 400 for branch M. all 100 computers remain in Branch M will be sold to customer B and pending computer will be taken to other branches for the next dispatch.

Table 3 Calculation of new	penalty and	Third	allocation
Table 5 Culculation of new	penalty and	I IIII G	anocation

Branches	Customers	112025 ICPUIAJ 112022 I	Availability	Penalty	
	<b>B</b>	C	$\mathbf{D}_{11}$	12022 ICPARAPTIL2	23 IcparAprii20.
N	1400 (200)	1,200	1,300	400/200	100
$H_{22}$	1,800	1,500	1,200	200	300
Requirements	200	300	100	:12022 10par2pruz	025 10parApril 025 1
Penalty	400	300	100	12023 10pur2prii2	025 1cpurApruz 022 1

Highest penalty is 400 and Customer B are satisfied and only 200 computers remain in Branch N.

023 IcparApril F1.1 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 Ic Page 3 of 20 IcparApril2

Branches	Customers	2 ToparApril2023	Availability	Penalty	
	С	2 L <b>D</b>	Tepanapril2025 IcparA		
N <sub>2</sub> I mar (mil)	1200(200)	1,300	200	100	
$H_{2}$ Ionar (mill)	1,500	1,200	200	300	
Requirements	300/200	100	Topantpruzozo Topant Topantpruzozo Topant	pri2025 TeparApril null2022 Ionau (nuil)	
Penalty	300	100	Iopanipi n2025 Iopani Iopanipi n2025 Iopani	prizzozo zoparzipriiz nu 12022 Ionau (nui)	

Table 4 Calculation of new penalty and fourth allocation

Highest penalty is 300 for branch H and Customer C so it is up to candidate to choose where to start. For this let us start with penalty for customer. all 200 computers remain in Branch N will be sold to customer C and pending computer will be taken to other branches for the next dispatch.

Table 5 Calculation of new penalty and fifth allocation

Branches pril20	Customers	023 IcparApril2023 Icp	Availability A	Penalty and pril20	
	CcparApril2	023 Icp <b>D</b> rApril2023 Icp	par April 2023 Icpar A	pril2023 IcparApril20.	
H23 IcparApril20	1,500 April2	023 [ 1,200 (100) [cr	ar 4 <b>200</b> 2023 IcparA	pril3003 IcparApril20.	
Requirements	100 ar April2	023 Icp <b>100</b> pril2023 Icp	oar April 2023 IcparA	pr 12023 IcparApril20.	

## Table 6 Calculation of new penalty and fifth allocation

023 TeparAprii2023 TeparAp	Customers	Availability
Branches	vil2023 Icon April2023 IcparA	pril202) IcparApril2023 IcparApril20 pril2022 IcparApril2022 IcparApril20
H <sup>23</sup> IcparApril2023 IcparAp	1,500 (100)	nri1202 100 Anri12023 Jonar Anri120
Requirements	ril2023 Ico 100 pril2023 IcparA	pril2023 IcparApril2023 IcparApril2(

The optimal transportation schedule is that Muhanga branch supplies customer A and B, Nyagatare supplies customers B and C while Huye supplies customers C and D

ii) Minimum transportation cost = (200\*1,300) + (100\*1,100) + (200\*1,400) + (200\*1)+(100\*1,500) + (100\*1,200) = FRW 1,160,000Б)23 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2

- i) Linear programming problem for BL
- Decision variables: Let x represent the number of carpets of X type and y be the number of carpets of Y type
- Objective function: The objective is maximizing profi Profit (P) = 4,000 x + 6,000 y (in FRW)
- Constraint:

F1.1

Subject to:  $10x + 16y \le 6,000$  Material constraint – wool

 $10x + 8y \le 3,600$  (60 minutes\*60 hours) Labor constraint

$$x \ge 0$$
,  $y \ge 0$  Non – negativity constraint

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ii) Solution of linear programming problem using simplex method

Insertion of slack variables in the constraints and objective function parap

 $10x + 16y + 1S_1 = 6,000$  Material constraint

 $10x + 8y + 1S_2 = 3,600$  Material constraint

 $P - 4,000x - 6,000y + 0S_1 + 0S_2 = 0$ 

Initial simplex tableau ar April 2023 Icpar April 2023 Ic

023 Icp	arApr <mark>X</mark> 2023 Icpar.	Y $12023$ $1cp$	$S_1^{il2023}$	$S_2$ pril2	$^{023}$ [ParAp]	Solution
S <sub>1</sub>	arApr <mark>10</mark> 2023 Icpar.	16 <sup>2023</sup> Icp	parApril2023	Icp 0 April 2	023 [ <b>0</b> arAp	6,000
$S_2$	arApy10 <sup>023</sup> Icpar	18112023 Icp	00000000000000000000000000000000000000	IcparApril2	023 <b>0</b> arAp	3,600
P <sup>3</sup> Icp	-4,000	-6,000	$a_0$ ril2023	Icp @April2	023 [qparAp	ril20201cparAp

Taking the most negative value in the last row of the initial table, we find the pivot number as is 16 since 6000/16 = 375 and 3600/8 = 450. We therefore take the smaller value which is 375.

Table 2. Divide all the elements in the first row by 16 because it is the pivot number

2023 Icpa	Xril2023 Io	pYApril2023	SparApril20	$2S_2$ cparA	pr <b>P</b> 2023 Ic	Solution	cparApril.
( <b>Y</b> 3 Icpa	0.625 23 1	phrApril2023	0.0625	20 IcparA	02023 Ic	o375pril2023 I	$R_1/16$
S <sub>2</sub> Icpa	A0 il2023 Id	p8rApril2023	0parApril20	21 IcparA	02023 Id	3,600 2023	cparApril.
P.B. Icpa	-4,000	- 6,000	0parApril20	20 IcparA	pr <b>1</b> /2023 Ic	0 <b>rApril2023</b>	cparApril.

Under table 3, make all the elements below 1 in the Y column to be zero using row elementary operation

023 10	X	Y	$S_1^{(202)}$	<b>S</b> <sub>2</sub>	P	Solution	mu2023 IcparApr
Y	0.625	o IoparApri	0.0625	0	0	375	mizuza icparApr
<b>S</b> <sub>2</sub>	par 5 1202.	0	-0.5	1207310	0	600	$-8R_{1}+R_{2}$
P	- 250	0	375	0	parapr	2,250,000	$6,000R_1 + R_3$

Under table 4, start again with the most negative number in the last row and look for the pivot number which will be 5. This is because 600/5=120 and 375/0.625=600

023 Ic	$\mathbf{x}_{ril202}$	YrAnn	12023StnarAnr	S <sub>2</sub>	P	Solution	nil2023 IcparApril2
Y	0.625	In Inter	0.0625	12 0 3 1	0	375	nil2023 IcnarApril2
X	nar Inril2023	0	12023-0.1rAm	i12013 In	0	120 mar A	R <sub>2</sub> /5
Par	- 250	0	375	12 0 3 1	nalin	2,250,000	nil2023 IcnarApril2

Under table 5, make all the elements above and below 1 in the X column to be zero other

023 Ic	X	Y	S1-12023	S2 mil2023	P	Solution	ril2023 Icnar April2
Y	no Onril	202 R Ter	0.125	0.5 12023	0	300	$-0.625R_2+R_1$
X	nor Inril	0	-0.1023	0.2	0	120	vil2023 Icnar April2
Par	0	0.1	350 2023	50	Innerline	2,280,000	$250R_2 + R_3$

cparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparA cparApril2023 IcparApril2023 IcparApril2023

023 IcparApril F1.1 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 I

Decision: 120 carpets of X and 300 carpets of Y should be produced to maximize a profit of FRW 2,280,000.

iii)Areas of application linear programing

- Budgeting: Linear programming is useful in budgeting. When there is more than one scarce resource, linear programming can be used to identify the most profitable use of resources.
- Farming: Farmers use linear programming to increase the revenue of their operations, like what to grow, how much of it, and what to use it for.
- The Manufacturing Industry: Many other industries rely on linear programming to enhance the economy of their business.
- Capital budgeting: Linear programming can be used to determine the combination of investment proposals that should be selected if investment funds are restricted in more than one period.

And any other related application not stated may be considered

## QUESTION TWO Marking Guide

a) (i) Definition of sampling techniques ((1 Mark each, max 2)

(ii) Advantages and disadvantages of stratified sampling Advantages (1 Mark each, max 2)
Disadvantages (1 Mark each, max 2)
Maximum marks

b) (i) Frequency distribution Table
Cumulative frequency (0.5 marks each value, max 3)
Class boundary (0.5 marks each class, max 3)
Class mid-point (0.5 marks each value, max 3)
Maximum marks

(ii) Calculation of  $\Sigma f$  and  $\Sigma f x$  (0.5 mark each, n Formula for mean Computation of mean (iii) Formula for median Showing median class Computation of median **Maximum marks Total marks** 

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05

0.5

0.5

15

5

#### Model Answers

### a) i) Differentiation of stratified and systematic sampling techniques

Stratified sampling technique is a sampling technique applied to a heterogeneous (having groups with varied attributes) population that can be subdivided into homogeneous groups known as strata. Stratified sampling involves obtaining simple samples from each of the strata of the population and the simple samples combined to give the stratified sample of the population. This ensures that each homogeneous segment of the population is proportionally represented in the sample

While Systematic sampling is a technique used when the population is listed in a given order or some of it is physically in evidence, for example, a row of houses or clients visiting a particular webpage in one hour on a given day.

The sample is drawn according to some predetermined point (place/object) chosen at random, and then systematically sample the nth item in the population, the number n chosen depending on the size of the sample required.

For a population of 100 items, if a sample of five items is required the n becomes 20, that is, the 20th, 40th, 60th, 80th and 100th items form the sample.

## ii) Advantages and disadvantages of stratified sampling techniques Advantages of systematic sampling

- It is easy to implement.
- Works where there is no sampling frame as long as the items are physically in evidence.
- Saves time and is not costly.

#### Disadvantages of systematic sampling

- Bias may occur where recurring sets in a population are possible.
- This sampling technique is not perfectly random. Once the starting point has been determined, all the subjects are predetermined.
- b)

## i) Raw data

18 20	20 <sup>ml</sup> 20	19 <sup>par</sup>	$^{Ap}21^{023}$	35 <sup>Apr</sup>	$\frac{120}{27}$ <i>Icp</i>	36	40	pr 2025	$1cpa37^{pn12}$
25 3 10	$21^{21}$	28	42	<sup>1</sup> C <sup>30</sup> <sup>4</sup> <i>p</i> <sup>1</sup>	<sup>1120</sup> 31 <sup>1cp</sup>	$28^{120}$	23 26arA	33	180712
36	$26^{rn}$	<sup>22</sup> 21 <sup>par</sup>	Apr <b>30</b> 023	<sup>1</sup> <i>C</i> <sup>2</sup> 21 <sup><i>A</i></sup> <sup>2</sup> 1	12030 <sup>1</sup> <i>cp</i>	$ar^{4}24^{l20}$	23 22 <sup>ar</sup> A	$pril_{23}^{23}$	1cpa19pril20
32 5 10	$23^{rn}$	20	A 36	10p26Apr	<sup>112</sup> 037 <sup>1cp</sup>	$ar^{4}25^{1120}$	20 20	22	(cpa <sub>25</sub> pril2)
30 3 10	$23^{m20}$	$^{23}26^{par}$	45	28 28	$\frac{12027}{27}$ icp	ana 30''.20	23 <b>27</b> <i>arA</i>	<sup>pr</sup> 29 <sup>23</sup>	$1cpa_{27}^{pril_2}$
26 5 10	$24^{rn120}$	$^{12}325^{par}$	$^{Ap}21^{023}$	39	$\frac{12026}{26}$ lcp	<sup>ard</sup> 28 <sup>120</sup>	<sup>23</sup> 30 <sup>arA</sup>	pr 2823	$100^{a}30^{on120}$
27 3 10	28 <sup>mi20</sup>	36	$^{Apr}24^{023}$	10p26Apr	$\frac{12}{21}$ 21 $\frac{1cp}{21}$	$21^{arA}21^{arZ}$	$\frac{125}{25}$	pr 3723	330712
21	20 20	34	AP 33 23	<sup>1</sup> C <sup>2</sup> 30 <sup>A</sup> P <sup>1</sup>	<sup>112</sup> 029 <sup>1</sup> cp	28 28	20	$pr_{23}^{23}$	$1cpa_{24}^{24}$ pril20

Page

Class limits	Frequency (F)	Class boundaries	Class mid- point (x)	Cumulative Frequency (CF)	FX
18-22	20	17.5 - 22.5	20	20 <sup>23</sup> 1000000000000000000000000000000000000	400
23 - 27	25	22.5 - 27.5	25	45 45	625
28-32	19	27.5 - 32.5	30	64 64	570
33 – 37	12	32.5 - 37.5	35	76	420
38-42	3	37.5 - 42.5	40	79	120
43 - 47	12025 IeparA	42.5 - 47.5	45	80	45
2025 IcparApi	$\Sigma f = 80$	pruzoz3 icpai	April2025 IcparAp	ruzozo icparApruz	$\Sigma f x = 2180$

Frequency Distribution Table

ii) Mean age

Mean  $=\frac{\Sigma f x}{\Sigma f} = \frac{2180}{80} = 27.2$ 

iii) Median age

Median =L +  $\left(\frac{\frac{N}{2} - CFbmc}{Fmc}\right) \times c$ 

L is lower class boundary of median class, L = 22.5

CFbm, cumulative frequency before median class, = 20 Fmc, frequency of median class, = 25,

C, class interval, = 5. N, the total frequency, = 80

Median =  $22.5 + \left(\frac{\frac{80}{2} - 20}{25}\right) \times$ 

Median =  $22.5 + \left(\frac{20}{25}\right)$ Median = 26.5

## **QUESTION THREE**

## **Marking Guide**

a) (i) Branches of the decision tree (0.5 marks each, max 3)Labels on the branches (0.5 marks each, max 3)Maximum marks

(ii) Expected Monetary Value
Expected monetary value of buying new buses
Expected monetary value of sub contraction
Maximum marks
(iii) Advice on the right decision to make

b) i) Decision under maximax criterion

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IcparApril23

Marks

3

3

4pril2023 Ic

ril20

ii) Computation of Laplace payoffs (1 Mark each, max 3) Decision about Laplace criterion **Maximum marks** iii) Minimax criterion Calculation regret for favorable condition (0.5 Marks each) Calculation regret for stable condition (0.5 Marks each) pril2023 IcparApril2023 Icpar Calculation regret for unfavorable condition (0.5 Marks each) Decision under Minimax criterion CoarApril2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 arApril2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2 Maximum marks **Total marks** 

## **Model Answers**

a) i) Decision tree

## **Decision Tree**

Probability

0.30 450 million

## Payoff (FRW"000")

4pril2023 IcparApril202

April23

April202

pril242

1.5

15 0.5

20

4 pri 1.5

High Demand	0.70	800 millio	on
	arApril2073 Id		
	arApril/023 Id		
cparApril2023 Icp cparApril2023 Icp		w Demand 0	.30
cparApril2023 cparApril202 Buy	new buses		

FRW 500 million

Subcontract

0

F1.1

Let I a set I a			
FRW 150 million	High Demand	0.70	

Low Demand

0.30

2

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602 million

380 million

## ii) Expected Monetary Value (EMV)

Buy new bus: EMV = [(0.7\*800 M) + (0.3\*450 M)]

= FRW 560 M + FRW 135 M = FRW 695 M.

EMV after subtracting initial cost = FRW 695 M - FRW 500 M = FRW 195 M

Sub contraction: EMV = [(0.7\*602M) + (0.3\*380M)]

= FRW 421.4M + FRW 114M = FRW 535.4M

EMV after subtracting initial cost = FRW 535.4M - FRW 150M = FRW 385.4M

iii) The right decision to make is to choose the second possibility of sub contraction

b)?3 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 Icpar

023 Iopar April 2023 Iop	Market Con	nditions	art neil2023 Tonart neil20	
Alternative projects	Favorable	Stable	Unfavorable Maximum payoffs	Maximum payoffs
A <sub>2</sub> Longer Appril 2022 Long	71	60	46	71
$\mathbf{B}_{2}$ Ionar April 2023 Ion	67	54	41	67
$C_{2}$ Longer Aprel 2023 Lop	76	65	51	76

i) 2 Maximax criterion arApril2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023

Decision under Maximax is to choose project C because it has the maximum of the maximum payoff of FRW76 million

## ii) Laplace criterion

Project A; Payoff P = (71 + 60 + 46)/3 = 177/3 = FRW 59 million

Project B; Payoff P = (67 + 54 + 41)/3 = 162/3 = FRW 54 million

Project C; Payoff P = (76 + 65 + 51)/3 = 192/3 = FRW 64 million

Decision under Laplace is to choose project C because it has the highest payoff of FRW64 million

## iii)Minimax criterion

Regret table

023 IcparApril2023 Icp	Market Cor	nditions <sup>2023</sup>	IcparApril2023 IcparA	pril2023 IcparApril2(
Alternative projects	Favorable	Stable 223	Unfavorable Com	Maximum regrets
A3 IcparApril2023 Icp	a16>ril2023 Id	p.0:April2023	I5parApril2023 IcparA	p162023 IcparApril2(
B3 IcparApril2023 Icp	a <b>9</b> 1pril2023 Id	pd <b>7</b> 1pril2023	IloarApril2023 Icparz	pl72023 IcparApril2
C3 IcparApril2023 Icp	01pril2023 Id	p.6 April 2023	10parApril2023 Icpar	6il2023 IcparApril2

Decision under minimax is to choose project C because it has the minimum of the maximum

## regret of FRW6 million

023 IcparApril F1.1 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 IPage 10 of 20

## **QUESTION FOUR Marking Guide**

a) Statement of the hypotheses (0.5 Marks each, max 1) Computation of expected frequencies (0.5 Marks each, max 3)

2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 Computation of  $(0-E)^2$  /E (1 Mark each, max 6) April 2023 (cparApril 2023 ( Calculated  $\gamma^2$  il2023 IcparApril2023 IcparApril2

Tabulated  $\gamma^2$  (reading from the table) ril2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparApr

Conclusion

**Maximum marks** 

IcparApril2023 IcparApril2023 IcparApril2023 IcparApril20 b) Statement of the hypotheses (0.5 Marks each, max 1) Finding the critical value of t from the t table 2023 IcparApril2023 IcparApril2023 IcparApril 1023 Calculation of the standardized value of the Conclusion pril2023 Icpar April2023 Icpar April2023 Icpar April2023 Icpar April2023 Icpar April2023 Icpar April2023 Maximum marks<sup>3</sup> IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril 5)23 Icpar

c) Applications of Poisson distribution (1 Mark each, max 3) 3 **Total marks** 

## Model Answers

(a) <sup>23</sup> IcparApril2023 Icp 2023 IcparApril2023 Icp					
Level nar April 2023 Ic	Male	Female	Total		
Foundation 12023 Te	parApril (120 cparApri	12023 I 140 pril2023 I	parA 260 23 IcparApril20		
Intermediate 12023 Ic	parApril 90 IcparApri	12023 Ic <mark>1101pril2023</mark> Id	cparAp 200 23 IcparApril20.		
Advanced	parApril 60 IcparApri	12023 1 80 April2023 Id	cparAp 140 23 IcparApril20.		
Total par April 2023 Ici	parApril 270 cparApri	12023 1 330 pril2023 10	cparAp <mark>600</mark> 23 IcparApril20.		

## Solution: April2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 Icpar

023 IcparApril **F1.1** 

H<sub>0</sub>: there is no difference between male and female in passing CPA exams H<sub>1</sub>: there is a difference between male and female in passing CPA exams

Calculation of expected frequencies (E)

$$E_{11} = \frac{R_1 C_1}{n} = \frac{260 \times 270}{600} = 117$$

$$E_{12} = \frac{R_1 C_2}{n} = \frac{260 \times 330}{600} = 143$$

$$E_{21} = \frac{R_2 C_1}{n} = \frac{200 \times 270}{600} = 90$$

$$E_{22} = \frac{R_2 C_2}{n} = \frac{200 \times 330}{600} = 110$$

$$E_{31} = \frac{R_3 C_1}{n} = \frac{140 \times 270}{600} = 63$$

arApril2023 IcparApril2023 IcparApril2023 IcparApril2023 IPage 11 of 20

Marks

0.5

rilzo

April 2023

20

IcparApril2023 IcparApril202

2023 IcparApril2023 IcparApril202

	$R_3C_2$	$140 \times 330$	pril20.
32 =	n n	600	= 77

$\chi^2 = \sum \frac{(O-E)^2}{E}$			
Observed values (O)	Expected Frequency	$(0-E)^2$	$(0-E)^{2}/E$
120 IcparApril2023 Icp	d117ril2023 IcparApril202	9 IcparApril2023 Icpa	0.077 023 Icpar April20
2140 IcparApril2023 Icp	a143ril2023 IeparApril202	9IcparApril2023 Icpa	0.063 023 IcparApril20
903 IcparApril2023 Icp	c90pril2023 IcparApril202	0IcparApril2023 Icpa	0pril2023 IcparApril20
110 IcparApril2023 Icp	al10ril2023 IcparApril202	0IcparApril2023 Icpa	0pril2023 IcparApril20.
60 3 IcparApril2023 Icp	63pril2023 IeparApril202	9IcparApril2023 Icpa	0.143 023 Icpar April 20
80 3 IcparApril2023 Icp	a77 pril2023 IcparApril202	9IcparApril2023 Icpa	0.117 023 IcparApril20
2023 IcparApril2023 Icp	arApril2023 IcparApril202	3 IcparApril2023 Icpa	$\sum \frac{(O-E)^2}{E} = 0.4$

Calculated  $\chi^2 = 0.4$ 

Df = (r-1)(c-1) = (3-1)(2-1) = 2

il2023 IcparAprilE

Df is degree of freedom

R is number of row

C is number of column

Tabulated  $\chi^2_{(0.05)} = 5.99$ 

Since calculated  $\chi^2$  < tabulated  $\chi^2_{(0.05)}$ , H<sub>0</sub> is accepted 0.4< 5.99 **Conclusion:** There is no difference between male and female in passing CPA exams pass rate is independent of gender.

b) 1. Statement of hypotheses 2023 [cparApril2023]

F1.1

Null hypothesis,  $H_0$ :  $\mu$  (mean weight) = 3.5 kgs

Alternative hypothesis, H<sub>A</sub>: µ (mean weight) < 3.5 kgs r April 2023 Icpar April 2023 Icpa

2. The level of significance is 1% and critical value of one tailed test under degree of freedom (n-1) of 24 is 2.492. Critical value of t is 2.492

3. The standardizes value of the sample mean is

Sample mean,  $\bar{x} = 3.0$ kgs, standard deviation, s = 0.5 kgs sample size, n = 25, Population mean,  $\mu = 3.5$  kgs

$$t = \left| \frac{\overline{x} - \mu}{\frac{s}{\sqrt{n}}} \right| = \left| \frac{3.5 - 3.0}{\frac{0.5}{\sqrt{25}}} \right| = 5.$$
 Standardized value of t is 5

6. Conclusion: Since the standardized value of 5 is greater than the critical value of 2.492, we accept the null hypothesis but reject the alternative hypothesis at 1% level of significance. This means that babies are born with weight of 3.5 kgs and therefore the belief that babies are with the weight of 3.5 kgs is true in Mahoro Cell

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	Price	Quantit	Price	Quantit	P0Q0	P1Q1	P1Q0	P0Q1
2023 Icpa	2020 23	IcparApril20	2022	12023 Icpa	April202	3 IcparAp	ril2023 Icp	arApril2023
Model A	Answers 23 arApril2023							
Total m	arks							20 <sup>23</sup>
Maxim	im marks	cparApril2	023 IcparApri	12023 Icpa	April202	3 IcparAp		arApril <b>5</b> 023
ii) Interp	lems of cons	wark each,	(IIIax 2) lex numbers (	1 Mark ea	ch max 3	3 IcparAp		arApril 2023
2023 Icpa 2:1) Tutoma	trApril2023	CparApril2	)23 IcparApri )23 IcparApri					arApril2023 arApril <b>3</b> 023
Maxim	ım marks							arApri15)23
computa	tion) 12023	IcparApril2(	)23 IcparApri					arApril2023
Marshal	l Edge Woi	rth's price	index (0.5 ]	Marks for	formula	and 0.5	Marks fo	arApril2023 tarApril2023
Paasche	's price inde	x (0.5 Mark	s for formula	and 0.5 M	arks for c	computatio	on) 023 Icr	arApril 2023
Laspeyr	e's price ind	ex (0.5 Mar	ks for formul	a and 0.5 N	Aarks for	computat	ion) 23 Ict 12023 Ict	oarApril2023 0arApril2023
i) Comp	utation of wo	eighted indi	ces in the tab	le (0.5 mai	ks each, 1	max 12)		12 arApril2023
Markin	g guide							oarApril2023
QUESI								Mark
OUEST								
- It is a	lso used in c	lueuing theo	ory IcparApri					
found	l in a lot	cparApril2(	)23 IcparApri	12023 Icpa	April202	3 IcparAp	il2023 Icp	arApril2023
- Printi - Ouali	ng mistakes	in a page of	I a book of manufact	12023 Icpai uring indu	April202: stries to 2	3 IcparApi	number o	arApril2023 f. defects
- Insur	ance claims	made to a co	ompany in a	given time.				
- Accio	lents in a fac	tory in one	week.	12023 Icpa 12023 Icpa				
- Telep	hone calls n	nade to a sw	vitch board in	a given mi	inute.			
- Car a	ccidents on a	a particular	road in one d	12023 Icpa ay.				
c) Appli	cation of Po	isson distril	oution in anal	ysis of Poi	sson even	nts <i>cparAp</i>		

	il2023 Icpar	Kg - <b>P</b> 0	- Q0	2-P1parApri	- Q1	Spril2023	jcparApr	1))023 Icp	a)April20.
	Sugar	1,000	600	1,200	500	600	600	720	500
	Rice	1,500	100	1,700	150	150	255	120 170	225
	Salt Icpar	20020231	ap160 pril2	250 parApri	200 Icpa	April 32	Icpa 50	1202.40p	arApr400
	Beans	600 2023	350 pril2	800 par Apri	460	210	368	280	276
	Potatoes	250	420	400	500	105	200	168	125
023 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 Icp						1,097	1,473	1,378	1,166

023 IcparApril F1.1 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 I Page 13 of 20 IcparApril2

## Laspeyre's price index

Laspeyre's price index  $=\frac{\sum P_1 Q_0}{\sum P_0 Q_0} \times 100 = \frac{1,378,000}{1,097,000} \times 100 = 125.62$ 

## Paasche's price index

Paasche's price index =  $\frac{\sum P_1 Q_1}{\sum P_0 Q_1} \times 100 = \frac{1,473,000}{1,166,000} \times 100 = 126.33$ 

#### Marshall Edge Worth's price index

Marshall Edge Worth's price index  $=\frac{\sum P_1 Q_0 + \sum P_1 Q_1}{\sum P_0 Q_0 + \sum P_0 Q_1} \times 100 = \frac{1,378,000 + 1,473,000}{1,097,000 + 1,166,000} \times 100 = 125.98$ 

### ii) Interpretation

For Laspyere's price index: There was an increase of 25.62 % for the basket of commodities from 2020 to 2022.

For Paasche's price index: There was an increase of 26.33 % for the basket of commodities from 2020 to 2022

For Marshall Edge Worth's price index: There was an increase of 25.98 % for the basket of commodities from 2020 to 2022

## iii) Problems of constructing index numbers:

### 1. It is not possible to make comparisons between different locations:

Even if various locations within a country are chosen, the same index number cannot be assigned to them. This is due to variances in people's consumption habits. Individuals in the northern part of country consume different commodities than people in the southern portion of same country.

## 2. Not Appropriate to Individuals:

An index number is not applicable to a single person who is a member of the group it was created. A person may not be affected if there is a rise in the price level index number shows. This is since an index number reflects averages.

### 3. Difficulty in Choosing a Statistical Approach:

Another challenge is deciding on a suitable approach for calculating averages. However, each strategy produces a unique set of findings. As a result, deciding which strategy to use is challenging.

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### 4. Difficulties Resulting from Changes Over Time:

In today's world, changes in commodities occur on a continuous basis because of technological advancements. So, consumers begin to consume them, and instead of the old, new commodities are introduced. Furthermore, commodity prices may fluctuate because of technological advancements. They might fall. However, when calculating the index numbers, new commodities are not added to the list of commodities. As a result, the index figures based on ancient commodities are unreal.

## QUESTION SIX Marking guide

a) i) Derivative of revenue function Second derivative of revenue function Total revenue at the given point **Maximum marks** ii) Deriving Marginal cost function First derivative of marginal cost function Second derivative of marginal cost function Marginal cost at minimum level **Maximum marks** iii) Deriving the profit function First derivative of profit function at each step (0.5 Marks each, max 3.0) Second derivative of profit function at each step (0.5 Marks each, max 2.0) Maximum profit **Maximum marks** b) i) Finding the profit function ii) Calculation of break - even point Interpretation of break – even points iii) Computation of number of shoes and maximum 1 Mark for Formula and 1 Mark for computation **Total marks** 

2

## Model Answers

a) i) Output when revenue is maximum Revenue function  $R(x) = 21x - x^2$ Revenue is maximum at the second derivati  $\frac{dR(x)}{dx} = \frac{d(21x - x^2)}{dx} = 21 - 2x$   $\frac{dR(x)}{dx} = 0, 21 - 2x = 0$  x = 21/2 = 10.5

F1.1

Find the second derivative for confirmation of the sign

 $\frac{d^2 R(x)}{dx^2} = \frac{d^2(21 - 2x)}{x^2} = -2$ 

 $\frac{d^2 R(x)}{dx^2} < 0$ , therefore revenue is maximum at this point Total revenue at this point

The output that maximizes revenue is x = 10.5. It is this x = 10.5 that is substituted into the

revenue function to find the total revenue

Revenue function  $R(x) = 21x - x^2$ 

Revenue function  $R(x) = 21(10.5) - (10.5)^2 = 220.5 - 110.25 = FRW 110.25$  million

ii) Marginal Cost at a minimum level

Total cost function C = 
$$\frac{x^3}{3} - 3x^2 + 9x + 16$$

First find marginal cost from the derivative of total cost function

 $\frac{dC(x)}{dx} = \frac{d(\frac{x^3}{3} - 3x^2 + 9x + 16)}{dx} = x^2 - 6x + 9$ 

Marginal cost MC =  $x^2 - 6x + 9$ 

Find the first derivative of marginal cost to get the output that maximizes MC  $\frac{dMC(x)}{dx} = \frac{d(x^2 - 6x + 9)}{dx} = 2x - 6$   $\frac{dMC(x)}{dx} = 0, 2x - 6 = 0. x = 3$ 

Then find the second derivative of MC to check for the sign. If it is found to be positive then MC is minimum  $d^{2}MC(x) = d^{2}(2x-6)$ 

m at this point

 $\frac{d^2 MC(x)}{dx^2} = \frac{d^2(2x-6)}{x^2} = 2$  $\frac{d^2 MC(x)}{dx^2} > 0, \text{ therefore MC is minimum}$ 

Marginal cost MC(x) =  $x^2 - 6x + 9$ Marginal Cost when x =3. MC =  $(3)^2 - 6(3) + 9$ 

## The Marginal cost at minimum level is 0

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iii) Output that maximizes profit Profit function (P) = Total Revenue (R) – Total Profit function (P) =  $(21x - x^2) - (\frac{x^3}{3} - 3x^2 + 9x + 16)$ Profit function (P) =  $-\frac{x^3}{3} + 2x^2 + 12x - 16$ Find the first derivative of profit  $\frac{dP(x)}{dx} = \frac{d(-\frac{x^3}{3} + 2x^2 + 12x - 16)}{dx}$ 12  $\frac{dP(x)}{dx} = 0, -x^2 + 4x + 12 = 0$  $x^2 - 4x - 12 = 0$  $x^2 - 6x + 2x - 12 = 0$ x(x-6) + 2(x-6) = 0(x-6) = 0 or (x+2) = 0x = 6 or x - 2Proceed to find the second der  $\frac{d^2 P(x)}{dx^2} =$  $\frac{d^2(-x^2+4x)}{x^2}$  $\frac{d^2P(x)}{dx^2} = -2x + 4$ At x = 6,  $\frac{d^2 P(x)}{dx^2} = -(2 \times 6) + 4$ At x = -2,  $\frac{d^2 P(x)}{dx^2} = -(2 \times -2) + 4 = 8 > 0$ Therefore, profit is maximum at x = 6Then compute the maximum profit using the ou Profit function (P) =  $-\frac{x^3}{3} + 2x^2 + 12x - 16$ Profit (P) =  $-\frac{(6)^3}{3} + 2(6)^2 + (12 * 6) - 16 = 56$ **Maximum Profit = FRW 56 million** b) i) Profit function Profit = Total Revenue - Total Cost Profit = [(30 - 2x)x] - [2x + 26]Profit =  $30x - 2x^2 - 2x - 26$ Profit function =  $28x - 2x^2 - 26$  for  $0 \le x \le 1$ 

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F1.1/c

ii) Break even points and interpretation Break-even point is obtained when profit is 0  $28x - 2x^2 - 26 = 0$  divide through by 2  $14x - x^2 - 13 = 0$  rearranging to find the values of x  $x^2 - 14x + 13 = 0$  by factorization  $x^2 - x - 13x + 13 = 0$ x(x - 1) - 13(x - 1) = 0. (x - 1) = 0 or (x - 13) = 0x = 1 or x = 13

## The break – even points are at x = 1 and x = 13

Interpretation: The firm should produce between one 1 or 13 shoes to break - even iii) Number of shoes which need to be sold in order to maximize profit

We can find the first and second derivatives of the profit function or use the vertex formula since the profit function is a quadratic equation

Marks

6

0.5

0.5

i120

2

Profit =28x - 2x<sup>2</sup> - 26  

$$y = ax^{2} + bx + c$$
  
 $V\left(-\frac{b}{2a}, -\frac{\Delta}{4a}\right)$  where  $\Delta = b^{2} - 4ac$ , V is vertex,  $a = -2$ ,  $b = 28$  and  $c = -26$   
 $V\left(-\frac{28}{2(-2)}, -\frac{28^{2}-4*(-2)*(-26)}{4*(-2)}\right)$   
 $V(7, 72)$ 

7 shoes are needed to maximize a profit of FRW 72,000

## QUESTION SEVEN Marking Guide

a) Computation expected duration (0.5 Marks each, max 6) b) Construction of each activity (0.5 Marks each, max 6) c) Identification of the critical path d) Calculation of the variance of each critical activity (0.5 Marks each, max 3) Calculation of total variance Calculation of standard deviation e) Computation of probability of completion Formula Computation **Total marks Total marks F1.1** 

## Model Answer

## 023 IcparApril a) Expected time 23 IcparApril 2023 IcparApril 2023

Activity	Optimistic	Most	Pessimistic	Expected Tme (in	Variance		
2023 Icpar.	Time (in	Likely	Time (in	days) -	(in days) $\sigma 2$		
	days) Icpor A	Time (in	days) <sup>2023</sup> Icpo	Te=(to+4tm+tp)/6	$= \int (tp^{-12})$		
	April2023 IcparAp	days)	arApril2023 Icpa	April2023 IcparApril202.	$to)/6]^2$		
(1 – 2)	212023 IcparA	4.2023 Icp	6	4 4 4 4 4 4 4 7 7 7 7 7 7 7 7 7 7 7 7 7	0.444		
(2-3)	April2023 Icparty	2 2023 In	$a^{3}Anril2023$ Icpa	r <sup>2</sup> nril2023 Icnar April202	l IcnarAnril2(		
(2 - 4)	Apr 12023 IcparA	32023 Ict	a 5 April 2023 Icpa	.3 pril2023 IcparApril202	0.444		
(3 – 5)	Api <mark>3</mark> 12023 IcparAj	r42023 Icp	a5April2023 Icpa	r4pril2023 IcparApril202.	IcparApril2(		
(4 – 5)	Api <mark>2</mark> 12023 IcparAp	r32023 Icp	a4April2023 Icpa	r.3pril2023 IcparApril202.	IcparApril20		
(4-6)	Apr <u>3</u> l2023 IcparAp	r <b>5</b> 2023 Icp	a <b>7</b> 4pril2023 Icpa	r. <b>5</b> pril2023 IcparApril202.	0.444		
(5-7)	Apr <mark>4</mark> 12023 IcparAp	r52023 Icp	6 <sup>4</sup> <i>pril2023 lcpa</i>	r5pril2023 IcparApril202	IcparApril20		
(6-7)	6	7,2023 ICP	8	7 April2023 IcparApril202.	0.111		
(7-8)	212023 IcparA	4	6	4 4 4 4 12023 IoparApril202	l IcparAprii20 1 IcparApril20		
(7 – 9)	An 512023 JenarA	62023 10	a7April2023 Icpo	r6 <sub>nril2023</sub> IcnarApril202	0.111		
(8 – 10)	Apr 12023 IcparA	22023 Ict	a <sup>3</sup> April2023 Icpa	r. 2pril2023 IcparApril202.	IcparApril2(		
(9 - 10)	Api <mark>3</mark> 12023 IcparAj	r52023 Icp	a <b>7</b> April2023 Icpa	r.5pril2023 IcparApril202.	0.444 pril20		
SumIcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril202							

5

-12073

6

5

b) Network diagram

2cparApril2 Icp4rApril2

2

023 IcparApril202**4** IcparApril2023 IcparApr

1

023 IcparApril2023 Bpa

April2023 Icpar April2 Icpar April2 Icpar

> px Ap par X 23 Icpar Ap

8

9

| 10



3

4

023 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2

1 - 2 - 4 - 6 - 7 - 8 - 10 Duration: 4 + 3 + 5 + 7 + 4 + 2 = 25 weeks

2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparA

1-2-4-6-7-9-10 Duration: 4+3+5+7+6+5=30 weeks Critical path

023 IcparApril F1.1 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 I Page 19 of 20 IcparApril2

3 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparAp 3 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparApril2023 IcparAp 3 IcparApril2023 d) Variance and standard deviation

Variance = 0.44+0.44+0.44+0.44+0.11+0.11 = 1.98Standard deviation =  $\sqrt{1.98} = 1.41$ 

e) Probability of completing the project within 28 weeks or less

 $Z = \frac{Ts - Te}{\sigma}$  Z is the z score for finding the probability in question

Ts is the scheduled project duration

END OF M

Te is expected time/critical path duration

$$P(Z \le \frac{28 - 30}{1.41}) = -1.42)$$

Reading from the table the P-value of z = -1.42 is 0.0778  $\approx$ 7.78%.

Page 20 F1.1

DE AND MODEL ANSWER

023 IeparApril2023 Iepar