CERTIFIED PUBLIC ACCOUNTANT

FOUNDATION LEVEL 1 EXAMINATION

F1.1: BUSINESS MATHEMATICS AND QUANTITATIVE METHODS

DATE: THURSDAY, 26 AUGUST 2021

MODEL ANSWER AND MARKING GUIDE

QUESTION ONE

Marking Guide	**Marks**
(A) Pearson product moment correlation coefficient	
Calculations (1 Mark per calculation maximum 5)	5
Formula of correlation coefficient	1
Computation of correlation coefficient (2 marks for computation and 1 for Final answer)	3
Conclusion	1
Maximum marks	**10**
(B) **Type I error and Type II error as used in hypothesis testing**	
Define Type I error	1
Define Type II error	1
Maximum marks	**2**
(C) Mean life of the new light bulbs exceeds the old bulb average	
State null hypothesis (Ho	1
State alternative hypothesis (H1)	1
Select the desired level of significance	1
Formulate the decision rule.	1
Test statistics (1 mark for formula, 1 mark for computation, 1 mark for final answer)	3
Make decision.	1
Maximum mark	**8**
Total	**20**

Detailed answer

(a) **Computation of the Pearson product moment correlation coefficient for the given data and commenting on the result**

Lifter	Hours(X)	Milk(Y)	XY	X^2	Y^2
H1	3	48	144	9	2,304
H2	0	8	0	0	64
H3	2	32	64	4	1,024
H4	5	64	320	25	4,096
H5	8	10	80	64	100
H6	5	32	160	25	1,024
H7	10	56	560	100	3,136
H8	2	72	144	4	5,184
H9	1	48	48	1	2,304
	$\sum X=36$	$\sum Y=370$	$\sum XY= 1520$	$\sum X^2=232$	$\sum Y^2=19,236$

The Pearson product moment correlation coefficient (r)

$$r = \frac{n\sum(XY)-(\sum X)(\sum Y)}{\sqrt{n(\sum X\text{^}2)-(\sum(X)\text{^}2)(n\sum Y\text{^}2-\sum Y\text{^}2)}}$$

$$= \frac{9*1520-36*370}{\sqrt{(9*232-(36)\text{^}2)(9*19{,}236-370\text{^}2)}} = \frac{360}{\sqrt{792*36224}} = 0.067$$

As conclusion, there is a weak positive correlation between the time heavy weight lifters use to practice and the amount of milk each lifter consumes per session

(b) Terms Type I error and Type II error as used in hypothesis testing are defined as follows:

i. Type I error in statistical hypothesis testing is the rejection of a true null hypothesis also called a as false positive

ii. Type II error is the non-rejection of false null hypothesis also called a false negative finding or conclusion

c) Given data: Sample of 1,000; Sample mean of 704 hours, old bulb average of 700 hours and Sample standard deviation of 150 hours and α = 0.05

H_o: $\mu_x \leq 700$hours Vs H1: $\mu_x \geq 700$hours and $\alpha = 0.05$

For $\alpha = 0.05$ in the right tail test, the critical value is $Z_{0.05} = 1.65$

So, the rejection rule is: Reject H_o if $Z_{calculated} \geq 1.65$ otherwise do not reject H_o

Test statistics $Z = \frac{X-\mu}{\sigma/\sqrt{n}}$ $Z = \frac{704-700}{\frac{150}{\sqrt{1000}}} = 0.8433$

Therefore, since $0.8433 < 1.65$, we can fail to reject the H_o. Thus, the mean life of the new light bulbs does not exceed that of the old bulbs

QUESTION TWO

Marking Guide	**Marks**
(A) Rules governing construction of simple networks (1 Mark per each, maximum 4)	4
(B)i Draw network (0.5Marks for each correct drawn activity, maximum 5)	5
Find the critical path (2marks) and project duration (1mark)	3
ii) Gantt chart for the project (0.5Marks for each activity well drawn Maximum 5)	5
Well labelled diagram	3

Total marks **20**

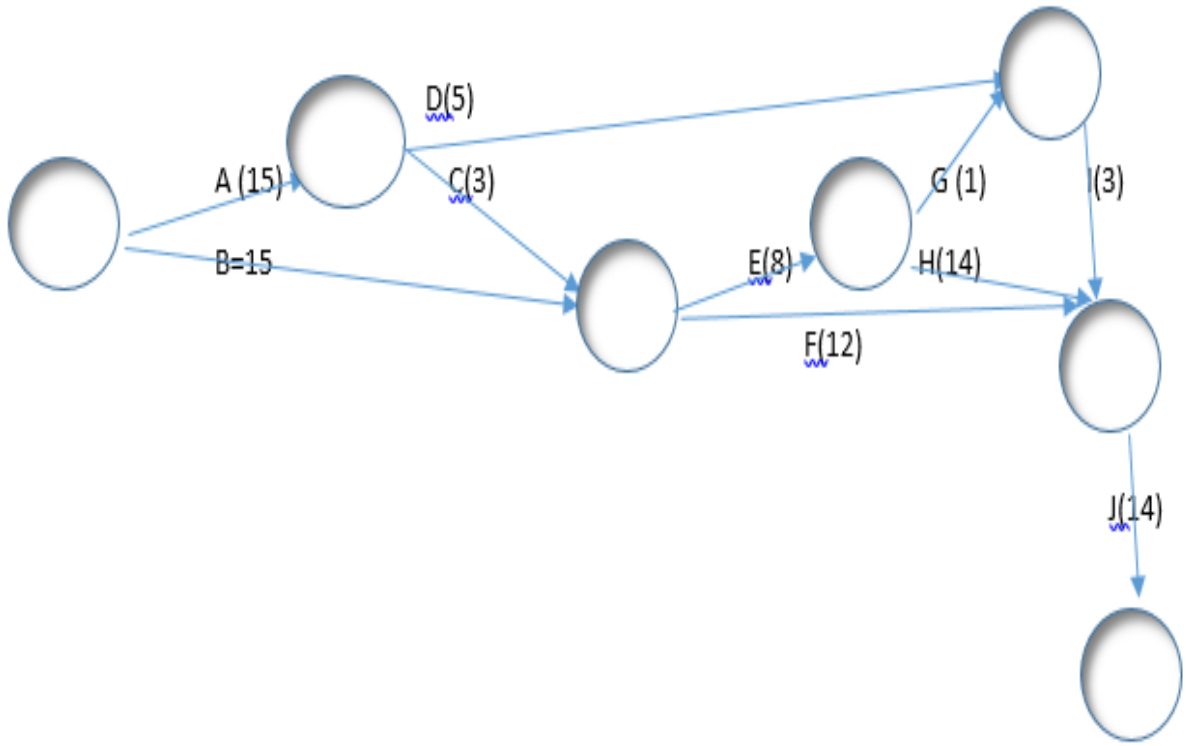
Detailed answer

(a) The four Rules governing construction of simple networks are:

- Each activity is represented by one and only one arrow. This implies that no single activity can be represented twice in the network
- Not two activities can be identified by the same end events. This implies that there must be no loops in the network.
- Every node must have at least one activity preceding it and at least one activity following it except for the very beginning and at the very end of the network. The beginning node has no activities before it and the ending node has no activities following it
- Only one activity may connect any two nodes. This rule is necessary so that an activity can be specified by giving the numbers of its beginning and ending nodes
- Time flows from left to right. Arrows pointing in opposite direction must be avoided. Arrows should be kept straight and not curved or bent. Avoid arrows which cross each other
- Use dummies freely in rough draft but final network should not have any redundant dummies.

(b)

(i) The network of the production project

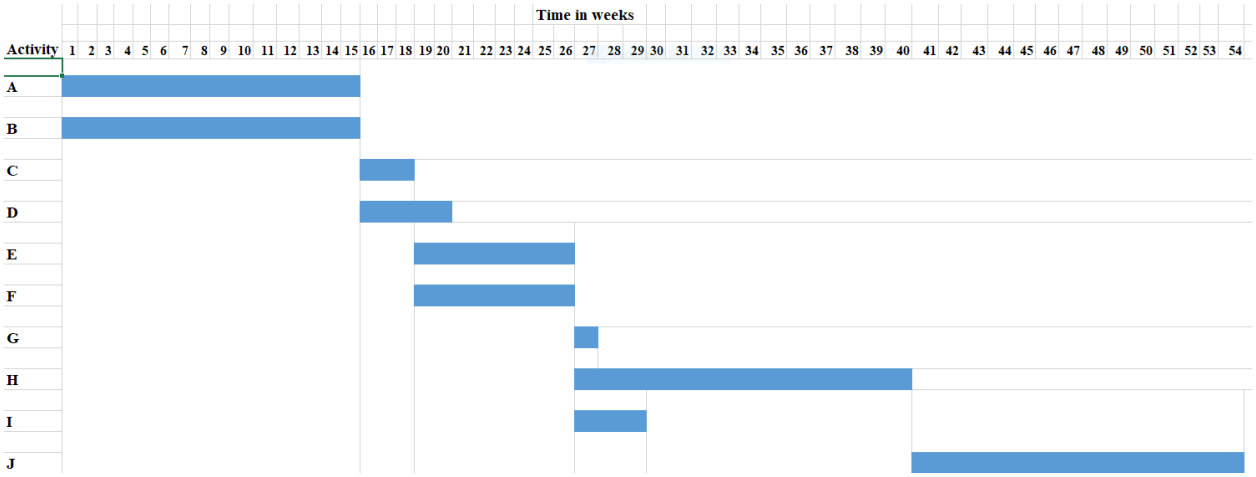


B) C**ritical path and project duration**

Path	Duration	
ADIJ	15+5+3+14	37
ACEGIJ	15+3+8+1+3+14	44
ACEHJ	15+3+8+14+14	54
ACFJ	15+3+12+14	44
BEGIJ	15+8+1+3+14	41
BEHJ	15+8+14+14	51
BFJ	15+12+14	41

Critical path is ACEHJ, and duration is 54 Weeks

(ii) Gantt chart of the project:



QUESTION THREE

Marking Guide	**Marks**
(a) Limitations of the index numbers (0.5Mark for each maximum 2)	2
(b) Factors for the construction of the index numbers (0.5Mark for each maximum 3)	3
(c) The Fisher's Ideal Index Number (1 Mark per calculation maximum 7)	7
(d) Matrix operations.	
Draw matrices (2Marks for each matrix, maximum 6)	6
Calculation of cost	1
Conclusion	1
Total marks	**20**

Detailed answer

(a) Four limitations of the index numbers

- ❖ It is not practicable to price all the goods and services as well as to take into account all changes in quantity and price of products
- ❖ The construction of index numbers is based on sampling may contain sampling errors
- ❖ The choice of a base period may be difficult as few periods can be regards as normal for all segments of the economy.
- ❖ The results obtained by different methods of construction may not quite agree Comparisons of changes in variables over long periods are not reliable. Index numbers may not be suitable for all purposes. The users are strongly ac. sec to understand the purpose for the index number.

(b) Six main factors for the construction of the index numbers

Items	2019		2020					
	P_0	Q_0	P_1	Q_1	P_1Q_0	P_0Q_0	P_1Q_1	P_0Q_1
Maize	65	20	135	30	2,700	1,300	4,050	1,950
Wheat	95	8	160	7	1,280	760	1,120	665
Beans	150	5	320	8	1,600	750	2,560	1,200
					$\sum P_1Q_0$=5,580	$\sum P_0Q_0$=2,810	$\sum P_1Q_1$=7,730	$P_0Q\sum$3,815

- **Purpose of the index numbers**: This is to guide on choice of the technique or method of construction, and this ensures that the results obtained are relevant.
- **Selection of commodities**: While selecting the commodities, a great care and skill should be used as the proper selection of the commodities helps achieve the purpose of the construction of index numbers
- **Price quotations:** It may not be possible to collect the prices for selected commodities from all the places where they are marketed. A sample of markets will, therefore, have to be selected. The criteria of selection will be to choose places where given commodities are marketed in large volumes. It is just possible that a sample may serve the purpose for many commodities rather that one commodity.
- **Choice of the base period**: The base, year should be one with neither very low prices nor very high prices, usually referred as a normal year. However, it is probable that no one year is sufficiently normal to be a good basis for comparison.
- **Choice of the average:** When studying the index number of a single commodity, average is not needed. But in a case involving more than one commodity the price relatives are computed and averaged. In this case the averages are to be used and it is to be decided which average is used as there are different measures of averages. Generally, the following averages are used for this purpose: arithmetic mean; median; and geometric mean.
- **Choice of proper weights**: Index numbers include many commodities which are not equally important. Therefore, it is important to give weights according to the importance of different commodities keeping in mind the purpose of the index numbers. Weighting shall be done with careful consideration and skill after a detailed study of the purpose of index numbers.

(c) **The Fisher's Ideal Index Number for the given dataset:**

Therefore, The Fisher's Ideal Index Number is:

$$\sqrt{\frac{\sum P1Qo}{\sum P0Q0}} X \frac{\sum P1Q1}{\sum P0Q1} X100$$

$= \sqrt{\frac{5,580}{2,810}} X \frac{7,730}{3,815} X100 = \sqrt{1.985X2.0262X100}$ =200.6

(d) The use the matrix operations to find the net savings of Mr. Sekarema John.

Let matrices Q and P represent quantity and price.

Then total price= Q*P

$$[3 \quad 10 \quad 1]*\begin{bmatrix} 2,000 & 1,500 \\ 1,000 & 800 \\ 800 & 600 \end{bmatrix} = [16,800 \quad 13,100]$$

Now, the cost of purchasing from shop = Frw 16,800 and cost of purchasing from the local market is Frw 13,100 +2,500 (cost of travel) = Frw 15,600.

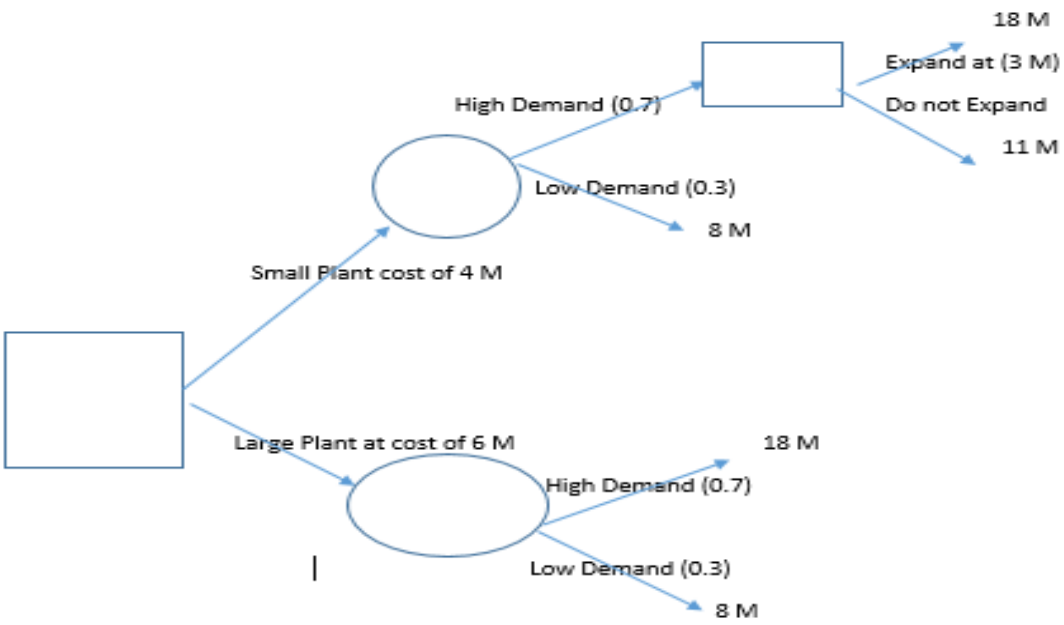
As conclusion the net savings to Mr. Sekarema John from purchasing through local market is Frw16,800-Frw15,600=Frw 1,200

QUESTION FOUR

Marking Guide	**Marks**
(a) Tree diagram to find the optimal policy for Hero Bicycle Company	
Draw tree diagram (0.5 Mark for each branch well drawn and labeled maximum 4)	4
Expected Monetary values for each decision (0.5 mark each maximum 2)	1
Net profit for each decision (0.5 marks each maximum 1)	1
Making decision	1
Maximum marks	**7**
(b) (i) Calculation of standard error of the mean	1
(ii)indicate z value	1
Confidence interval	2
Maximum mark	**4**
(c) Probability that none of them will have between 830 and 845	
Calculations (1mark per calculation, maximum 3)	3
(d) Testing the effectiveness of vaccine	
Computation of expected cell frequencies	2
Calculation of variance (0.5 mark per calculation, maximum 3)	3
Conclusion	1
Maximum mark	**6**
Total marks	**20**

Detailed Answer

(a) The use Tree diagram to find the optimal policy for Hero Bicycle Company



Find expected values for each alternative through all branches logically.
For large plant 18 (0.7) x 8 (0.3) = Frw 15.00 million.
Since cost of building the plant is 6 million, net profit = (Frw 15 Million-6 Million) = Frw 9 million.
Alternatively:
when a small plant is built and the demand is high and the decision to expand is made the revenue = Frw 18 million at of cost expansion of Frw 3 million
Net revenue for this branch (Frw 18Million -3Million) =Frw 15Million.
If the demand is high and no expansion is made the revenue and Frw11 million which is lower than Frw 15 million.
Hence, if the demand is high the decision not to expand would become impractical. When the demand is low, expansion is not logical the revenue of Frw 8 million with probability of low demand being 0.3
EMV (15 X 0.7) +(8 X 0.3) = 12.9, the cost of building a small plant = Frw 4 million.
Hence, expected net pay off is Frw 8.9 million.
The EMV for building a large plant = Frw 9.0 million.
The EMV for building a small plant = Frw 8.9 million.
Hence, it will be advisable to build a large plant

(b) This problem requires the candidates to find (i) he standard error of the mean of the oranges bought and the confidence interval of mean weight of the oranges at the level of confidence of 95%.

(i) Standard error of the mean: Given that $\bar{x} = 358g, n = 750\ and\ S = 50$.

Therefore, the standard error: S. Error = $\frac{S}{\sqrt{n}} = \frac{50}{\sqrt{750}}$

$= 1.826$

(ii) At the level of confidence of 95%, $Z_{(0.025)} = 1.96$.

Then, C.I = 358± 1.96 (1.826)

= 358 ± 3. S8

(c) The candidates are required to find the probability that none of them will have between 830 and 845 words given the frequency distribution and μ = 800 and σ = 50.

Let X be a random variable denoting the number of words per then X ~N (μ, σ2).

Where μ = 800 and σ = 50

P (830 < X <845) = $P(\frac{830-800}{50} \leq z \leq \frac{845-800)}{50}$

=P (-6 < Z < 0.9)

=P (0 < Z < 0.6) + P (0 < Z < 0.9)

=0.2257+0.3159

=0.5416

(d) The candidates were asked to test whether the vaccine is effective for the vaccine of covid-19 or not at 95% using Chi-Square test (X^2), given the information on sample under treatment and a summary of the findings in the given table.

Solution:

Let us take the null hypothesis that the drug is not effective in curing the diseases, applying X^2 test, the expected cell frequencies are computed as follows:

$E_{11}=\frac{R1C1}{N} = \frac{120X100}{200} = 60,\ E_{12}=\frac{R1C2}{N} = \frac{120X100}{200} = 60,\ E_{21}=\frac{R2C1}{N} = \frac{80X100}{200} = 40,\ E_{22}=\frac{R2C2}{N} = \frac{80X100}{200} = 60$

The table of expected frequencies is as follows:

60	60	120
40	40	80
100	100	200

O	**E**	**$(O-E)^2$**	**$(O-E)^2/E$**
65	60	25	0.417
55	60	25	0.417
35	40	25	0.625
45	40	25	0.625
			$\sum(O-E)^2/E=2.084$

V=(r-1) (c-1)

= (2-1) (2-1) =1

For V=1, $X^2_{0.05}$=3.84.

The calculated value of X^2 is less than the table value. We fail to reject the null hypothesis i.e. the drug is not effective to cure the diseases

QUESTION FIVE

Marking Guide	**Marks**
(a) **Mean as the average**:	
Advantage (0.5Marks for 2correct answer, maximum 2)	1
Disadvantages (0.5Marks for 2correct answer, maximum 2)	1
Maximum mark	**2**
(b)	
(i) Missing frequency:	
Cumulative frequency	1
Using median to find missing figure	1
Calculation of missing figure	1
Maximum mark	**3**
(ii) The mean of the sold items,	
Aggregate midpoint value	0.5
Aggregate frequency	0.5
Aggregate of midpoint value *frequency	1
Mean	1
Maximum mark	**3**
(iii) Modal class of the dataset	**1**
(iv) The Interquartile range	
Cumulative frequency	0.5
Quartile 1	1
Quartile 3	1
Interquartile	0.5
Maximum mark	**3**
(c)	
(i) Computation of mean	1
standard deviation of the scores	1
Conclusion	1

Maximum mark	**3**
(d) Computation of arithmetic mean salary (1 Mark per calculation, maximum 5)	5
Total marks	**20**

Detailed answer

(a) Candidates were required to **two** Advantages and any **two** disadvantages of mean as the average:

Advantages:

- The mean uses every value in the data and hence is a good representative of the data
- Arithmetic mean is simple to understand and easy to calculate
- It is rigidly defined
- It is suitable for further algebraic treatment.
- It is least affected fluctuation of sampling
- Repeated samples drawn from the same population tend to have similar means
- It is closely related to standard deviation, the most common measure of dispersion.

Disadvantages:

- he important disadvantage of mean is that it is sensitive to extreme values/outliers, Therefore, it is not an appropriate measure of central tendency for skewed distribution.
- Mean cannot be calculated for nominal or non-nominal ordinal data
- In absence of a single item, its value becomes inaccurate

(b) The candidates were required to find the (i) missing frequency and (ii) the mean of the sold items, (iii) Modal class of the dataset and (iv) the quartile range given the frequency table with some missing frequencies.

(i)

- The first step is to calculate the cumulative frequency

sales	fi	Ci fi
0-10	15	15
10-20	20	35
20-30	f	35+f
30-40	14	49+f
40-50	16	65+f

Total	65+f	65+f

- The second step is to calculate the median class: $\frac{N^{th}}{2}$ *item i.e.* $\frac{(65+f)^{th}}{2}$ *item.* Or the median is given as 24, so the median class is 20-30 which can be calculated using the equation below:
- $me = L + \frac{\frac{N}{2} - Cf}{f} xi = 20 + \frac{32.5 + 5f - 35}{f} x10 = 24$

  Solving for f, we get f=25

(ii) The mean of the sold items.

sales	**Mid-point (x_i)**	**f_i**	**$x_i f_i$**
0-10	5	15	75
10-20	15	20	300
20-30	25	25	625
30-40	35	14	490
40-50	45	16	720
Total		∑fi=90	$\sum xifi$ =2210

The mean sold items $\sum \frac{xi*fi}{N} = \frac{2,210}{90}$

=24.55556≈ 24.6 items sold

(iii) The mode of the dataset:

$Mode = Lmo + (\frac{D1}{D1+D2})C$, where Lm_o is the lower boundary of the modal class, D1 is the difference between frequency of modal class and frequency of the previous class, D2 is the difference between frequency of modal class and frequency of the next class, and c is the modal class interval or width.

$$Mode = 20 + \left(\frac{5}{5+11}\right)10$$

=23.125

iv. The quartile range:

Step1: Construct the cumulative frequency

sales	**f_i**	**Fi**
0-10	15	15
10-20	20	35

20-30	25	60
30-40	14	74
40-50	16	90 0.5

Class Q1= $\frac{n}{4}$= $\frac{90}{4} = 22.5$

Step2: Q1= $Lq1 + \left(\frac{n-F}{fq1}\right)c = 10 + \frac{(22.5-15)x10}{20} = 13.73$

Q3 = $\frac{3n}{4} = 3\left(\frac{90}{4}\right) = 67.5$

Q3=$Lq3 + \frac{\frac{3}{4}-F}{fq3} = 30 + \frac{67.5-60}{14}$x10

=35.36

IQR= Q3-Q1= 35.36-13.73=21.63

(c) Candidates were asked (i) to compute the mean and standard deviation of the scores and advice the new coach on best striker to use in the next match given the dataset, and (ii) Compute the lower and upper quartiles of the dataset and give proper interpretations of the findings.

For Striker (X)		For Striker (Y)	
x	(X-M) ^2	Y	(Y-M) ^2
7	1	3	9
5	1	8	4
5	1	9	9
6	0	6	0
4	4	4	4
6	0	6	0
9	9	5	1
6	0	7	1
∑x= 48	∑(x-M) ^2= 16 **(0**	∑Y=48	∑(Y-M) ^2=28
M= 48/8		M= 48/8	

Since the average is the same, the best measure to use is the standard deviation. That is for the striker X, $\boldsymbol{\sigma}_x$= 1.4

and for striker Y, $\boldsymbol{\sigma}_y$ = 1.9.

(d) Candidates were tested to find the correct arithmetic mean salary of the company, given some wrong data entered in the calculation of the mean and the correct data that were supposed to be entered to find the same.

Solution:

$\bar{x} = \frac{\sum fx}{N}$,

$180{,}000 = \frac{\sum fx}{100}$ or $180{,}000 * 100 = \sum fx$

Corrected $\sum fx = (N\overline{X}) - (Sum \quad of \quad wrong\ values) + (Sum\ of\ correct\ values)$

=180,000*100- (279,000+165,000) +(197,000+185,000) =1,862,000.

The correct mean salary was supposed to be: $\bar{x} = \frac{\sum 1{,}862{,}000}{100}$= Frw 18,620

QUESTION SIX

Marking guide	**Marks**
(a) The optimal assignment	
Step one:	2
Step two	**2**
Making assignment (1 Mark per each correct assignment, maximum 4)	4
The optimal schedule:	**1**
The optimal assignment cost	1
Maximum mark	**10**

(B)Gross output of each sector in order to meet the new demands

Input-output matrix of the system (1 Mark per calculation, maximum 6)	8
Gross output requirements of Agriculture	1
Gross output requirements of Industry	1
Maximum mark	**10**
Total marks	**20**

Detailed answer

(b) Candidates were asked to find the optimal assignment, given the assignment cost of any one operator to any one machine.

- **Step one**: Subtract the smallest element of each row from every element of the corresponding row, we get the reduced matrix as:

$$\begin{bmatrix} 5 & 0 & 8 & 10 \\ 0 & 6 & 15 & 0 \\ 8 & 5 & 1 & 0 \\ 0 & 6 & 4 & 2 \end{bmatrix}$$

Step Two: Subtract the smallest element of each column of the reduced matrix from every element of the corresponding column, we get the following reduced matrix as

$$\begin{bmatrix} 5 & 0 & 7 & 10 \\ 0 & 6 & 14 & 0 \\ 8 & 5 & 0 & 0 \\ 0 & 6 & 3 & 2 \end{bmatrix}$$

- Starting with row 1, we box a single zero (with +) i.e., make assignment), and cross (x) all other zeros in its column. Thus, we get:

$$\begin{bmatrix} 5 & \oplus & 7 & 10 \\ 0 & 6 & 14 & \oplus \\ 8 & 5 & \oplus & \otimes \\ \oplus & 6 & 3 & 2 \end{bmatrix}$$

Since each row and each column contain exactly one assignment, the correct assignment is optimal.

- The optimal schedule is now: **A→II, B→IV, C→III and D→I**
- The optimal assignment cost is then**: Frw (5000+3000+3000+5000) = Frw 16,000**

(c) Candidates were required to find the gross output of each sector in order to meet the new demands, The given transaction matrix gives the information as to how much is produced by each sector and how much is consumed by whom. Note that the system is open since there is some outside demand (project demand) in addition to demand for internal consumption by the two sectors.

The input-output or technology matrix of the system is computed as below:

Producing Industry	Purchase Sector		Projected demand	Total Output
	Agriculture	Industry		
Agriculture	300/1000=3/10	600/2000=3/10	100	1,000
industry	400/1000=2/5	1200/2000=3/5	400	2,000

Thus, here we have: $M = \begin{pmatrix} 3/10 & 3/10 \\ 2/5 & 3/5 \end{pmatrix}$, $D = \begin{bmatrix} 200 \\ 800 \end{bmatrix}$ and are required to determine X $=[x1, x2]$ so as to satisfy the I/O balance equation Mx+d=x, where x is desired output vector and d is the final demand vector, desired to be met by producing x_1 and x_2 units of the two sectors respectively.

The solution to the above balance equation is given by

$x=(I_2-M)^{-1}d$

$= \begin{bmatrix} 7/10 & -3/10 \\ -2/5 & 2/5 \end{bmatrix}^{-1} \begin{bmatrix} 200 \\ 800 \end{bmatrix}$, after inverting the matrix, we obtain

$= \begin{bmatrix} 2{,}000 \\ 4{,}000 \end{bmatrix}$

Thus, the gross output requirements of the two sectors are:

- Agriculture → 2,000 units
- Industry →4,000 units

QUESTION SEVEN

Marking Guide		**Marks**
(a)	Quadratic function	
(i)	Initial cost of the project	3
(ii)	The best time to end the project (1 Mark per calculation, maximum 4)	4
(iii)	Break-even" time points for the project (1 Mark per calculation, maximum 3)	3
Maximum mark		**10**
(b)	(i) Forecast using exponential smoothing methods	
	Forecast demand (0.5 marks per calculations, maximum 3)	3
	Computation of error (0.5 marks per calculations, maximum 3)	3
	(ii) components of time series (0.5 marks per each maximum 2)	3
	Example of each component (0.5 marks per each maximum 2).	3
Total marks		**20**

Detailed Answer

(c) Candidates were given a quadratic function and required and.

(i) to find the initial cost of the project

At time x=0, we set x=0 x,

And find the profit to be seen as -80 000,000 Frw)

And since the project is not yet underway at this time, 80 (000,000 Frw) must be initial cost of the project

(ii) the best time to end the project

Since the given function is cumulative profit of the project, the best time to end the project would be when this function attains its maximum value.

Therefore, the maximum of quadratic function is found by f(-b/2a) or one can use graphical method to find the peak point as the quadratic opens downward.

a=-3, b=31.5 and c=-80.

f(-b/2a) = f (31.5/6)= 31.5(31.5/6)- 3(31.5/6)^2- 80=2.6875

Hence, the best time to end the project is 2.7monts

(iii) to calculate the" break-even" time points for the project

The break-even time points for the project are the time points that makes zero the quadratic function.

Δ= (b)^2-4ac or

Δ= (31.5)^2-4(-3) (-80) =992.25-960 =32.25

$X_1=\frac{-b+\sqrt{b^2-4ac}}{2a}$; $X_1 = \frac{-31.5+\sqrt{32.25}}{2(-3)} \approx$ 6.2 months

$X_2=\frac{-b-\sqrt{b^2-4ac}}{2a}$; $X_2= = \frac{-31.5-\sqrt{32.25}}{2(-3)} \approx$ 4.3 months

The break- even time points for the project are approximately 6.2 months and 4.3 months as it's where the project does not make zero profit

(d)

(i) The forecasted demand is calculated for the table below:

Period	Actual Demand (Yt)	Forecasted Demand $Lt= \alpha Y_t+(1- \alpha) Yt_{-1}$	Error for α
1	2,700	2,700	0
2	2,950	2,700	250
3	2,2660	2,775	-115
4	2,980	2,740.5	239.5
5	3,010	2,812.35	197.65
6	3,140	2871,645	268.355
7		2952,152	

(ii)

- **Secular trend**: This is the general tendency of the time series to increase or decrease or stagnate during a long period of time, which is usually observed in most of the series that show growth. For example, an upward tendency is usually observed in time series relating to population, production and sales of products, prices, income, bank deposits, etc. while a downward tendency is notice d in the time series relating to death, epidemics etc. due to

advancement in technology, improved medical facilities etc. Secular trend is regular, smooth and long-term movement of a statistical series. It reveals the general tendency of the data

- **Seasonal variation**: This represents a periodic movement where the period is no longer than one year. The factors which mainly cause this type of variation in time series are climatic changes of the different seasons and the customs and habits which people follow at different times. The short-range stock and brisk periods of business activity at different seasons of the year, production and consumption of commodities, sales and profits of a company, etc. are in fact attributed to seasonal variations. The main objective of the measurement of seasonal variations is to isolate them from the attend and study their effects. A study of the seasonal patterns is extremely useful to- businessmen, producers, sale managers etc. It helps in planning future operations and formulation of policy, in decisions regarding purchase or production, inventory control, personal requirements, selling and advertising.
- **Cyclical variations**: Cyclical variations or fluctuations are another type of periodic movement, with a period more than one year. Such movements are fairly regular in nature. One complains period is called a cycle. Cyclical fluctuations are found to exist in most of the business and economic time series. The four phases of business cycle are usually x uncompleted over a period of 8 to 10 years. These phases are: (i) prosperity, (ii) decline, (iii) depression and (iv) recovery.
- **Irregular variation**: Irregular variations or ‘movements are -such variations which are completely unpredictable in character. These are unforeseen variations usually caused by factors which are either wholly unaccountable or caused by such unforeseen events as war, flood strikes and lockouts etc. These may sometimes be the result of many small forces each of which has a negligible effect but their combined effect is not negligible. They are in most cases beyond human control.

End of Model answer and Marking guide