2020/2021A.Y Fourth Quarter **Math Lesson** Note for Grade 12

UNIT 8

Further on Statistic

Statistics as a science deals with the proper collection, organization, presentation, analysis, and interpretation of numerical data. Since statistics is useful for making decisions or forecasting future events and it is useful in social, economic and political activities. Therefore some of the applications of statistics are:

1. Statistics in business

Statistics is widely used in business to make business forecasts. A successful business must keep a proper record of information in order to predict the future course of the business; moreover, it helps in formulating economic policies and evaluating their effect.

2. Statistics in meteorology

Meteorologists'uses statistics in order to forecast weather for future days based on information they obtain from different sources.

3. Statistics in schools

In schools, teachers rank their students at the end of a semester based on information collected through different methods (exams, tests, quizzes, etc.) which gives an indication of the students' performance.

In practical use of data from the whole population or to make census survey. It is frequently necessary to use the process of sampling, which is important for conclusions drown about a whole population. Therefore, a sampling technique is very important.

A sample is a limited number of items taken from a population, which is being studied or investigated.

A sample needs to be taken in such a way that it is a true representation of the population. It should not be biased to cause a wrong conclusion. Avoiding bias requires the use of proper sampling techniques. Before examining sampling techniques, you need to note the following.

During sampling, the following points must be considered.

1. Size of a sample: There is no single rule for determining the size of a sample of a given population. However, the size should be adequate in order to represent the population.

To get an adequate size, you check

A). Homogeneity or heterogeneity of the population: If the population has a homogeneous nature, a smaller size sample is sufficient. (For example, a drop of blood is

sufficient to take a blood test from someone).

B). Availability of resources: If sufficient resources are available, it is advisable to increase the size of the sample.

2. Independence: Each item or individual in the population should have an equal chance of being selected as a member of the sample.

Techniques of sampling

There are different techniques of sampling, but the two most common divisions are:

A) Random or probability sampling

B) Non Random or Non Probability sampling

On this lesson we will consider only random sampling.

I. Random Sampling (probability)

In this method, every member of the population has an equal chance of being selected.

Three of the most commonly used sampling methods are:

i). Simple random sampling (SRS)

Simple random sampling is characterized by random selection of data. To apply this method, you may use the lottery method

ii). Systematic sampling

Systematic sampling is another random sampling technique used for selecting a sample from a population.

If N = size of the population and n = size of the sample, then we use:

$K = \frac{N}{n}$ for a sampling interval. After this, you arbitrarily select one number between 1 and k, and then every next sample member is selected by considering the k^{th} member

after the selected one.

Example:

In a class, there are 80 students with class list numbers written from1-80. You need to select a sample of 10 students. How can you apply the systematic sampling technique?

Answer: given that N=80 and n =10 and hence $K = K = \frac{N}{n} = = \frac{80}{10} = 8$

Now, sort the list in ascending order and choose one number at random from the first 8 numbers. If the selected number is 5, then the sample numbers that you obtain by taking every eighth number until you get the tenth sample number are 5, 13, 21, 29, 37, 45, 53, 61, 69, 77.

What do you think will the sample be, if the first randomly selected number is 3? List them

iii). Stratified sampling

Stratified sampling is useful whenever the population under consideration has some identifiable stratum or categorical difference, in each stratum, the data values or items are supposed to be homogeneous. In this method, the population is divided into homogeneous groups or classes called strata and a sample is drawn from each stratum. Once you identify the strata, you select a sample from each stratum either by simple random sampling or systematic sampling.

Example: If you consider students in a section, you may consider intervals of age as strata. In such a case, you could take the age groups 12 – 14 15 – 17 and 18 – 20 as stratification of the students. Samples are taken from each stratum proportionally. In this case, strata are age groups from 12-14, 15-17, and 18-20.

REPRESENTATION OF DATA

The most common data representing methods are graphs, tables and charts.

Graphical Representation of Data

A frequency distribution can be graphically presented by:

I). Histograms

ii). Frequency polygons

iii).Frequency curves

A. Histograms

Histograms are used to illustrate grouped or continuous data. There is an important difference between a bar chart and a histogram. A bar chart shows qualitative or discrete data and hence the variable axis is just divided into spaces.

On the other hand, a histogram illustrates grouped or continuous data and therefore the variable axis is a continuous number line.

B. Frequency polygons

This is another type of graph used to represent grouped data. In drawing a frequency polygon, you plot the mid points (class-marks) of the class intervals on the horizontal axis and the corresponding frequencies on the vertical axis. After plotting the points, you join them by consecutive line segments.

C. Cumulative frequency curve (Ogive)

Graph of cumulative frequency curve (Ogive) depends on cumulative frequency table.

Histograms of grouped frequency distributions often display a low frequency on the left, rise steadily up to a peak and then drop down to a low frequency again on the right or the peak can be in the center and the slopes on either side are virtually equal to each

other. That means

The distribution is said to be:

1). Symmetrical only if the distribution is uni-modal. i.e. mode =mean=median

2).Skewed that means, Skewness is lack of symmetry in the data. For a skewed distribution, if the peak lies to the left of the center,then the distribution is positively – skewed, I.e. mean>median>mode and if the peak of the distribution is to the right of the center, the distribution is said to be negatively – skewed, I.e. mean<median<mode.

MEASURES OF CENTRAL TENDENCY AND MEASURES OF VARIABILITY

The measures of central tendency are mean, mode and median for ungrouped and grouped data and the measures of variation are range, variance, and standard deviation. In this sub unit, we will see other measures of variation such as inter-quartile range and mean deviation.

Example1: Considering the following grouped frequency distribution of weight of students and calculate a) the mean b) the median

c) the range d) the standard deviation

Weight (in k.g)x	Class midpoint (m)	Number of students (f)
48 - 49	48.5	23
50 - 51	50.5	15
52 - 53	52.5	25

54 - 55	54.5	8
56 - 57	56.5	7
58 - 59	58.5	5

$\sum f = 83$

X	f	cf
10 - 19	3	3
20 - 29	5	8
30 - 39	14	22
40 - 49	8	30

Ex2: Calculate Q_1, Q_2 and Q_3 of the following data.

Note: refer formulas to find the above cases grade 11 text book

Further on Measures of Variation

In previous grades, you studied the definition of variation and measures of variation such as range, variance and standard deviation. In this sub unit, you are going to discuss additional measures of variation, namely, mean deviation and some relative measures of variation such as the coefficient of variation.

A measure of variation can be defined in either of the following ways:

a). the degree to which numerical data tends to spread about an average;

b). the scatter or variation of variables about a central value.

Measure of Variation can be measured either absolutely or relatively.

Measure of Variations

Absolute	Relative
a. Range	a. Coefficient of range
b. Quartile deviation	b. Coefficient of quartile deviation
c. Mean deviation	c. Coefficient of mean deviation
d. Standard deviation	d. Coefficient of variation

Mean deviation (MD)

When we calculated standard deviation, you may have noticed that it is the square root of the sum of the squares of the deviations of each observation from the mean, divided by n-1, where n stands for sample size.

Another measure of deviation that also considers all members of a data set is the mean deviation.

Definition

Mean deviation is the sum of deviations (in absolute value) of each item from the average divided by the number of items. It can be considered as the mean of the deviations of each value from a central value).

To calculate mean deviation about the mean, the median and the mode for ungrouped data, for discrete frequency distributions and for grouped data will be described as given below.

1). Mean deviation for ungrouped data

To calculate the mean deviation from the mean, consider the following steps.

Step 1: Find the mean of the data set.

Step 2: Find the deviation of each item from the mean regardless of sign (since mean deviation is an absolute value).

Step 3: Find the sum of the deviations.

Step 4: Divide the sum by the total number of items in the data set.

And hence

$$MD(X) = \frac{|x_{1} - X| + |x_{2} - X| + |x_{3} - X| + |x_{4} - X| + \ldots + |x_{n} - X|}{n} = \frac{\sum_{i=1}^{n} |x_{i} - X|}{n}$$

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2). Mean deviation about the median MD(m_d)

To calculate the mean deviation from the median, simply use the median in place of the mean and proceed in the same way, as follows.

Step 1: Find the median of the data set.

Step 2: Find the absolute deviation of each item from the median.

Step 3: Find the sum of the deviations.

Step 4: Divide the sum by the total number of items in the data set.

$$MD(m_d) = \frac{|x_{1} - md| + |x_{2} - md| + |x_{3} - md| + |x_{4} - md| + \ldots + |x_{n} - md|}{n} = \frac{\sum_{i=1}^{n} |x_{i} - md|}{n}$$

3. Mean deviation about the mode MD(mo)

Again proceed in a similar way:

Step 1: Find the mode of the data set.

Step 2: Find the absolute deviation of each item from the mode.

Step 3: Find the sum of the deviations.

Step 4: Divide the sum by the total number of items in the data set

$$MD(m_o) = \frac{|x_{1} - mo| + |x_{2} - mo| + |x_{3} - mo| + |x_{4} - mo| + \ldots + |x_{n} - mo|}{n} = \frac{\sum_{i=1}^{n} |x_{i} - mo|}{n}$$

Example1: Find the mean deviation about the mean, median and mode of the following

the data 5, 8, 8, 11, 11, 11, 14, 16?

Answer: see your text book on page 350 & 351

Mean deviation for discrete frequency distributions

To calculate the mean deviation for a discrete frequency distribution about the mean, the median and the mode you take similar steps as in the process for discrete data.

If $x_1, x_2, x_3, \ldots, x_n$ are values with corresponding frequencies $f_1, f_2, \ldots, f_n$, then the mean deviation about the mean, median and mode is given respectively as below.

$$1).\ MD(X) = \frac{\sum f|x - X|}{\sum f}$$

$$2).\ MD(m_d) = \frac{\sum f|x - m_d|}{\sum f}$$

$$3).\ MD(m_o) = \frac{\sum f|x - m_o|}{\sum f}$$

Mean deviation for grouped frequency distributions

For continuous grouped frequency distributions, mean deviation is calculated in the same way as above except that each x_i is substituted by the midpoint of each class (m_i) and it is given as below.

$$1).\ MD(X) = \frac{\sum_{i=1}^{n} f_i|m_i - X|}{\sum_{i=1}^{n} f_i}$$

$$2).\ MD(m_d) = \frac{\sum_{i=1}^{n} f_i|m_i - m_d|}{\sum_{i=1}^{n} f_i}$$

$$3).\ MD(m_o) = \frac{\sum_{i=1}^{n} f_i|m_i - m_o|}{\sum_{i=1}^{n} f_i}$$

Ex1: Find the mean deviation about the mean, the median, and the mode for the following.

Note : first find the mean, median and mode of the group data as you know in grade 11.

X	f
0 – 5	5
6 – 11	8
12 – 17	7
18 – 23	10
24 – 29	3

Range and inter-quartile range (IQR)

Range is the difference between the highest and the lowest values in a data set or it is the difference between two extreme data set. Sometimes, it may not be possible to get the range, especially in open ended data, where highest or lowest value may not be known. It may sometimes also be true that the range is highly affected by extreme values. And hence the difference between the third quartile and the first quartile is called the Inter-quartile range. Inter-quartile range is a measure of variation which overcomes the limitations of range.

That is

$IQR = Q_3 - Q_1$

Example1: find the IQR of the following two sets of data:

A). 2, 7, 7, 7, 7, 7, 7, 10

B). 2, 3, 5, 8, 9, 10

The range of the data A and B are:

R (A)= 10 – 2 = 8 and R(A) = 10 – 2 = 8

Note1: To find the IQR, first always find Q_1 and Q_2

2: Data B possesses higher variability than data A. The greater the measure of variation, the greater the variability (dispersion) of the data set.

That means IQR (B) >IQR(A) because data B has more variable than data A.

ANALYSIS OF FREQUENCY DISTRIBUTIONS

In the case of data analysis, let's consider three data, A, B and C. If the standard deviation of these data is given as $S_C < S_B < S_A$. Then data C is the most consistent and data A is highly variable. In the discussion given, the standard deviations are important to compare consistency of a data where the data sets considered have the same mean and the same unit. However, you may face data sets that do not have the same mean. You may also face data sets that do not have the same unit. If the units are different, it will be difficult to compare them. For example, for two sets of data A and B, if S_A = 1.6 kg and S_B = 1.7 cm,which have different units, it's very difficult to compare which of the data sets A or B is more variable?

You cannot compare kg to cm. as this time, you need to see a relative measure of variation which is a pure number. Such a pure number, which is used as a relative measure of variation, is the coefficient of variation given by:

$$C.V = \frac{SD}{X} \times 100$$, where SD= standard deviation, CV= coefficient of variation and X = mean

Example1: let the mean income of two persons A and B is 8000 but their standard deviations are 120 and140respectively. Then find CV of A and B?

Solution:

$$CV_A = \frac{120}{8000} = 1.5 \text{ and } CV_B = \frac{140}{8000} = 1.75$$

When you compare these two data sets, you can see that $CV_B > CV_A$ from which you can conclude that data set A is more consistent than data set B because data set B has a higher degree of variability. From which you can conclude that the data set with lesser standard deviation is more consistent than the data set with larger standard deviation.

EX1:Two basketball teams scored the following points in ten different games as follows:

Team A:	42	17	83	59	72	76	64	45	40	32
Team B:	28	70	31	0	59	108	82	14	3	95

Then calculate the standard deviation of each team and determine which team scored more consistent points?

Skewness Based on Relationships between Measures of Central Tendency and Measures of Variation

The measures of central tendency is important to determine the skewness of a distribution. With the help of central tendencies and standard deviation, it is also possible to determine skewness of a distribution. This is sometimes called a mathematical measure of skewness. Mathematically, skewness can be measured in one of the following ways by calculating a coefficient of skewness.

1 Karl Pearson's coefficient of skewness

2 Bowley's coefficient of skewness

1). Karl Pearson's coefficient of skewness

Karl Pearson's coefficient of skewness (usually called Pearson's coefficient of skewness) is obtained by expressing the difference between the mean and the median relative to the standard deviation. It is usually denoted by α.

$$\text{Coefficient of skewness} = \alpha = \frac{3(\text{mean} - \text{median})}{\text{standred deviation}}$$

If mean = median, we can see that Coefficient of skewness = α = 0 I.e. the distribution is symmetrical. Following the same approach, we can state the following interpretation on skewness using Pearson's coefficient of skewness.

1). If Pearson's coefficient of skewness α = 0, the distribution is symmetrical.

2). If Pearson's coefficient of skewness α > 0 (positive), the distribution is skewed positively (skewed to the right).

3). If Pearson's coefficient of skewness α < 0 (negative), the distribution is negatively skewed (skewed to the left).

2. Bowley's coefficient of skewness

Previously, we have seen how determine skewness by using relationships between mean, median and standard deviation. It is also possible to determine skewness by using positional measures of central tendency, the quartiles. Such a coefficient of skewness, based on quartiles, is called Bowley's coefficient of skewness.

Bowley's coefficient of skewness, which is usually denoted by β, is given by

$$\text{Bowley's coefficient of skewness} = \beta = \frac{Q_3 + Q_1 - 2(\text{median})}{Q_3 - Q_1}$$

The interpretation for skewness based on Bowley's coefficient of skewness is also the

same as that of Pearson's that

1 If Bowley's coefficient of skewness $\beta = 0$, the distribution is symmetrical.

2 If Bowley's coefficient of skewness $\beta > 0$ (positive), the distribution is skewed positively (skewed to the right).

3 If Bowley's coefficient of skewness $\beta < 0$ (negative), the distribution is negatively skewed (skewed to the left).

Ex: Find Karl Pearson's and Bowley's coefficient of skewness for the following data and determine the skewness of the distribution 15, 18, 19, 3, 2, 7, 10, 6, 9, 8 ?

UNIT 9

Mathematical Application for Business and Consumers

APPLICATIONS TO PURCHASING

One of the most difficult tasks in calculating the financial consequences of alternatives is estimating exactly how costs differ. In this section, you will learn how to use unit cost to determine the most economical purchase.

Note that unit cost is the cost of one unit, and total cost is obtained by multiplying the unit cost by the number of units.

Example1: If 20 litter of kerosene cost Birr 170, what is the cost of kerosene per litter?

Solution:

$$\text{Unit cost} = \frac{\text{total cost}}{\text{number of units}} = \frac{\text{birr}170}{20\text{litre}} = 8.50 \text{ birr per litter}$$

Example2: How much would you pay for 120 textbooks at Birr 25.30 each, 50 pens at Birr 1.50 each and 30 dozen erasers at Birr 0.75 each?

Solution Total cost = unit cost × number of units.

Total price for textbooks:	120 × Birr 25.30 = Birr 3,036
Total price for pens:	50 × Birr 1.50 = Birr 75
Total price for erasers:	30 × 12 × Birr 0.75 = Birr 270

Thus, the total cost is Birr 3036 + Birr 75 + Birr 270 = Birr 3,381.

Ex: One store sells 6 cans of cola for Birr 20.40, and another store sells 24 cans of the same brand for Birr 79.20. Find the better buy?

PERCENT INCREASE AND PERCENT DECREASE

Definition of percentage

Percentage is the amount (value) that is out of hundred. And it is given as

Percentage (P) = Rate (R) × Base (B)

Example1: Find 15% of 420.

Solution Here, 15% = 0.15 is called the rate (expressed in percent);

420 is the base (entire amount), and P = R × B.

So P = 0.15 × 420 = 63

Example 2: What is the number whose 30% is 600?

Solution:

Given: R = 30% = 0.30. P = 600. Required: B

$P = R \times B,$

$B = \frac{P}{R} = \frac{600}{0.3} = 2000$

Percentage Increases and Decreases

Example1: A car company increases the price of a Toyota car by 20%. If the original price was Birr 170,000, calculate its new price.

Solution Method 1 20% of Birr 170,000 = 0.20 × Birr 170,000 = Birr 34,000. Now add this to the original price:

New price = Birr 170,000 + Birr 34,000 = Birr 204,000.

Method 2 The original price represents 100%, and therefore the increased price can be represented as 120%:

120% of Birr 170,000 = 1.20 × Birr 170,000 = Birr 204,000

Example2: A shop is offering a 15% discount on its goods for Christmas. If the price of a shirt in the shop was Birr 150 before the discount, what is the current (sale) price of the shirt?

Solution

Method 1

Step 1 Find the discount, 15% of Birr 150:

0.15 × Birr 150 = Br 22.50

Step 2 Deduct the discount:

Birr 150 − Birr 22.50 = Birr 127.50

Method 2

Since the original price represents 100%, the shirt is now being sold at 85%. Therefore, 85% of Birr 150 = 0.85 Birr × 150 = Birr 127.50

Percentage Profit and Loss

When people sell goods for a living, they try to make some money from their sales. The amount of money made on the sale of an article is called the profit. If the goods are sold for less than the trader paid for them, he/she makes a loss. The price a trader pays for an article is called the cost price (c. p.). The price at which articles are sold to the public is known as the selling price (s.p.). If the selling price is greater than the cost price, the trader makes a profit. If the cost price is greater than the selling price, the trader suffers a loss. Both profit and loss are calculated as percentages of the cost price.

$$\text{Percentage profit} = \frac{\text{actual profit}}{\text{original cost(price)}} \times 100$$

$$\text{Percentage loss} = \frac{\text{actual loss}}{\text{original cost(price)}} \times 100$$

Example1: A mobile phone is bought for Birr 1200 and sold for Birr 1600. What is the percentage profit?

Solution

Actual profit = selling price − cost price = Birr 1600 − Birr 1200 = Birr 400

$$\text{Percentage profit} = \frac{\text{actual profit}}{\text{original cost(price)}} \times 100 = \frac{400}{1200} \times 100 = 33.3\%$$

Example 2 A person buys a car for Birr 150,000 and sells it for Birr 130,000. Calculate the percentage loss?

Solution

Loss = c.p. − s.p = Birr 150, 000 − Birr 130,000 = Birr 20,000

$$\text{Percentage loss} = \frac{\text{actual loss}}{\text{original cost(price)}} \times 100 = \frac{20000}{15000} \times 100 = 13.3\%$$

Merchandising: Markup, Based on Cost and Selling Price

Definition

Merchandising Business: A business whose main activity is that of buying and selling a product.

Cost Price (c.p.) is either the price at which a dealer buys the goods or the cost incurred by a company in producing it. Selling Price (s.p.) is the price at which a dealer sells the goods.

Mark-up (Mu) is the difference between the selling price and the cost price. i.e. Mu = s.p. − c.p

The mark-up must cover both the expenses related to the sale (like transport, rent, wages, and utilities) and the amount of profit desired on each item.

Mark up ≥ profit

$$\text{Percent} = \frac{\text{percentage}}{\text{base}} \times 100, \quad \text{where} \quad \text{percent} = \text{mark-up percent}$$

Percentage = mark

Base = selling or cost price

Definition

Discount (D) is a reduction in the original selling price. Regular (Marked) price is the price at which an article is offered for sale. Sale Price is the price that the customer pays in the case of a discounted article; the sales price is obtained by deducting the discount from the marked price.

Note: The terms discount and markdown can be used interchangeably. The percent of markdown is always based on the original selling price.

$$\text{Discount rate} = \frac{\text{amount of discount}}{\text{marked price}} \times 100\%$$

Example1: What is the mark-up on an automobile that sells for Birr 145,000 and costs the dealer Birr 129,000?

Solution:

Mark-up = s.p− c.p = Bi145, 000 − Bi129, 000 = Birr 16,000

Example2: Calculate the discount and selling price (net price) for a Birr 600 radio offered at 18% discount?

Solution: Amount of discount = discount rate × regular price (marked or list price): = 18% × Bi 600 = 0.18 × Bi 600 = Bi108

The discount is Birr 108, and hence the selling price for the radio is Bi 600 - Bi 108 = Bi 492.

Initial Expenses of Buying a House

A house is usually the most expensive item that someone will purchase in his/her lifetime. Since a house is expensive, the way that many people are able to afford a home is by taking out a long-term loan, also known as a mortgage.

Mortgage

A mortgage is an amount that is borrowed, often from a bank, to buy real estate. A person will not be able to get a loan for the full purchase price of the house, because the lender expects him/her to pay a percentage of the purchase price immediately.

The money that is paid at the time of purchase is called the down payment (usually 20%) and the remaining money still to be paid is known as the mortgage or balance due. Thus, mortgage = purchase price - down payment

Installment plan

An installment plan is a system in which an item is bought by paying a certain amount of money now, as the cash price of the item, and then paying the remainder later, in periodic payments (typically monthly).

Installment charge

The installment charge is the interest paid on the unpaid balance.

Monthly payment

The monthly payment is the amount of money to be paid every month.

Example: 1AtoAsrat bought a house from Sunshine Real estate by paying 20% of the purchase (cash) price, which is Birr 450,000, then find

a). the down payment. b). the mortgage amount.

a). Down payment = 20% of 450,000 = $\frac{20}{100}$ ×Birr 450,000 = Birr 90,000

b). Mortgage = purchase price - down payment

= Birr 450,000 - Birr 90,000 = Birr 360,000

You have seen that one of the major initial expenses in buying a house is the down payment. In addition, there are other costs (like loan-origination fee, appraisal fee, home-inspection fee, title insurance, etc.) that you must pay to your lender.

These expenses are called closing costs. Of all these closing costs, the biggest expense, and an expense that must be paid at the beginning, is the loan-origination fee. Most states have laws governing the maximum amount of interest that can be charged to a buyer of a private home.

Since the rate of interest that lending agencies can charge is restricted by law, they have found a way to "get around the law" by charging the borrower "points". Points is a term used by banks to mean percent. For example, "8 points" means"8%".

This loan-origination fee is usually a percent of the mortgage:

Note: points × mortgage = loan – origination fee.

Example: A home is purchased with a mortgage of Birr 600,000. The buyer pays a loan origination fee of $2\frac{1}{2}$ points. How much is the loan origination fee?

Solution

Loan origination fee = mortgage × points

= Birr 600,000 × $2\frac{1}{2}$%= Birr 15,000

Ongoing Expenses of Owning a House

As you can recall from the previous discussion, you have seen that the major initial expenses in the process of buying a home are the down payment and the loan origination fee. In this section, you will look at the continuing monthly expenses involved in owning a house. The monthly mortgage payment, utilities, insurance, home inspection fee, and taxes are some of these ongoing expenses. Of these expenses, the largest one is normally the monthly mortgage payment.

Definition

Amortization is a process in which a debt is “retired” in a given length of time of equal payments. The payments include compound interest. At retirement, the borrower has paid the entire amount of the principal and the interest.

A loan is amortized, if both the principal and interest are paid off with a single periodic payment whose amount is fixed for the life of the loan. The percentages of the payment that go toward paying the principal and the interest, respectively, are not necessarily fixed within the fixed payment. The most common example of an amortized loan is a home mortgage, which is typically paid off in monthly instalments over a period of 10 to 30 years. The amount of the monthly mortgage payment depends on three factors: the amount of the loan, the interest rate on the loan and the number of years required to pay back the loan. Note that the monthly mortgage payment includes the payment of both the principal and the interest on the mortgage. The interest charged during any one month is charged against the unpaid balance of the loan.

The amortization formula is given by:

$$pp = p \times \frac{i}{1 - (1 + i)^{-n}}$$

Where, pp. ≡ periodic payment

p ≡ principal i ≡ interest rate per payment interval

n ≡ number of payments made

Example: Calculate the monthly payment on Birr 200,000 at a 6% annual interest rate that is amortized over 10 years.

Solution:

Interest rate, per payment interval $(i) = \frac{6\%}{12} = 0.005$

Number of payments made (n) = 10 × 12 = 120

$pp = p \times \frac{i}{1 - (1 + i)^{-n}}$, where p = Birr 200,000, and i = .005

$$pp = \text{Birr}200,000 \times \frac{0.005}{1 - (1 + 0.005)^{-120}} = \text{Birr } 2,220.41$$

Thus, the monthly payment is Birr 2,220.41.

Note that calculating the monthly payment using the above method is fairly difficult. So, tables given at the end of this book are used to simplify the calculations

Wages and Salaries

Definition

A wage is a payment for services rendered. Usually unskilled (manual) workers are paid weekly is wages. These are calculated according to the number of hours worked.

A salary is a fixed amount of money that will be paid monthly, weekly, or biweekly, regardless of the number of hours worked.

Example: W/o Serkalem, an administrative assistant at Addis Ababa University, earns Birr 28,800 a year and works 40 hours each week. Find her monthly salary and hourly rate of pay.

Solution

Birr 28,800 ÷ 12 = Birr 2,400, She gets Birr 2,400 per month, and to get her hourly rate of pay, you proceed as follows:

Birr 28,800 ÷ 52 = Birr 553.85 (Why is it divided by 52?) Birr 553.85 is her weekly salary, and hence,

Birr 553.85 ÷ 40 = Birr 13.85 is the amount she is paid per hour