CHAPTER 7: MEASUREMENT OF WORKS AND COST ESTIMATION

7.1 Introduction

This unit describes competencies required to perform measurement of works and cost estimation. It involves preparing tender documents, taking off quantities, working up dimensions and abstracting measured quantities

7 .2 Performance Standard

Prepare tender documents, take off quantities, work up dimensions and abstract measured quantities as per the client's requirements, SOPs, specifications and drawings, nature of the project, conditions of the contract, and nature of the contract.

7.3.1 Summary of Learning Outcomes

a) Prepare tender documents
b) Take off quantities
c) Work up dimensions
d) Abstract measured quantities

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7.3.2 Learning Outcome No 1: Prepare Tender Documents

7.3.2.1 Learning Activities

Learning Outcome No 1: Prepare Tender Documents	
 **Learning Activities**	**Special Instructions**
1.1 ***Working drawings (***Architectural, Structural, Electrical, Mechanical, Civil) are prepared 1.2 Identify ***Specifications*** (Material, Workmanship) are prepared 1.3 Bill of quantities is prepared 1.4 Schedule of rates are prepared 1.5 Condition of contract is prepared 1.6 Form of agreement is prepared 1.7 Form of tender is prepared	• Direct instruction • Project • Case studies • Field trips

7.3.2.2 Information Sheet No7/LO1: Prepare Tender Documents

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Introduction to learning outcome

This learning outcome covers prepare tender documents, working drawing, specification and bill of quantities.

Definition of key terms

Bill of quantities: These are documents that contains all measured quantities required for the completion of the project.

Tender documents: This is a document containing specifications, BoQ, schedules as well as working drawings that are to be used during the project.

Content/Procedures/Methods/Illustrations

1.1 *Working drawings (*Architectural, Structural, Electrical, Mechanical, Civil) are prepared as per client requirements

Working drawings are a guide to how the final outcome should resemble. These drawings should be followed closely and interpreted in the right way to ensure that the project being undertaken meets the desires of the client.

Such drawings include:

a. Architectural drawings

Architectural drawings form the back bone for all construction works. This is because, it defines the site plan as well as the placing of objects and the required type of material needed for the construction works.

b. Structural drawings

Structural drawings define the specific sizes of the structural members. These structural members could be beams, columns, and load bearing walls as well as trusses.
The structural drawings are fully dependent on the architectural drawings.

c. Electrical drawings

These drawings normally show the position of electric switches as well as positions for electronics installations.

d. Mechanical drawings

e. Civil drawings

These includes drawings for highway/ transport projects. They define the materials to be used as well as the thickness of the transport system.
Apart from the transport system drawings, civil drawings also define the positions of water and waste water pipes.

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1.2 Identify *Specifications* (Material, Workmanship) are prepared as per SOPs

Specifications are such as designs, drawings, blueprints etc.

- They describe the work, material as well as the kind of work that need to be done by the contractor.
- The type of material and its required quality should never be compromised for any project.
- It is very important to ensure that as a contractor you have clearly understood the specifications of your work and hire someone to interpret to you if need be.
- Also, the contractor is expected to involve only experts in the given field to work with otherwise, he/she, might compromise the quality of the work done.

1.3 Bill of quantities is prepared based on specifications and working drawings

Bill of Quantities, (BOQ) is a document that contains all measured quantities required for the completion of the project. The BoQ is prepared in such a way that it meets specifications and drawings provided.
Below is a sample BoQ.

Table 12: A sample BoQ.

	Item	Quantity	Unit price	Total price
1	Cement	25bags	1000/=	25000/=
2	Ballast	20 lorries	800/=	16000/=
3	Sand	15 lorries	1500/=	22500/=
4	Steel, T16	250kg	100/=	25000/=
5	Steel, T12	400kg	200/=	80000/=
6	Masonry	20 lorries	300/=	6000/=

Note: The data above is only used for the purpose of demonstrating how a BoQ looks like. The values are not correct.

1.4 Schedule of rates are prepared as per SOPs

These are provided by the contractor pertaining the rates of plants hire, man power costs as well as rates of work completion. The schedule of rates is commonly developed by the contractor who submits it to the client. This is important as it gives a clear indication on what is expected on site and the client can easily supervise the kind of work done.
Due to the variation in contracts types, schedule of rates differs as well.

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1.5 Condition of contract is prepared based on nature of the project

Contract is a legal agreement between two or more parties. For example, an agreement between the client and the contracting company. Every contract is unique in its own way depending on the nature of the project. The key elements in any contract are;

- Payment considerations
- Exists an offer and an acceptance
- Both parties have an intention to create a legal relationship

The different types of contracts are:

a. Lump sum contract
   - This type of contract is also known as fixed contract.
   - In this type of contract, the contractor agrees to do a specified amount of work at a fixed amount of money.

b. Admeasurement contracts
   - It is also known as measure and value contract.
   - For this contract, the client provides the Bill of Quantities and the contractor quotes against each of the listed items in the BoQ.
   - The sum of the item costs forms the total project cost.
   - Other types of contracts under admeasurement contracts include; -
     - ♦ Cost plus contracts
     - ♦ Unit price contracts

c. Turnkey contract
    - In this type of contract, the contractor is given the work and has to delivered the project in a completion. The client doesn't take part in any decisions in this type of contract.
    - Instead, he/she can hire a developer who makes such decision for them.

d. Design and build
    - As the name states, the contractor agrees to do both design and construction works.
    - This method has become common these days as many engineers are turning into contractors and do the entire design and construction works.

1.6 Form of agreement is prepared as per the conditions of the contract

These are standardized forms in which the agreement of the client and the contracting company is put.

Standard forms (forms of agreement) differ based on;

- Type of the project
- Main contract or sub-contract
- Public or private works
- Local or international

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Some of the standard forms include:

- Joint Building council Kenya (JBC)
- The FIDIC
- Public Procurement Oversight Authority (PPOA)
- The Orange book

1.7 Form of tender is prepared based on the nature of the contract

Also known as the tender document. As discussed above there are different contracts. Different contracts contain different tender forms.

However, certain elements in the tender forms are common and they include: -

- Work Drawings
- Specifications
- Bill of quantities
- General conditions
- Construction schedule

Tender forms are normally issued before the contract can be awarded to a contractor. Once the form is filled with the relevant information, it is submitted back to the client who gives consideration to one contractor who meets the threshold of his specifications putting budget into considerations.

Conclusion

This unit covers competencies required to perform measurement of works and cost estimation. It involves preparing tender documents, taking off quantities, working up dimensions and abstracting measured quantities

Further Reading

7.3.2.3 Self-Assessment

Written Assessment

1. The following are types of contracts which one is not?
    a) Turn key
    b) Lumpsum contract
    c) Design and build contract
    d) Public contracts
2. Which of the following is not included in the BoQ?
    a) Quantity
    b) Unit price
    c) Specifications
    d) Item
3. Working drawings are necessary for any engineering works. Which of the following is not a working drawing?
    a) Civil drawings
    b) Mechanical drawings
    c) Civil works
    d) Electrical drawing
4. Which of the following is not a standard contract form?
    a) JBC
    b) PPOA
    c) BoQ
    d) FIDIC

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5. Nature of the contract document depends on the following except?
    a) Public/private works
    b) Local/international works
    c) Type of the project
    d) Time of the year
6. Tender forms have the following except?
    a) Specifications
    b) Construction schedule
    c) FIDIC
    d) BoQ
7. What is not included in a contract document?
    a) Payment considerations
    b) Exists an offer and an acceptance
    c) Both parties have an intention to create a legal relationship
    d) Specifications
8. Define turnkey contracts
9. What is Bill of quantities
10. Why is it important to tender?
11. What are civil drawings?
12. Define civil drawings
13. Compare and contrast Turnkey contracts and design and build contracts
14. Describe the different types of working drawings

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Oral Assessment

1. In your own understanding define tendering
2. Who is eligible for tendering?

Oral Assessment

1. Why do you think it's important to tender?
2. How is the tendering system in Kenya today?

Practical Assessment

Obtain a Tender document and try to interpret it.

7.3.2.4 Tools, Equipment, Supplies and Materials

- Computers
- Office equipment
- Calculators
- Scale rule

7.3.2.5 References

Ashworth, A. Contractual procedures in the construction industry.

Ashworth, A. Cost Studies of Buildings.

Brook, M. (2004). Estimating and tendering for construction work. Amsterdam: Elsevier Butterworth-Heinemann.

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7.3.3 Learning Outcome No 2: Take Off Building Quantities

7.3.3.1 Learning Activities

Learning Outcome No 2: Take Off Building Quantities	
 **Learning Activities**	**Special Instructions**
2.1 Prepare dimension sheet/paper 2.2 Prepare List of quantities to be measured 2.3 Book Dimensions 2.4 Describe booked items	• Demonstrate using charts • Practical assessment • Group work

7.3.3.2 Information Sheet No.7/LO2: Take Off Building Quantities

Introduction

This learning outcome covers Acquiring and interpreting Building plans as per workplace procedures, Preparing Dimension sheet/paper based on the standard format, Preparing List of quantities to be measured based on SMM, Calculating Quantities based on the unit of measure Book Dimensions based on the principles of measurement and Describing Booked items based on the standard method of measurement for building and associated civil works (SMM) and civil engineering standard method of measurements (CESMM).

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Definition of key terms

Dimension sheet/paper- a piece of paper divided into a series of columns concerning multiplication factors, dimensions, squaring and work descriptions used in taking off

Building plans: A set of drawings prepared by the design consultant as a means of communicating construction information in form of floor plans, elevations, cross sections, site plans.

Civil engineering standard method of measurements (CESMM): This is an interpretation format used by civil engineers to prepare bills of quantities for civil work.

Content/Procedures/Methods/Illustrations

1.1 Dimension sheet/paper is prepared based on the standard format

A dimension sheet is an important part of taking off as it is a tool that assists in the identification, measurement and pricing of elements for construction works.

A dimension paper is made up of a series of columns each concerned with informational specific aspect. The most commonly used method of ruling of dimension paper conforms to the requirements of B.S 3327: 1961-Stationery for Quantity Surveying

Procedure for preparation of dimension sheet

i. Split the sheet of paper into two identically ruled parts each consisting of four columns.

1	2	3	4	1	2	3	4

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Column 1 is known as the "timesing column" in which multiplying figures are entered when there is more than one of the particular item being measured.

Column 2 is known as the "dimension column" in which the actual scaled dimensions are provided in the drawing are entered.

Column 3 is known as the "Squaring Column" in which the length, area or volume obtained by multiplying together the figures in column 1 and 2 is recorded, ready for transfer to the abstract or bill.

Column 4 is known as the "description column" in which a written description of each item is entered.

ii. For each work item input the material information provided in the appropriate column.

iii. Compute the qualities and generate the accompanying costs.

1.2 List of quantities to be measured is prepared based on SMM

The items used in the taking off procedure may be determined through the following procedure:

i. Analyzing the scope of work to be done based on the drawings given.
ii. Break down the work into construction tasks.
iii. Systematically arrange the tasks into a check list with work activities following a chronological order.
iv. Generate the material requirements list with regard to the specific tasks being covered.
v. Consider items with no given material but require a cost.

1.3 Quantities are calculated based on the unit of measure

Computation phase of the taking off process is usually done using the information contained in the first three columns that is the time sing dimension and the squaring column.

Procedure for computational of building process

i. In the time sing column, indicate the number of times an item with the measurement appears; to avoid replicating calculations.
ii. In the dimension column, indicate the measurement value provided in the drawings.
iii. In the squaring column, multiply the measurement value provided with the factor indicated in the time sing column. The value obtained should be correct to 2 d.p.
iv. Repeat these steps for all recurring items within a specific task.
v. Add the values obtained together in the squaring column and double underline the total value of measurement.

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Check list (work items)

- Site clearance
- Excavate vegetable soil
- Excavate for foundation
- Concrete blinding
- Concrete footing
- Foundation walling
- Backfilling
- Hardcore fill
- Blinding to hardcore above
- DPM
- BRC mesh

- Concrete in floor bed
- Apply plaster to walls
- Paint walls

Item 1 Site Clearance

A	B	C	D
2/ 2/ 2/ 2	11.10 0.20 0.50 11.10 0.40 1.00 6.00 O.20 0.50 6.00 0.40 1.00 12.50 7.40	O.40 1.00 12.50 0.40 1.00 7.40 92.50	

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Clear the site of all bushes and burn/dispose the arising.

1.4 Dimensions are booked based on the principles of measurement

The dimensions are entered into the dimension sheet following the principles below:

- They are set down in order of horizontal length, horizontal width and finally vertical depth.
- The units of measurements used include

LM- Linear meter i.e. 2M
SM- square meter i.e. 2M*2M
CM- cubic Meter i.e. 2M*2M*2M

KG- Kilogram
Enumerated Items i.e. Nr 3
The dimensions are then put in the dimension column as illustrated in the table below.

1.5 Booked items are described based on the standard method of measurement for building and associated civil works (SMM) and civil engineering standard method of measurements (CESMM)

The items that are entered into the dimension sheet are usually described in the description column. The description used is dependent on the format used; whether SMM or CESMM for CESMM refer to the example below
CESMM Page 15, Class F: In Situ Concrete:
Item descriptions for components classed as other concrete forms shall include:

- The principal dimensions of the concrete component.
- The type or mark number of a concrete component whose principal dimensions are given on the drawings.
- A statement identifying or locating a concrete component whore principal dimensions are given on the drawings.

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Conclusion

This learning outcome has covered Acquiring and interpreting Building plans as per workplace procedures, Preparing Dimension sheet/paper based on the standard format, Preparing List of quantities to be measured based on SMM, calculating Quantities based on the unit of measure Book Dimensions based on the principles of measurement and Describing Booked items based on the standard method of measurement for building and associated civil works (SMM) and civil engineering standard method of measurements (CESMM)

Further Reading

1. Read on the method of description of booked items from SMM 7th edition
2. Read further on the principles of taking off from Building Quantities Explained by I.H. Sehley
3. Principles of Measurement from the principles of measurement for works of construction by the RICS group.

7.3.3.3 Self-Assessment

Written Assessment

1. The measurements used in taking off should be rounded off to?
    a) d.p
    b) d.p
    c) d.p
    d) 1 d.p
2. Linear measurement are recorded in the
    a) Dimension column
    b) Squaring column
    c) Description Column
    d) Timensing Column
3. Which of the following is not a unit of measurement?
    a) LM
    b) CM
    c) MM
    d) KG
4. Which column of the dimension sheet is not used during computation of quantities?
    a) Dimension
    b) Squaring
    c) Description
    d) Timensing.
5. Who among the Following consultants is not involved in the preparation of bills of quantities?
    a) Architect
    b) Engineer
    c) Quantity Surveyor
    d) Construction Manager
6. Which of the following is not considered when preparing a measurement list during a pre-contact stage?
    a) Scope of work
    b) Chronology of tasks
    c) Nonmaterial costs
    d) Contractors estimate

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7. How many classes of work are contained in the CESMM?
    a) 26
    b) 30
    c) 15
    d) 20
8. What is meant by the term dimension sheet?
9. Enumerate the uses of SMM
10. Compare and contrast SMM and the CESMM?
11. Describe how plans are acquired and interpreted.
12. The dimension sheet is based on which industry standard(s)?

Oral Assessment

1. Analyse the principle of measurements
2. Develop a presentation on the preparation of dimension sheet.

Practical Assessment

You have been provided with the building documents for A 4-bedroom bungalow. Using this information;

a) Derive the building quantities.
b) Prepare a bill of Quantities (BOQ)

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7.3.3.4 Tools, Equipment, Supplies and Materials

- Dimension sheets
- Abstract sheets
- Billing sheets
- Measuring tools
- Calculators
- CESSM/SMM

7.3.3.5 References

Harris, F., & McCaffer, R. (2013). Modern construction management. John Wiley & Sons.
Ashworth, A., & Perera, S. (2015). Cost studies of buildings. Routledge.
RICS. (1979) Principles of Measurement. London. RICS Business Services Limited revised 2004

7.3.4 Learning Outcome No 3: Work Up Dimensions

7.3.4.1 Learning Activities

Learning Outcome No 3: Work Up Dimensions	
Learning Activities	**Special Instruction**
3.1 Carry out Timesing of dimensions 3.2 Determine Quantities	• Conduct group discussions • Practical assessments • Project demonstrations

7.3.4.2 Information Sheet No7/LO3 Work Up Dimensions

Introduction

This learning outcome covers Carrying out Timesing of dimensions as per SOPs and Determining Quantities as per SOPs.

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Definition of key terms

SOPs: (Standard Operating Procedures). These are the documented processes that a company has in place to ensure services or products are delivered consistently overtime

Timesing: This is the multiplication of measurements taken from taking off of the drawings in the dimension column during the preparation of Bill of Quantities.

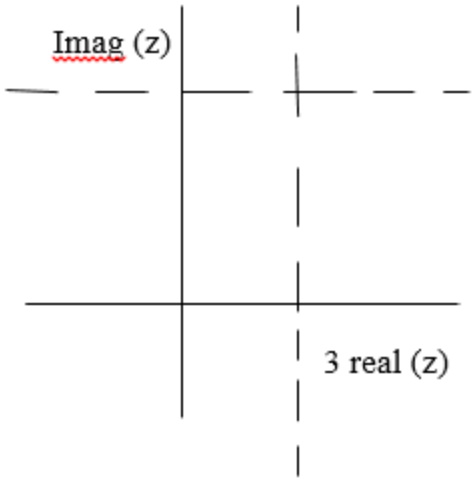
Content/Procedures/Methods/Illustrations

3.1 Complex numbers are represented using Argand diagrams

Argand diagram

A diagram on which complex numbers are represented geometrically using Cartesian axes. The horizontal coordinate representing the real part of the number and the vertical coordinate the complex part.

The vertical axis represents imaginary numbers. The axes cross ta zero, again just like in a Cartesian graph, eg a complex number like $z = 3 + 4i$ would have the co-ordinates $(3, 4)$ on an Argand diagram.



The horizontal axis is labeled Real (Z) and the vertical axis is labeled Imag (Z) where the word imaginary has been shortened to Imag.

The Argand diagram is used in the calculation of dimensions during the casting up and setting out during the construction.

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3.2 Operations involving complex numbers are performed

A complex number is a number that can be put in the form $a + bi$ $a + b$ where a and b are real numbers and i is called the imaginary unit, where $iz = -1$ $i2 = -1$. Complex numbers have applications in many scientific areas, including signal processing, control theory, electromagnetism, fluid dynamics, quantum mechanics, and cartography and vibration analysis. Complex operations involve addition, subtraction, multiplication, etc, defined on ordered pairs of scalars according to conventions of complex algebra eg in the preparation of the abstraction sheet and the transfer of booked quantities within the sheet and the multiplication of the items to get the amount.

Example

Complex numbers in the running through dimensions in the Bill of Quantities in the taking off of quantities.

	2	3.00		EXCAVATIONS
		2.00		FOUNDATIONS
			6.00	
	3	3.00		DEDUCT
	3	3.00		FILING
			9.00	

Complex numbers evident in the symbols used in the construction of the Bill of Quantities. Some of the operations of complex numbers are as follows:

1. Simplify $\frac{3}{2i}$

$$\frac{3}{2i} = \frac{3}{2i} \cdot \frac{i}{i} = \frac{3i}{2i^2} = \frac{3i}{-2} = \frac{-3i}{2} = \frac{-3i}{2}$$

Whereby, $i^2 = -1$

2. Simplify $\frac{3}{2+i}$

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Differentiation of squares in Complex Numbers

$$\begin{aligned}(a+bi)(a-bi) &= a^2 - abi + abi - (bi^2) \\ &= a^2 - b^2(i^2) \\ &= a^2 - b^2(-1) \\ &= a^2 + b^2\end{aligned}$$

The meanings of the symbols used in the running through dimensions is as follows:

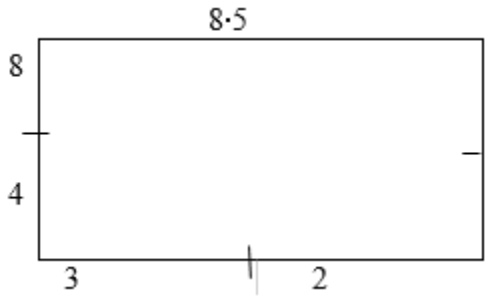
$$a^2 \rightarrow Square\ of\ a$$

$$(-) \rightarrow Subtraction$$

$$\frac{3}{2+a^2} \rightarrow Division\ of\ the\ number$$

$$3i \cdot a^2\ (\cdot) \rightarrow Multiplication\ of\ the\ numbers$$

The symbols come in handy in the running through dimensions eg on site as follows.



Eg In the calculation of the areas of a site $12 * 8 = 96cm^2$

3.3 Calculations involving complex numbers are performed using De Moivre's theorem

De Moiré's Theorem

De Moiré's theorem gives a formula for computing powers of complex numbers. The theorem is applied during the multiplication of complex numbers by squaring the complex numbers.

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The theorem states that:

$(cos\,\theta + i\,sin\,\theta)n = cos(n\,\theta) + i\,sin(n\theta)\ \forall n \in R$ *where I is the root of* -1.

The examples

Given any complex number $cos\,\theta$+i$sin\,\theta$ and any integer n,

$(cos\,\theta + i\,sin\,\theta)^n$=$cos\,n\theta$+i$sin\,n\theta$

Whereby:

(1) $[cos\,\theta - i\ sin\,\theta]^n$ = $cosn\,\theta$ − i $sinn\,\theta$

(2) $[cos\,\theta + i\ sin\,\theta]^{-n}$=$cosn\,\theta - i\ sin\,\theta$

(3) $(cos\,\theta - i\ sin\,\theta)^{-n}$ =$cos\,\theta + i\ sin\,\theta$

(4) $sin\,\theta + i\ cos\,\theta$ = i$(cos\,\theta - i\ sin\,\theta)$

Example One

If z= $(cos\,\theta + i\ sin\,\theta)$, show that $Z^n + {}^1/_{Z^n} = 2\ cos\,n\theta$ and

$$Z^n - [{}^1/_{Z^n}] = Zi\ sin\,\theta$$

By de Moivre's solution;

$$Z^n = (cos\,\theta + i\ sin\,\theta)^n = cos\,n\theta + i\ sin\,n\theta$$

$$Z^n = (cos\,\theta + i\ sin\,\theta)^n = cos\,n\theta + i\ sin\,n\theta$$

$$\frac{1}{Z^n} = Z^{-n} = cos\,n\theta - i\ sin\,\theta$$

Therefore, $Z^n + \frac{1}{Z^n} = (cos\, n\theta + i\ sin\, n\theta) + (cosn\, \theta - i\, sin\, n\theta)$

$$Z^n + \frac{1}{Z^n} = 2\, cos\, n\theta$$

Similarly, $Z^n - \frac{1}{Z^n} = (cosn\, \theta + i\, sin\, n\theta) - (cosn\, \theta - i\, sinn\, \theta)$

The $cos\, \theta$ and $tan\, \theta$ are among the symbols used in casting up and running through e.g in calculations of the angles of a site during design.

Conclusion

This learning outcome has covered Carrying out Timesing of dimensions as per SOPs and Determining Quantities as per SOPs.

Further Reading

Research further on the applications of De Moivre's theorem and applications of complex numbers in construction industry.

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7.3.4.3 Self-Assessment

Written Assessment

1. What is timesing?
    a) Division of measurements during taking off on site.
    b) Multiplication of measurements during taking off.
    c) Measurements of site dimensions.
    d) Using a tape measure to determine dimensions of site.
2. What is the threshold requirement of the column numbers in an abstracting sheet
    a) Four
    b) Six
    c) Three
    d) Five
3. Which of the following best states the De Moivre's theorem mathematically?
    a) $(cos\, \theta + i\ sin\, \theta)n = cos(n\theta) + i\ sin(n\theta) \forall n \in R$
    b) $cos\, \theta = tan\, \theta * i\, sin\, \theta$
    c) $cos\, \theta + sin\, \theta i + tan\, \theta i$
    d) None of the above

4. What is the meaning of this symbol as used in work up dimensions? a^2
    a) Division of the number
    b) Multiplication of the number
    c) Square of the number
    d) Subtraction of the number
5. Which of the following is not part of running through dimension
    a) Dimension of the measured variables
    b) Symbol of the measurement
    c) The extended line
    d) Arrowheads
6. On an abstracting sheet, the stroke symbol below an entry of the first column represents?
    a) Divide
    b) Multiply
    c) Add
    d) Subtract
7. Which of the following procedures is often indicated on the third column of abstracting sheet
    a) Dimensioning
    b) Multiplication
    c) Squaring
    d) Description
8. What is meant by timesing?
9. Outline the De Moivre's theory and state its application
10. Explain the meanings of three symbols used in work up dimensions
11. Describe the applications of complex numbers in dimensioning.
12. Elabourate on the procedures performed during timesing

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Oral Assessment

1. Simplify $\frac{3}{2+i}$
2. If z= $(cos\,\theta + i\ sin\,\theta)$, show that $Z^n + {}^1/_{Z^n} = 2\ cos\,n\theta$ and

$$Z^n - \left[{}^1/_{Z^n}\right] = Zi\ sin\,\theta$$

Practical Assessment

1. Use De Moivre's formula to find $z7$ where $z=1+i$**.**
2. Perform the indicated operation and write your answer in standard form.
    a) $(4-5i)(12+11i)$
    b) $(-3-i)-(6-7i)$
    c) $(1+4i)-(-16+9i)$

7.3.2.4 Tools, Equipment, Supplies and Materials

- Dimension sheets
- Abstract sheets
- Billing sheets
- Measuring tools
- Computers
- Office equipment
- Calculators
- Computer software
- CESSM/SMM
- Stationer
- Dust coat
- First aid kit

7.3.2.5 References

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7.3.4 Learning Outcome No 4: Abstract Take Off Data

7.3.4.1 Learning Activities

Learning Outcome No. 4: Abstract Take Off Data	
 **Learning Activities**	**Special Instructions**
4.1 Prepare Abstracting sheet 4.2 Transfer Description of booked items to the abstracting sheet 4.3 Transfer Quantities **(**Cubic, Square, Linear, Numbers (enumeration)) to the abstracting sheet 4.4 Calculate Net quantities 4.5 Carry out Running through dimensions	• Classroom instructions • Group work activities • Practical work

7.3.4.2 Information Sheet No. 7/LO. 4 Abstract Take Off Data

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Introduction

This learning outcome covers: Preparing abstracting sheet based on the standard format**,** transferring description of booked items to the abstracting sheet as per sops**,** transferring **quantities (**cubic, square, linear, numbers (enumeration)) to the abstracting sheet, calculating net quantities as per sops and carrying out running through dimensions as per SOPs.

Definition of key terms

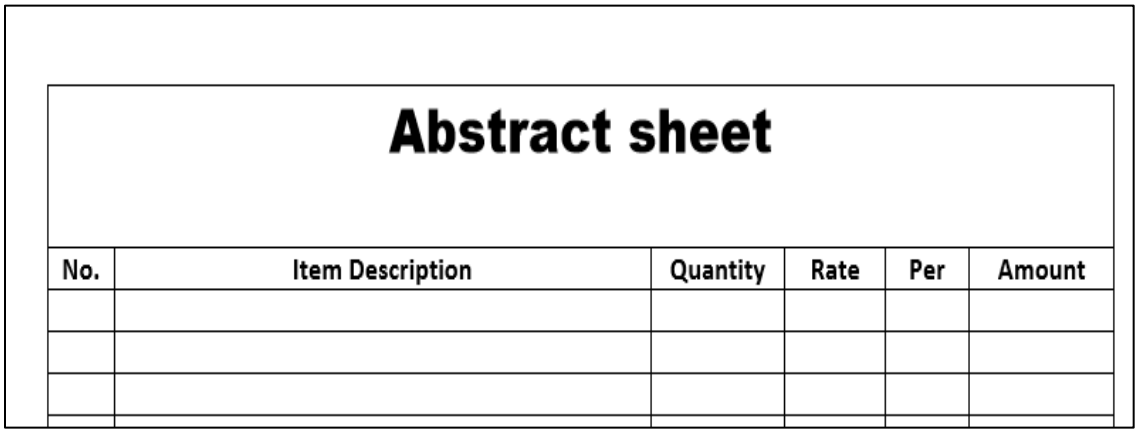
Abstracting sheet – this is the tabulated summary of an in-depth building or any construction analysis mainly done by the quantity surveyor for all the construction work.

Taking off – this refers to the detailed measurement of materials and labour to the required specifications that are needed to ensure the successful completion of construction projects. This entails the breakdown of the project into specific units that are easier to measure.

Booked quantities – these are quantities shown on a sale order which are not restricted by any means and are not associated with any particular orders.

Content/Procedures/Methods/Illustrations

4.1 Abstracting sheet is prepared based on the standard format



Abstract sheet

No.	Item Description	Quantity	Rate	Per	Amount

Figure 92: Sample Abstract sheet

An abstract sheet is normally prepared by a quantity surveyor and is mainly divided into several sections depending on the complexity and size of the construction project. Within those sections, there are specific requirements that need to be fulfilled in order to achieve the accurate measurements for all quantities. On the abstracting sheet, there is usually the name of the project e.g. KENCOM Towers. This project name is usually stated at every stage and each stage is normally arranged in a chronological order as per the activities that will be carried on the ground. In each section, there is a list of activities that will be carried out and, on each activity, there is a list of building materials to be used.

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Dimensions must be provided for each of the materials used and areas where necessary in case one is accounting for materials such as poured concrete. An abstract sheet is normally prepared during the design stage of a project after all the architectural designs are prepared and before construction commences. It is normally done to measure the accurate dimensions of the building materials to be used for proper costing.

4.2 Description of booked items are transferred to the abstracting sheet as per SOPs

The items to be transferred to an abstracting sheet are obtained from the working drawings and specifications of the building materials by the architect. Once the quantity surveyor has analysed the architect's specifications, he/she writes them down in the abstracting sheet in the required thickness e.g. Structural timber rafters of 100mm by 50 mm. (Insert picture, specifications sample 1 and 2).

After writing down the required material thickness the quantity surveyor calculates the required size of the building materials in accordance with the standards units of measurements (Si units) whether in dimensions. (Length and Width) or in other areas.

These calculations are derived from the architectural plans and elevations provided by the architect. During this stage, the booked items are normally transferred to a rough abstracting sheet where all the calculations are done before transferring them to a clean sheet.

4.3 Quantities are transferred to the abstracting sheet

When transferring the quantities to an abstracting sheet, the following procedure must be followed.

Note: The abstraction sheet contains four columns

Table 13. Abstraction sheet columns

A	B	C	D
This is the multiplication column	This is the dimension column. All quantities in this column are added as per the specific section.	This is the squaring column. All quantities in this column are added as per the specific section.	This is the description column

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i. At the beginning of the abstract sheet, all sections are stated in a chronological order as per the activities to be carried out during the construction process.
ii. Dimensions of each quantity are then recorded in the second column of the abstract sheet.
iii. Write down the number of quantities of quantities required to be multiplied on the first column in order to determine the total dimensions required for the specific quantity. If there is only one quantity required, there is no need to fill the first column. When indicating the number of multiplied, always use the stoke symbol below the number e.g. 6/ to indicate that the quantity needs to be multiplied by six.
iv. After multiplying, fill in the new dimensions on the third column where all quantities of the same nature are added up.
v. Provide a brief description of the specific quantity stating its thickness for instance in wood, ratios in case of concrete or any other detail of a material that is specific to it.

4.4 Net quantities are calculated as per SOPs

Description of calculations on the fourth column

A	B	C	D
	5/	5/	This represents an item that has been repeated 5 times
4/	1/	4/	This means the same item can be expressed as 4 multiplied by 1
	5.00	5.00	This means that the length of the item is 5 meters. NB: The difference between 5.00 and the 5 at the first row is the decimal point. Once a decimal point is introduced. The item ceases to be in quantity and becomes a measurement.
	8.00 4.00	12.00	This means that the lengths of 8 meters and 4 meters are added together to get 12 meters
	8.00 4.00	32.00	This means that the area if the item is 32 square meters and it has sides measuring 8 meters and 4 meters.
	3.00 2.00 7.00 6.00	6.00 42.00 48.00	This section shows two areas that add up to 48 square meters. Whereas in the second column, lack of a line below a measurement means multiplication with the underlying measurement, in the third column, lack of a line means addition.
	5.40 3.60 50.00	972.00	This means that the item has been measured as a volume of 972 cubic metres consisting of a length of 5.4 metres, width of 3.6 metres and a depth/height of 50 metres
	5.00 3.00 7.00	15.00	The lines separating the dimensions indicate three separate linear measurements that ass up to 15 meters unlike the three measurements in the above row which indicate a volume.

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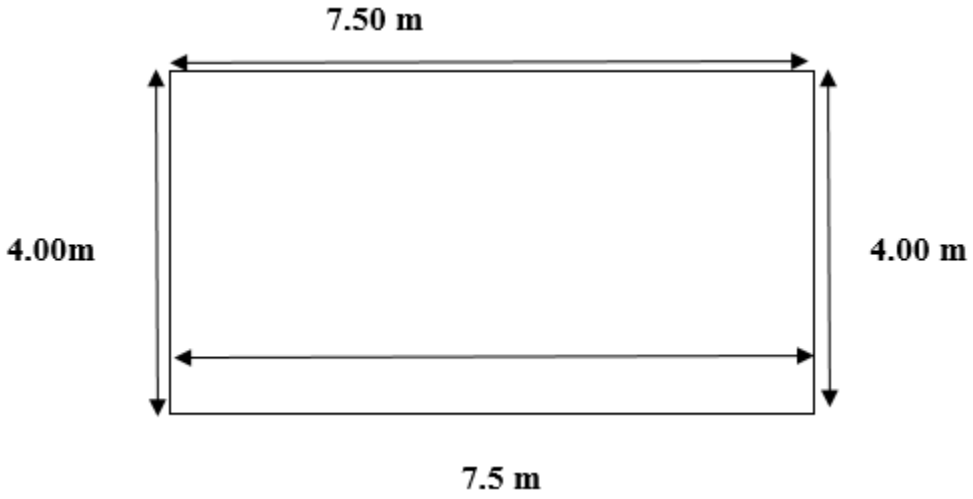
4.5 Running through dimensions is carried out as per SOPs

A running dimension is that which is taken from one end of the structure to another end but has multiple points in between that increases consistently. Running dimensions are usually used to mark out boundaries and other linear measurements of items which constitute a perimeter whether on regular or irregular polygons when setting out. The dimension itself has one extension line, one arrow head and a numerical value of the item being dimensions.

Below is an example.

Running Dimension



When carrying out running through dimensions, one must first identify the number of complete sides and partitions that a proposed project has. Using a tape measure, measure the lengths of each sides and partitions of the proposed construction project. Draw and extended line along the side of the partition with arrowheads at both ends. Write the dimensions of the sides or partitions on top of the extended line. Repeat the above procedure to all the other sides and partitions hence making up their running through dimensions.

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Conclusion

This learning outcome has covered: Preparing abstracting sheet based on the standard format**,** transferring description of booked items to the abstracting sheet as per sops**,** transferring **quantities (**cubic, square, linear, numbers (enumeration)) to the abstracting sheet, calculating net quantities as per sops and carrying out running through dimensions as per SOPs.

Further Reading

1. Find and research more on the various standards and formats of abstracting sheets.

7.3.4.3 Self-Assessment

Written Assessment

1. Which one of the following procedures is normally indicate on the fourth column of an abstracting sheet?
    a) Dimensioning
    b) Squaring
    c) Description
    d) Multiplication
2. On an abstracting sheet, the stroke symbol below on entry on the first column represents?
    a) Divide
    b) Add
    c) Multiply
    d) Subtract
3. Which one of the following is not part of a running through dimension?
    a) Arrowheads
    b) Dimension unit of measurement
    c) An extended line
    d) Symbol of measurement
4. Which one of the following clearly shows the difference between 5 and 5.00 on an abstracting sheet?
    a) One is a measurement unit while the other shows the quantity of an item.
    b) Both are the same
    c) One has a decimal point and the other does not
    d) None of the above
5. When is an abstracting sheet prepared?
    a) During construction of a project
    b) Before architectural drawings are prepared
    c) During project commissioning
    d) After preparation of architectural drawings but before construction
6. During transferring of booked quantities on an abstracting sheet, which of the following is not included?
    a) Number of booked quantities
    b) Description of booked quantities
    c) Price of the booked quantities
    d) Dimensions of the booked quantities

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7. What is the minimum number of columns that a standard format abstracting sheet have?
    a) Four
    b) Six
    c) Three
    d) Five
8. Enumerate procedures represented by each column on an abstracting sheet.
9. Elabourate the use of underlined quantity on an abstracting sheet.
10. Using a sketch illustration, draw and state the various parts of a running through dimension.
11. Outline the basic standard units of measurement used in abstracting sheets.
12. Compare and contrast between booked items and net quantities in relevance to abstracting take off data.

Oral Assessment

1. Outline the steps taken when ferrying quantities to an abstracting sheet.
2. Analyse the relevance of preparing an abstracting sheet in quantity surveying.

Practical Assessment

In groups of five members, prepare an abstracting sheet for an architectural drawing that one of your members has done.

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7.3.2.4 Tools, Equipment, Supplies and Materials

- Dimension sheets
- Abstract sheets
- Billing sheets
- Measuring tools
- Computers
- Office equipment
- Calculators
- Computer software
- CESSM/SMM
- Stationer
- Dust coat
- First aid kit

7.3.2.5 References

Duncan P. Cartlidge. (2002). New Aspects of Quantity Surveying Practice. Oxford: Elsevier Butterworth – Heinemann.

Lee, Sandra, Trench W. & Willis A. (2005). Willis's Elements of Quantity Surveying. United Kingdom: Blackwell Publishers.

Steve Pittard & Peter. Sell. (2016). BIM and Quantity Surveyors. London: Rutledge Publishers.

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