

## APPLY MATERIAL SCIENCE

**UNIT CODE:** ENG/OS/TXP/CC/05/5/A

### UNIT DESCRIPTION

The learner will be introduced to performing material testing and metallurgical processes. It involves analyzing properties of engineering materials, performing extraction processes, producing iron materials, ceramics, composites and alloys, performing heat treatment, material testing and identifying corrosion and its prevention

### ELEMENTS AND PERFORMANCE CRITERIA

<b>ELEMENT</b>	<b>PERFORMANCE CRITERIA</b>
These describe the key outcomes which make up workplace function	These are assessable statements which specify the required level of performance for each of the elements <i>(Bold and italicized terms are elaborated in the Range)</i>
1. Analyze properties of engineering materials	1.1 Type of engineering materials is identified as per the procedures 1.2 <b>Physical properties</b> of engineering material are determined 1.3 <b>Mechanical properties</b> of engineering materials are tested 1.4 Crystal structure of materials is analyzed
2. Perform ore extraction processes	2.1 Safety procedures are observed according OSHA 2.2 Method of extraction is determined as per material properties and its composition 2.3 Procedure in extraction process is determined as per extraction method 2.4 Extraction by- products are stored as per SOPs 2.5 Extraction by- products are disposed as per SOPs
3. Produce iron materials	3.1 Perform ore smelting according to standard operating procedures. 3.2 <b>Composition of iron</b> is determined 3.3 Method of producing <b>iron material</b> is established 3.4 Refinement processes are identified based on iron material required
4. Produce alloy materials	4.1 Materials in alloy formation are identified

	<p>4.2 Alloy formation process is identified based on alloy to be produced</p> <p>4.3 Alloy tested based on alloy production requirement</p>
5. Produce non-ferrous materials	<p>5.1 <b>Non-ferrous materials</b> are extracted according to SOP</p> <p>5.2 Extracted non-ferrous material is smelted and purified as per the SOP</p> <p>5.3 Non-ferrous material is tested according to SOP</p> <p>5.4 Alloying elements for non-ferrous materials are identified</p> <p>5.5 Alloy formation process is identified based on alloy to be produced</p> <p>5.6 Alloys for non-ferrous material are tested based on production requirement</p>
6. Produce ceramics materials	<p>6.1 Composition of <b>ceramic materials</b> is identified</p> <p>6.2 Manufacturing process is identified</p> <p>6.3 Ceramic materials are produced according to manufacturing processes</p> <p>6.4 <b>Finishing processes</b> are identified</p>
7. Produce composite materials	<p>7.1 Type of composite to be produced is identified</p> <p>7.2 Elements involve in composite formation are identified</p> <p>7.3 Formation process of composite to be produced is identified</p> <p>7.4 Composite is tested as per composite production requirement</p>
8. Utilise <b>other engineering materials</b>	<p>8.1 Identify and select engineering material according to production requirements.</p> <p>8.2 Operation plan is developed according to engineering drawing.</p> <p>8.3 Appropriate machine is set up according to manufacturer's manual</p> <p>8.4 Production parameters are set according to production requirement</p> <p>8.5 Production is performed</p>
9. Perform heat treatment	<p>9.1 Safety practices are observed according to OSHA 2007</p> <p>9.2 <b>Heat treatment processes</b> are identified</p> <p>9.3 Procedure in heat treatment processes</p>

	9.4 Heat treatment of metals are performed
10. Perform material testing	<p>10.1 Safety is observed in material testing procedures</p> <p>10.2 <b>Material testing methods</b> are identified depending on material to be tested</p> <p>10.3 Procedure of material testing is followed as per material testing method</p> <p>10.4 Material testing results are tabulated, calculated and interpreted</p> <p>10.5 Material testing equipment are taken care of and maintained.</p>
11. Prevent material corrosion	<p>11.1 Safety is observed during corrosion prevention</p> <p>11.2 <b>Corrosion type</b> is identified</p> <p>11.3 Corrosive atmosphere is identified</p> <p>11.4 <b>Methods of corrosion prevention</b> are identified</p> <p>11.5 Corrosion is prevented</p>

## RANGE

This section provides work environments and conditions to which the performance criteria apply. It allows for different work environments and situations that will affect performance.

VARIABLE	RANGE
1. Mechanical properties may include but is not limited to:	<ul style="list-style-type: none"> <li>• Ductility</li> <li>• Malleability</li> <li>• Elasticity</li> <li>• Toughness</li> <li>• Hardness</li> <li>• Brittleness</li> <li>• Plasticity</li> <li>• Strength</li> </ul>
2. Physical properties may include but is not limited to:	<ul style="list-style-type: none"> <li>• Density</li> <li>• Color</li> <li>• Texture</li> <li>• Melting point</li> <li>• Thermo conductivity</li> <li>• Electrical resistivity</li> </ul>
3. Composition of iron may include but is not limited to:	<ul style="list-style-type: none"> <li>• Iron (II) oxide</li> <li>• Iron (III) oxide</li> </ul>

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4. Ceramic materials may include but is not limited to:	<ul style="list-style-type: none"> <li>• Cast iron</li> <li>• Steel</li> <li>• Oxides</li> <li>• Nitrides</li> <li>• Carbides</li> <li>• Silica</li> </ul>
5. Finishing processes may include but is not limited to:	<ul style="list-style-type: none"> <li>• Lapping</li> <li>• Fine grinding</li> <li>• Polishing</li> </ul>
6. Corrosion type may include but is not limited to:	<ul style="list-style-type: none"> <li>• Galvanic</li> <li>• Stress corrosion cracking</li> </ul>
7. Methods of corrosion prevention may include but is not limited to:	<ul style="list-style-type: none"> <li>• Painting</li> <li>• Electroplating</li> <li>• Galvanizing</li> <li>• Cathodic</li> <li>• Chromizing</li> </ul>

## REQUIRED KNOWLEDGE AND SKILLS

The individual needs to demonstrate the following skills

### Required Skills

- Measuring and marking
- Material testing

- Use of hand tools
- Inspection and testing

## REQUIRED KNOWLEDGE AND UNDERSTANDING

### *The individual needs to demonstrate knowledge and understanding of:*

- Occupational Health and Safety Act of Kenya laws 2007 with focus on personal safety, machine safety and workplace
- National Environment Management Authority Act, Kenya 2004
- OSH ACT 2007
- Equipment manuals
- Mathematics & science
- Physics and mechanics
- Metallurgy and materials
- Inspection and testing
- WIBA ACT
- Report writing

## EVIDENCE GUIDE

This provides advice on assessment and must be read in conjunction with the performance criteria, required skills and knowledge and range.

<p>1. Critical Aspects of Competency</p>	<p>Assessment requires evidence that the learner</p> <ul style="list-style-type: none"> <li>1.1 Observed safety as per work place procedures</li> <li>1.2 Demonstrated understanding of physical, chemical and mechanical properties of engineering materials</li> <li>1.3 Performed extraction processes</li> <li>1.4 Produced iron materials</li> <li>1.5 Produced ceramics</li> <li>1.6 Produced composites</li> <li>1.7 Produced alloys</li> <li>1.8 Performed heat treatment</li> <li>1.9 Performed material testing</li> <li>1.10 Demonstrated understanding of corrosion types and its prevention</li> </ul>
<p>2. Resource Implications</p>	<ul style="list-style-type: none"> <li>2.1 Testing materials</li> <li>2.2 Extraction materials</li> <li>2.3 Measuring instruments</li> <li>2.4 Inspection tools</li> </ul>

3. Methods of Assessment	Competency may be accessed through: 3.1 The behaviour of the learner in the working environment 3.2 Inspection of finished product 3.3 Process analysis
4. Context of Assessment	Competency may be assessed individually in the actual workplace or through accredited institution or during industrial attachment.
5. Guidance information for assessment	Holistic assessment of other units relevant to the industry sector, workplace and job role is recommended.

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