

## 18.2.0 ENGINEERING DRAWING AND DESIGN

### 18.2.1 Introduction

This module unit is designed to equip the trainee with the necessary skills and attitudes in Engineering drawing and design.

The module unit is intended to provide trainee with fundamentals of Engineering drawing and design using traditional equipment. The knowledge gained will be used in designing various products in structural fabrication and tool room processes.

Trainees undertaking this module unit will require knowledge of basic engineering drawing.

### 18.2.2 General Objectives

By the end of the module unit, the trainee should be able to:  
understand the principles of mechanical engineering components  
understand the principles of Mechanical Engineering design  
design a product  
draw assembly drawings

### 18.2.3 Module Unit Summary and Time Allocation

#### Engineering Drawing and Design

Code	Sub-Module	Content	Time Hrs
18.2.1	Gears	<ul style="list-style-type: none"><li>• Uses of gears</li><li>• Constructional Features</li></ul>	2
18.2.2	Screw Threads	<ul style="list-style-type: none"><li>• Helix</li><li>• Types of screws threads</li><li>• Parts of screw</li></ul>	6
18.2.3	Cams	<ul style="list-style-type: none"><li>• Types of CAM followers</li><li>• Types of CAM:</li><li>• Motion graphs:</li><li>• Cam profiles</li></ul>	6
18.2.4	Bearings	<ul style="list-style-type: none"><li>• Bearings and Bushes</li><li>• Bearing Applications</li></ul>	2
18.2.5	Limits and Fits	<ul style="list-style-type: none"><li>• Definition of terms of terms</li></ul>	4

		<ul style="list-style-type: none"> <li>• Types of Fits</li> <li>• Dimensioning using Limits and fits</li> <li>• Application of limits and fits</li> </ul>	
18.2.6	Fasteners and Locking Devices	<ul style="list-style-type: none"> <li>• Temporary fasteners</li> <li>• Permanent Fasteners:</li> </ul>	2
18.2.7	Assembly Drawing	<ul style="list-style-type: none"> <li>• Orthographic Exploded views</li> <li>• Pictorial Exploded views</li> <li>• Parts list</li> <li>• Sectional views:</li> <li>• Hatching methods</li> </ul>	16
18.2.8	Engineering Design	<ul style="list-style-type: none"> <li>• Principles of design</li> <li>• Design consideration</li> <li>• Functional object</li> <li>• Risk management</li> <li>• Material estimation and costing</li> <li>• Cost benefit analysis</li> </ul>	6
18.2.9	Design of Jigs and Fixtures	<ul style="list-style-type: none"> <li>• Definition of jigs and fixtures</li> <li>• Elements of jigs</li> <li>• Functions of jigs and fixtures</li> <li>• Design steps</li> <li>• Degree of freedom of location</li> <li>• Design jigs and fixture</li> <li>• General design principles</li> <li>• Application of jigs and fixtures</li> <li>• Machining on lathe</li> </ul>	12
18.2.10	Geometrical Tolerance	<ul style="list-style-type: none"> <li>• Definition of Geometrical tolerancing</li> <li>• Principles of tolerancing</li> <li>• Application exercises</li> </ul>	6

18.2.11	Product Design and Specification	<ul style="list-style-type: none"> <li>• Feasibility studies</li> <li>• Design</li> <li>• Factors affecting product design</li> </ul>	4
<b>Total Time</b>			<b>66</b>

## 18.2.1 SPUR GEAR

### Theory

#### 18.2.1T0 Specific Objectives

By the end of the sub module the trainee should be able to:

- state the uses of spur gears in engineering
- construct a spur gear
- calculate the gear data from the given information

diameter

- Module
- Pressure angle
- Clearance
- Base circle
- Addendum
- Dedendum

#### Suggested Learning Resources

- Engine gear models
- Textbooks
- The internet

## 18.2.2 SCREW THREADS

### Theory

#### 18.2.2T0 Specific Objectives

By the end of the sub module the trainee should be able to:

- construct helices with reference to single and multi-start threads
- sketch and label the parts of a screw thread
- identify different types of screw threads

#### 18.2.2C Competence

The trainee should have the ability to draw single start and multi start helices

#### 18.2.1C Competence

The trainee should have the ability to design involute gear teeth

#### Content

#### 18.2.1T1 Uses of gears

- Torque reduction/multiplication
- Motion transmission
- Speed reduction/increase
- Motion direction change

#### 18.2.1T2 Constructional Features

#### 18.2.1T3 Gear data calculation

- Pitch circle

- Content*
- 18.2.2T1 Helix
- i) Single-start thread
  - ii) Multi-start thread
- 18.2.2T2 Types of screws threads
- i) V- threads
  - ii) Square threads
  - iii) ACME
  - iv) Buttress
- 18.2.2T3 Parts of screw thread
- i) Pitch
  - ii) Crest
  - iii) Root
  - iv) Diameter

*Suggested Learning Resources*

- i) Models
- ii) Textbooks
- iii) The internet

**18.2.3 CAMS**

**Theory**

- 18.2.3T0 *Specific Objectives*  
By the end of the sub module the trainee should be able:
- a) explain the functions of a cam
  - b) draw various types of cam followers
  - c) construct various cam profiles for given motions

**18.2.3C Competence**

The trainee should have the ability to design cam profiles for different types of

engine

- Content*
- 18.2.3T1 Functions of a cam
- i) Types
  - ii) Radial disc
  - iii) Cylindrical
- 18.2.3T2 Cam followers
- i) Knife edge
  - ii) Roller
  - iii) Flat follower
- 18.2.3T3 Cam profiles
- i) Uniform velocity
  - ii) Uniform acceleration and retardation
  - iii) Simple harmonic motion
  - iv) Combined profile of the above motions

*Suggested Learning Resources*

- i) Engine camshaft model
- ii) Cam lobes model
- iii) Textbooks
- iv) The internet

**18.2.4 BEARINGS**

**Theory**

- 18.2.4T0 *Specific Objectives*  
By the end of the sub module the trainee should be able:
- a) explain the need for a bearing
  - b) identify and sketch various types of bearings
  - c) select a suitable bearing for use in a given part of a vehicle

drawings

### 18.2.5C Competence

The trainee should have the ability to select and use bearings

#### *Content*

- 18.2.4T1 Purpose of bearing
- 18.2.4T2 Bearings and Bushes
  - i) Ball bearing
  - ii) Roller bearing
  - iii) Taper
  - iv) Needle
  - v) Plane
  - vi) Bush bearing
- 18.2.4T3 Bearing Applications
  - i) Gearboxes
  - ii) Wheels and tyres
  - iii) Engines
  - iv) Lathe
  - v) Miller

#### *Suggested Learning Resources*

- i) Engine models
- ii) Gearbox models
- iii) Textbooks
- iv) The internet

## 18.2.5 LIMITS AND FITS

### Theory

#### 18.2.5T0 *Specific Objectives*

By the end of the sub module the trainee should be able to:

- a) define limits and fits
- b) identify and apply the various types fits
- c) use BS 4500, Kenya Bureau of Standard and ISO to dimension

### 18.2.5C Competence

The trainee should have the ability to apply limits and fits in mechanical designs

#### *Content*

- 18.2.5T1 Definition of terms of terms
  - i) Upper and lower limit
  - ii) Tolerance
  - iii) Unilateral
  - iv) Bilateral
  - v) Nominal size (Basic size )
  - vi) Hole-basis system
  - vii) Shaft-basis system
- 18.2.5T2 Types of Fits
  - i) Clearance
  - ii) Transition
  - iii) Interference
  - iv) Applications
  - v) Engineering design and manufacture
- 18.2.5T3 Dimensioning
  - i) The BS 4500 A & BS 4500B charts
  - ii) Tolerancing

#### *Suggested Learning Resources*

- i) Text Books
- ii) The BS 4500 A & BS 4500B Charts
- iii) Internet

## 18.2.6 FASTENERS AND LOCKING DEVICES

### Theory

**18.2.6T0 Specific Objectives**

By the end of the sub module the trainee should be able to:

- a) identify and draw temporary fastening devices
- b) identify and draw of permanent fastening devices
- c) sketch and draw types of locking devices

**18.2.6C Competence**

The trainee should have the ability to:

- i) Differentiate between permanent and temporary fasteners
- ii) Sketch and draw screws, nuts bolts and rivets

*Content*

**18.2.6T1 Temporary fasteners**

- i) Screws
- ii) Cap screws
- iii) Countersunk screws
- iv) Grub screws
- v) Hexagonal head screws
- vi) Nuts and bolts
- vii) Hexagonal
- viii) Square
- ix) Round
- x) Flat
- xi) Pins
- xii) Tapered cotter
- xiii) Split pins
- xiv) Keys and keyways
- xv) Woodruff

xvi) Straight

xvii) Tapered

xviii) Round

xix) Feather

xx) Parallel rectangle

**18.2.6T2 Permanent Fasteners:**

- i) Rivets
- ii) Snap head
- iii) Pan head
- iv) Round countersunk
- v) Counter sunk
- vi) Hexagon slotted grub screw

**18.2.6T3 Locking devices**

*Suggested Learning Resources*

- i) Fastening devices models
- ii) Text books and charts
- iii) The internet

**18.2.7 ASSEMBLY DRAWING**

**Theory**

**18.2.7T0 Specific Objectives**

By the end of the sub module the trainee should be able to:

- a) draw orthographic projection from working drawing and assembly drawing
- b) draw various types of sectional views
- c) draw sectional views, plan and elevation of an assembled component

- d) produce a parts list for an assembled component

- ii) Part name
- iii) Part material
- iv) Number off
- v) Description

**18.2.7C Competence**

- The trainee should have the ability to:
- i) Read and interpret exploded views
  - ii) Produce working drawings
  - iii) Produce sectional views of details that cannot be seen from orthographic
  - iv) Prepare parts list

*Content*

- 18.2.7T1 Orthographic
  - i) Plan
  - ii) End elevation
  - iii) Front elevation
- 18.2.7T2 Sectional views:
  - i) Off -set sectional views
  - ii) Sectional front elevation
  - iii) End sectional elevation
  - iv) Sectional plan
  - v) Half – sectional views
  - vi) Aligned sectional view
  - vii) Revolved sectional views
  - viii) Broken out sectional views
- 18.2.7T3 Hatching methods
  - i) Hatching line
  - ii) Shading
- 18.2.7T4 Parts list
  - i) Part number

**Suggested Learning Resources**

- i) Textbooks
- ii) Drawing charts
- iii) The internet

**18.2.8 ENGINEERING DESIGN**

**Theory**

*18.2.8T0 Specific Objectives*

By the end of the sub module the trainee should be able to:

- a) explain principles of design
- b) describe considerations to be observed in design work
- c) design functional objects in Engineering
- d) manage potential design risks
- e) estimate and cost materials for a design
- f) carry out a cost benefit analysis for the design

**18.2.8C Competence**

The trainee should have the ability to:

- i) Practice Design principles that meets user requirements
- ii) Carry out design strategies that

meet both the deadline and estimated budget

iii) The industry

*Content*

- 18.2.8T1 Principles of design
  - i) Design brief
  - ii) Analysis
  - iii) Synthesis
  - iv) Evaluation
  - v) Implementation
- 18.2.8T2 Design consideration
  - i) Ergonomics
  - ii) Materials
  - iii) Manufacturing methods
  - iv) Casting
  - v) Machining
  - vi) Sintering
  - vii) Fabrication
  - viii) Hot and cold working
- 18.2.8T3 Functional object
  - i) User requirements
- 18.2.8T4 Risk Management
  - i) Risk identification
  - ii) Risk evaluation
  - iii) Risk reduction and minimization
- 18.2.8T5 Estimation and costing
  - i) Material Estimation
  - ii) Tasks
  - iii) Resources
  - iv) Manufacturing costing
  - v) Materials
  - vi) Labor
  - vii) Overheads
- 18.2.8T6 Cost benefit analysis

*Suggested Learning Resources*

- i) Text books
- ii) The internet

**18.2.9T0 DESIGN OF JIGS AND FIXTURES**

**Theory**

*18.2.9T0 Specific Objectives*

By the end of the sub module unit, the trainee should be able to:

- a) define a jig and a fixture
- b) explain the elements of Jigs and fixtures
- c) list functions of jigs and fixtures
- d) list the design steps of jigs and fixtures
- e) state the degree of freedom as applied to jigs and fixtures
- f) design jigs and fixtures for various applications

**18.2.9C Competence**

The trainee should have the ability to:

- i) Fabricate a jig for a given fabrication design
- ii) Design a jig for a given task

*Content*

- 18.2.9T1 Definition of jigs and fixtures



- 18.2.9T2 Elements of jigs
- i) Body
  - ii) Locating elements
  - iii) Tool guide
  - iv) Clamping elements
- 18.2.9T3 Functions of jigs and fixtures
- i) Reduction of costs of operation
  - ii) Increase in production
- 18.2.9T4 Design steps
- i) Sequence of the operation
  - ii) Location systems
  - iii) Clamping system
- 18.2.9T5 Degree of freedom of location
- i) Two linear and rotary movement on axis OX
  - ii) Two linear and rotary movement on axis OY
  - iii) Two linear and rotary movement on axis OZ
- 18.2.9T6 Design jigs and fixture
- i) Milling
  - ii) Drilling
  - iii) Machining on lathe
  - iv) General design principles
  - v) Location methods
  - vi) Clamping methods
  - vii) Loading and unloading process
  - viii) Work supports
  - ix) Stability and rigidity
- x) Clearance for chips
  - xi) Coolant to the cutting edge
  - xii) Application of jigs and fixtures
  - xiii) Milling
  - xiv) Drilling
  - xv) Machining on lathe
- Suggested Learning Resources*
- i) Charts
  - ii) Assorted jigs and fixtures
  - iii) Work pieces
- 18.2.10 GEOMETRICAL TOLERANCING**
- Theory**
- 18.2.10T0 Specific Objectives*
- By the end of the sub module unit, the trainee should be able to:
- a) define geometrical tolerancing
  - b) state the general principles of geometrical tolerancing
  - c) identify, draw and apply recommended symbols of tolerancing
- 18.2.10C Competence**

The trainee should have the ability to apply geometric tolerancing to produce a given design task

- a) product
- b) describe factors affecting product design
- c) describe factors affecting product design

*Content*

- 18.2.10T1 Definition of geometrical tolerancing
- 18.2.10T2 Principles of tolerancing
  - i) Straightness
  - ii) Parallelism
  - iii) Flatness
  - iv) Squareness
  - v) Roundness
  - vi) Datum
  - vii) Cylindricity
- 18.2.10T3 Application exercises

*Suggested Teaching/Learning Resources*

- i) BS 308 geometrical tolerancing charts
- ii) Assorted drawing instruments
- iii) Trainers manuals

**18.2.11 PRODUCT DESIGN AND SPECIFICATIONS**

*Theory*

- 18.2.11T0 *Specific Objectives*  
By the end of the sub module unit, the trainee should be able to:
- a) perform feasibility studies on simple designs
  - b) describe the design specifications of

*Content*

- 18.2.11T1 Feasibility studies
  - i) Aim of feasibility studies
  - ii) Functions of the design manufacture
  - iii) Methods of design manufacture
- 18.2.11T2 Design
  - i) Customer requirements
  - ii) Company requirements
- 18.2.11T3 Factors affecting product design
  - i) Material appearance (aesthetic value)
  - ii) Method of production

**18.2.11C Competence**

The trainee should have the ability to design and specify the product using standard symbols

*Suggested Teaching/Learning Resources*

- i) Various designed products
- ii) wheel barrow
- iii) screw jack
- iv) textbooks