

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
18.2.01	Spur Gears	<ul style="list-style-type: none">Uses of gears- Constructional Features	4
18.2.02	Screw Threads	<ul style="list-style-type: none">HelixTypes of screws threadsParts of screw	6
18.2.03	Cams	<ul style="list-style-type: none">Types of CAM followersTypes of CAM:Motion graphs:Cam profiles	8
18.2.04	Bearings	<ul style="list-style-type: none">Bearings and BushesBearing Applications	4
18.2.05	Limits and Fits	<ul style="list-style-type: none">Definition of terms of termsTypes of FitsDimensioning using Limits and fitsApplication of limits and fits	6
18.2.06	Fasteners and	<ul style="list-style-type: none">Temporary fasteners	4

	Locking Devices	<ul style="list-style-type: none"> • Permanent Fasteners: 	
18.2.07	Assembly Drawing	<ul style="list-style-type: none"> • Orthographic Exploded views • Pictorial Exploded views • Parts list • Sectional views: • Hatching methods 	12
18.2.08	Engineering Design	<ul style="list-style-type: none"> • Principles of design • Design consideration • Functional object • Risk management • Material estimation and costing • Cost benefit analysis 	8
18.2.09	Design of Jigs and Fixtures	<ul style="list-style-type: none"> • Definition of jigs and fixtures • Elements of jigs • Functions of jigs and fixtures • Design steps • Degree of freedom of location • Design jigs and fixture • General design principles • Application of jigs and fixtures • Machining on lathe 	6
18.2.10	Geometrical Tolerance	<ul style="list-style-type: none"> • Definition of Geometrical tolerancing • Principles of tolerancing • Application exercises 	4
18.2.11	Product Design and Specification	<ul style="list-style-type: none"> • Feasibility studies • Design • Factors affecting product design 	4
Total Time			66

<p>18.2.01 SPUR GEAR</p> <p>Theory</p> <p>18.2.01T0 <i>Specific Objectives</i> By the end of the sub module the trainee should be able to:</p> <p>a) state the uses of spur gears in engineering</p> <p>b) construct a spur gear</p> <p>c) calculate the gear data from the given information</p>	<ul style="list-style-type: none"> - Module - Pressure angle - Clearance - Base circle - Addendum - Dedendum <p><i>Suggested Learning Resources</i></p> <ul style="list-style-type: none"> - Engine gear models - Textbooks - The internet
<p>18.2.08C <i>Competence</i> The trainee should have the ability to design involute gear teeth</p> <p><i>Content</i></p> <p>18.2.01T1 Uses of gears</p> <ul style="list-style-type: none"> - Torque reduction/multiplication - Motion transmission - Speed reduction/increase - Motion direction change <p>18.2.01T2 Constructional Features</p> <p>18.2.01T3 Gear data calculation</p> <ul style="list-style-type: none"> - Pitch circle diameter 	<p>18.2.02 SCREW THREADS</p> <p>Theory</p> <p>18.2.02T0 <i>Specific Objectives</i> By the end of the sub module the trainee should be able to:</p> <p>a) construct helices with reference to single and multi-start threads</p> <p>b) sketch and label the parts of a screw thread</p> <p>c) identify different types of screw threads</p> <p>18.2.02C <i>Competence</i> The trainee should have the ability to draw single start and multi start helices</p>

			c) construct various cam profiles for given motions
18.2.02T1	<i>Content</i> Helix		
	- Single-start thread		
	- Multi-start thread	18.2.03C	<i>Competence</i>
18.2.02T2	Types of screws threads		The trainee should have the ability to design cam profiles for different types of engine
	- V- threads		
	- Square threads		
	- ACME		
	- Buttress		
18.2.02T3	Parts of screw thread	18.2.03T1	<i>Content</i> Functions of a cam
	- Pitch		- Types
	- Crest		o Radial disc
	- Root	18.2.03T2	o Cylindrical
	- Diameter		Cam followers
			- Knife edge
			- Roller
			- Flat follower
	<i>Suggested Learning Resources</i>	18.2.03T3	Cam profiles
	- Models		- Uniform velocity
	- Textbooks		- Uniform acceleration and retardation
	- The internet		- Simple harmonic motion
18.2.03	CAMS		- Combined profile of the above motions
	Theory		
18.2.03T0	<i>Specific Objectives</i> By the end of the sub module the trainee should be able:		
	a) explain the functions of a cam		<i>Suggested Learning Resources</i>
	b) draw various types of cam followers		- Engine camshaft model
			- Cam lobes model
			- Textbooks
			- The internet

18.2.04	BEARINGS	<ul style="list-style-type: none"> - Lathe - Miller
	Theory	<i>Suggested Learning Resources</i>
18.2.04T0	<i>Specific Objectives</i> By the end of the sub module the trainee should be able:	<ul style="list-style-type: none"> o Engine models - Gearbox models - Textbooks - The internet
	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	18.2.05
		LIMITS AND FITS
		Theory
		18.2.05T0
		<i>Specific Objectives</i> By the end of the sub module the trainee should be able to:
18.2.05C	<i>Competence</i> The trainee should have the ability to select and use bearings	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 drawings
	<i>Content</i>	
18.2.04T1	Purpose of bearing	
18.2.04T2	Bearings and Bushes <ul style="list-style-type: none"> - Ball bearing - Roller bearing - Taper - Needle - Plane - Bush bearing 	18.2.05C
		<i>Competence</i> The trainee should have the ability to apply limits and fits in mechanical designs
		<i>Content</i>
18.2.04T3	Bearing Applications <ul style="list-style-type: none"> - Gearboxes - Wheels and tyres - Engines 	18.2.05T1
		Definition of terms of terms <ul style="list-style-type: none"> - Upper and lower limit <ul style="list-style-type: none"> - Tolerance - Unilateral - Bilateral

	<ul style="list-style-type: none"> - Nominal size (Basic size) - Hole-basis system - Shaft-basis system 	<ul style="list-style-type: none"> fastening devices c) sketch and draw types of locking devices
18.2.05T2	<p>Types of Fits</p> <ul style="list-style-type: none"> - Clearance - Transition - Interference - Applications - Engineering design and manufacture 	<p>18.2.06C <i>Competence</i></p> <p>The trainee should have the ability to:</p> <ul style="list-style-type: none"> i) Differentiate between permanent and temporary fasteners ii) Sketch and draw screws, nuts bolts and rivets
18.2.05T3	<p>Dimensioning</p> <ul style="list-style-type: none"> - The BS 4500 A & BS 4500B charts - Tolerancing 	
	<p><i>Suggested Learning Resources</i></p> <ul style="list-style-type: none"> - Text Books - The BS 4500 A & BS 4500B Charts - Internet 	<p>18.2.06T1 <i>Content</i></p> <p>Temporary fasteners</p> <ul style="list-style-type: none"> - Screws <ul style="list-style-type: none"> o Cap screws o Countersunk screws o Grub screws o Hexagonal head screws - Nuts and bolts <ul style="list-style-type: none"> o Hexagonal o Square o Round o Flat - Pins <ul style="list-style-type: none"> o Tapered cotter o Split pins - Keys and keyways <ul style="list-style-type: none"> o Woodruff o Straight o Tapered o Round o Feather
18.2.06	<p>FASTENERS AND LOCKING DEVICES</p> <p>Theory</p>	
18.2.06T0	<p><i>Specific Objectives</i></p> <p>By the end of the sub module the trainee should be able to:</p> <ul style="list-style-type: none"> a) identify and draw temporary fastening devices b) identify and draw of permanent 	

18.2.06T2	<ul style="list-style-type: none"> ○ Parallel rectangle <p>Permanent Fasteners:</p> <ul style="list-style-type: none"> - Rivets <ul style="list-style-type: none"> ○ Snap head ○ Pan head ○ Round countersunk ○ Counter sunk - Hexagon slotted grub screw 		d) produce a parts list for an assembled component
18.2.06T3	Locking devices		
	<i>Suggested Learning Resources</i>		
	<ul style="list-style-type: none"> - Fastening devices models - Text books and charts - The internet 		
18.2.07	ASSEMBLY DRAWING		
	Theory		
18.2.07T0	<p><i>Specific Objectives</i></p> <p>By the end of the sub module the trainee should be able to:</p> <ul style="list-style-type: none"> 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 	18.2.07C	<p><i>Competence</i></p> <p>The trainee should have the ability to:</p> <ul style="list-style-type: none"> 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
		18.2.07T1	<p><i>Content</i></p> <p>Orthographic</p> <ul style="list-style-type: none"> - Plan - End elevation - Front elevation
		18.2.07T2	<p>Sectional views:</p> <ul style="list-style-type: none"> - Off set sectional views - Sectional front elevation - End sectional elevation - Sectional plan - Half – sectional views - Aligned sectional view - Revolved sectional views - Broken out sectional views
		18.2.07T3	<p>Hatching methods</p> <ul style="list-style-type: none"> - Hatching line - Shading
		18.2.07T4	Parts list

	<ul style="list-style-type: none"> - Part number - Part name - Part material - Number off - Description 	<ul style="list-style-type: none"> meets user requirements ii) Carry out design strategies that meet both the deadline and estimated budget
	<i>Suggested Learning Resources</i>	
	<ul style="list-style-type: none"> - Textbooks - Drawing charts - The internet 	<p>18.2.08T1</p> <p><i>Content</i></p> <p>Principles of design</p> <ul style="list-style-type: none"> - Design brief - Analysis - Synthesis - Evaluation - Implementation
18.2.08	ENGINEERING DESIGN	
	Theory	<p>18.2.08T2</p> <p>Design consideration</p> <ul style="list-style-type: none"> - Ergonomics - Materials - Manufacturing methods <ul style="list-style-type: none"> o Casting o Machining o Sintering o Fabrication <ul style="list-style-type: none"> o Hot and cold working
18.2.08T0	<i>Specific Objectives</i> 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	<p>18.2.08T3</p> <p>Functional object</p> <ul style="list-style-type: none"> - User requirements
	c) design functional objects in Engineering	<p>18.2.08T4</p> <p>Risk Management</p> <ul style="list-style-type: none"> - Risk identification - Risk evaluation - Risk reduction and minimization
	d) manage potential design risks	
	e) estimate and cost materials for a design	<p>18.2.08T5</p> <p>Estimation and costing</p> <ul style="list-style-type: none"> - Material Estimation <ul style="list-style-type: none"> o Tasks o Resources - Manufacturing costing <ul style="list-style-type: none"> o Materials o Labor
	f) carry out a cost benefit analysis for the design	
18.2.08C	<i>Competence</i> The trainee should have the ability to:	
	i) Practice Design principles that	

18.2.08T6	<ul style="list-style-type: none"> ○ Overheads Cost benefit analysis		ii) Design a jig for a given task
	<i>Suggested Learning Resources</i> <ul style="list-style-type: none"> - Text books - The internet - The industry 		<i>Content</i>
18.2.09T0	DESIGN OF JIGS AND FIXTURES	18.2.09T1	Definition of jigs and fixtures
		18.2.09T2	Elements of jigs <ul style="list-style-type: none"> - Body - Locating elements - Tool guide - Clamping elements
	Theory	18.2.09T3	Functions of jigs and fixtures <ul style="list-style-type: none"> - Reduction of costs of operation - Increase in production
18.2.09T0	<i>Specific Objectives</i> By the end of the sub module unit, the trainee should be able to: <ol style="list-style-type: none"> 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 	18.2.09T4	Design steps <ul style="list-style-type: none"> - Sequence of the operation - Location systems - Clamping system
		18.2.09T5	Degree of freedom of location <ul style="list-style-type: none"> - Two linear and rotary movement on axis OX - Two linear and rotary movement on axis OY - Two linear and rotary movement on axis OZ
18.2.09C	<i>Competence</i> The trainee should have the ability to: <ol style="list-style-type: none"> i) Fabricate a jig for a given fabrication design 	18.2.09T6	Design jigs and fixture <ul style="list-style-type: none"> - Milling - Drilling - Machining on lathe - General design principles <ul style="list-style-type: none"> ○ Location methods

	<ul style="list-style-type: none"> ○ Clamping methods ○ Loading and unloading process ○ Work supports ○ Stability and rigidity ○ Clearance for chips ○ Coolant to the cutting edge 		<p>symbols of tolerancing</p>
	<ul style="list-style-type: none"> - Application of jigs and fixtures <ul style="list-style-type: none"> ○ Milling ○ Drilling - Machining on lathe 	18.2.10C	<p><i>Competence</i> The trainee should have the ability to apply geometric tolerancing to produce a given design task</p>
		18.2.10T1	<p><i>Content</i> Definition of geometrical tolerancing</p>
		18.2.10T2	<p>Principles of tolerancing</p> <ul style="list-style-type: none"> - Straightness - Parallelism - Flatness - Squareness - Roundness - Datum - Cylindricity
	<p><i>Suggested Learning Resources</i></p> <ul style="list-style-type: none"> - Charts - Assorted jigs and fixtures - Work pieces 	18.2.10T3	<p>Application exercises</p>
18.2.10	GEOMETRICAL TOLERANCING		<p><i>Suggested Teaching/Learning Resources</i></p> <ul style="list-style-type: none"> - BS 308 geometrical tolerancing charts - Assorted drawing instruments - Trainers manuals
	Theory		
18.2.10T0	<p><i>Specific Objectives</i> By the end of the sub module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> a) define geometrical tolerancing b) state the general principles of geometrical tolerancing c) identify, draw and apply recommended 		
		18.2.11	PRODUCT DESIGN AND SPECIFICATIONS
			Theory
		18.2.11T0	<p><i>Specific Objectives</i> By the end of the sub module unit, the</p>

	trainee should be able to:			
	a) perform feasibility studies on simple designs	18.211T2	Design	- Methods of design manufacture
	b) describe the design specifications of a product			- Customer requirements
	c) describe factors affecting product design	18.2.11T3	Factors affecting product design	- Company requirements
18.2.11C	<i>Competence</i> The trainee should have the ability to design and specify the product using standard symbols			- Material appearance (aesthetic value)
				- Method of production
				<i>Suggested Teaching/Learning Resources</i>
18.211T1	<i>Content</i> Feasibility studies			- Various designed products
	- Aim of feasibility studies			o wheel barrow
	- Functions of the design manufacture			o screw jack
				o textbooks