SYLLABUS: 1 JANUARY 1994

REPUBLIC OF SOUTH AFRICA

CO-ORDINATOR: ENGINEERINGSTUDIES

SYLLABUS FOR

FITTING AND MACHINING THEORY

N1

NATIONAL CERTIFICATE

CODE NUMBER

9217

IMPLEMENTATION DATE OF
NEW SYLLABUS
APRIL 1994

FIRST EXAMINATION OF
NEW SYLLABUS
AUGUST 1994

LAST EXAMINATION BASED ON PREVIOUS SYLLABUS
APRIL 1995

FITTING AND MACHINING THEORY N1

NATIONAL CERTIFICATE

1. SUBJECT AIMS

1.1 General subject aims

1.1.1 The student must, on successful completion of Fitting and Machining Theory N1, be equipped with sufficient theoretical knowledge to enable him to integrate meaningfully into the training programme of the engineering practice.

1.1.2 The content of the course must be presented in such a manner that love for and appreciation of the subject is fostered in the student.

1.2 Specific subject aims

The student must

1.2.1 experience application of the theoretical subject content through practical demonstration in the laboratory and through visual learning experiences;

1.2.2 aquire knowledge about the following subject content: Occupational safety, Metals and Plastics, Handtools, Measuring Instruments, Marking-off, Screw Threads, Hand taps, Stocks, Dies and Reamers, Fasteners, Keys and Keyways, Grinding machines, Drilling machines, Shaping machines, Machine-cutting tools, Centre lathes and Milling machines.

2. DURATION AND INSTRUCTIONAL TIME OF INSTRUCTIONAL OFFERING

2.1 Duration

One trimester of 10 weeks.

2.2 Minimum instructional hours per week:

Full-time	:	7,5 hours per week.
Total full-time instructional time	:	10 x 7,5 = 75 hours.
Part-time	:	6 hours per week.
Total part-time instructional time	:	10 x 6 = 60 hours.

3. EVALUATION

3.1 Continuous evaluation

Class tests are given on completion of each module. These test marks are taken in conjuction with the weighted value given to the relevant module and are then used to determine a trimester mark.

4. EXAMINATION

4.1 Examination sessions

External examinations are written in April, August and November of each year. An instructional offering is examined in its entirety.

4.2 Examination paper

The duration of the question paper is 3 hours.

Pass requirements: To pass Fitting and Machining Theory N1, the candidate must achieve a final mark of 40 %.

The question paper consists of two sections:

Section A	- 60 marks
Section B	- 40 marks
Total marks	- 100 marks

In section A all the questions are compulsory, but in section B a choice of questions will be given, consisting of relevant questions to accommodate the different fitting trades. In this section six questions will be set from which any FOUR questions must be attempted. The setting of separate alternative questions is to eliminate the possibility that students in the different fitting trades are prejudiced.

Questions set on legislation will also make provision for optional questions on the Machinery and Occupational Safety Act, (Act No 6 of 1983) and the Minerals Act, (Act No 50 of 1991). See "General Information", paragraph 5.3.

4.3 Level of difficulty

The difficulty level in respect of knowledge, insight, application, analysis and synthesis is important and the weight values for FITTING AND MACHINING THEORY N1 should be as follows:

LEVEL	KNOWLEDGE	UNDERSTANDING	APPLICATION	ANALYSIS AND SYNTHESIS
N1	± 50 %	± 40 %	± 10 %	-

5. **GENERAL INFORMATION**

5.1 Fitting and Machining Theory N1 is applicable to all the relevant fitting trades, and is relevant to fitting, fitting and turning, fitting including machining, turning including machining and turning.

5.2 On completion of the course the student must be able to use the applicable SI-units, metric systems, recognised symbols, abbreviations and definitions correctly.

5.3 The legal aspects contained in this course are covered by the following:

5.3.1 Machinery and Occupational Safety Act, No 6 of 1983, and applicable Regulations, for students associated with the Metal Industry.

NOTE: The above-mentioned law will be replaced by the Occupational Safety and Health Act, 1993, after being endorsed and published in the Government Gazette.

OR

5.3.2 The Minerals Act, No 50 of 1991, and applicable Regulations, for students associated with the Mining Industry.

5.4 Emphasis is placed on the practical interpretation of the laws rather than verbatim memorisation. The student should, in other words, be familiar with the spirit rather than the letter of the law. The booklet "Questions and Answers" on Occupational Safety by the National Occupational Safety Association (NOSA), contains relevant information regarding this section.

5.5 Emphasis must be placed on the correct use of technical language, engineering terminology, especially in the formulation of definitions and concepts.

5.6 All calculations are limited to a maximum of two decimals.

5.7 All calculations presuppose the use of standard formulae and the applicable computations.

5.8 Calculations are made only where so specified.

5.9 All drawings must be made diagrammatically in pencil and must be supplied with the necessary subtitles (labels).

5.10 Where possible, all demonstrations must be carried out with the aid of actual components or models.

5.11 Much emphasis must be placed on practical demonstrations and audio-visual aids.

5.12 The lecturers must differentiate in the class situation in so far as this is practically possible to accommodate the different fitting trades.

5.13 The presentation of this instructional offering should be accompanied by a visit to a modern workshop.

6. LEARNING CONTENT

6.1 The modules for Fitting and Machining Theory N1 consist of the following (approximate weight value shown on right-hand side):

SECTION A: (General practice)

Module	Description	Approximate Weight Value
1.	Occupational Safety	6
2.	Metals and Plastics	12
3.	Hand Tools	6
4.	Measuring instruments	10
5.	Marking-off	5
6.	Screw-threads	6
7.	Hand taps, stocks, dies and reamers	5
8.	Fasteners	4
9.	Keys and Keyways	6

SECTION B: (Machine Cutting Tools and Machines)

Module	Description	
10.	Grinding machines (Bench, Pedestal and Portable Angle)	5
11.	Drilling machines	10
12.	Shaping machines	10
13.	Machine-cutting tools	5
14.	Centre lathes	10
15.	Milling machines	10

6.2 The approximate weight value of a module

6.2.1 indicates what percentage of the total content of the syllabus is occupied by the particular module;

6.2.2 gives an indication of what percentage of the available time allocated to the subject must be spent on the module; and

6.2.3 gives an indication of what percentage of the total marks of the examination paper must be allocated to the module.

6.3 The approximate weight values must be seen only as a guide and may vary slightly from trade to trade.

7. DETAILED SYLLABUS

MODULE 1: OCCUPATIONAL SAFETY

LEARNING OUTCOME

On completion of this module the student must be able to describe in full the following hand tools and machine regulations and answer questions on the practical application thereof.

1.1 Regulations applicable to the Machinery and Occupational Safety Act, No 6 of 1983:

1.1.1 General machinery

Regulations relating to responsible persons (C1), obedience to orders (C2), reports to persons in charge (C3), reportable machinery failures (C8), illumination of machinery (C10), loose outer clothing (C19), general machinery protection (C22), revolving machinery (C23) and starting and stopping of machinery (C27).

1.1.2 General safety measures

* To prevent accidents in the workshop when hand and machine tools are used

* To prevent accidents on the machines covered in this syllabus and discussed in the corresponding module

1.1.3 Outline of the main requirements contained in procedures relating to workshop safety

1.1.4 Colour codes of different pipelines as specified by NOSA

NOTE: This Act is only applicable till the endorsement and publication of the Occupational Safety and Health Act, 1993, in the Government Gazette.

OR

1.2 Regulations applicable to the Minerals Act, No 50 of 1991.

1.2.1 General provisions

* No unauthorized admittance (3.3.1), disobedience (3.12)

Workmen

* Change houses (4.3.4), complaint book (4.4.1), persons in state of intoxication (4.7.1)

Surface protection

* Life-lines (5.8.1), hard hat (5.8.3)

Protection in workings

* Tools, etc. not to be carried on ladderways (7.5.2)

Responsibility in workings

* Inflammable gas - no work (8.5.1)

Ventilation, gases and dust

* No work in harmful air (10.1.1 and 10.1.2), dust in workshops (10.2.3), use of compressed air (10.2.4), gases in workshops or other places (10.3.1), internal combustion engines underground (10.25.1 and 10.25.2)

DIDACTIC GUIDELINES

* This module differentiates between students associated with the Metal Industry (Machinery and Occupational Safety Act, 1983) or Mining Industry (Minerals Act, 1991).

* A choice question will be set on this module during examination.

* No verbatim memorisation of the regulations and regulation numbers are required.

* The booklet "Questions and Answers" on Occupational Safety by NOSA may be used for further information to lecturers and students.

* Make use of wall charts, pamphlets and videos.

* Safety precautions regarding the different machines covered in this syllabus (which include the grinding, drilling, shaping and milling machines and the lathe), will be dealt with in the corresponding module, but may also be included in this module for examination purposes.

MODULE 2: METALS AND PLASTICS

LEARNING OUTCOME

On completion of this module the student should be able to answer questions in full on the following:

2.1 Ferrous metals

* Influence of carbon on cast-iron and steel
* Classification according to the carbon content and the form of carbon in cast-iron: grey and white; low, medium and high carbon steel
* Chief properties and uses, giving reasons for the above-mentioned grades of cast-iron and steel
* Workshop tests, namely sound, spark, fracture and machining test to distinguish between cast-steel, high-speed steel, mild steel and cast-iron
* Purpose of the processes and properties given to steel by hardening, tempering, annealing, normalising and case-hardening

2.2 Ferrous alloys

* The effect of the following elements when alloyed with steel: carbon, manganese, nickel, chrome, vanadium, tungsten and cobalt and molybdenum
* The properties and uses of the various alloys which are manufactured: high speed steel, manganese steel, nickel steel, chrome steel, nickel-chrome steel, stainless steel, vanadium steel

2.3 Non-ferrous metals

* Properties and uses of tin, lead, copper, zinc, antimony and aluminium

2.4 Non-ferrous alloys

* Composition, properties and uses of brass, bronze, solder, white metal and duralumin

2.5 Plastics

* The properties and uses of Tufnol and Nylon

2.6 Colour codes of the metals generally used in a workshop, as specified by the SABS

DIDACTIC GUIDELINES

* Identify various metals and alloy samples displayed on a display board.

* Demonstrate the various workshop tests.

* Demonstrate the various heat treatment processes if facilities are available.

* No knowledge of the furnaces is required. Knowledge of percentages of content of the alloys is not required.

MODULE 3: HAND TOOLS

LEARNING OUTCOME

On completion of this module the student must be able to identify the following hand tools, describe how they should be cared for and indicate their use:

Hammers	:	Ball-pane, straight-pane, cross-pane, soft- face and general purpose 1,8 kg (4 lb) and 7,4 kg (16 lb) sledge hammer
Files	:	Hand file, flat file, square file, round file, half-round file, triangular file Bastard, 2nd cut and smooth cut Wood and plastic handles Types of cut: single and double Determination of file length
Chisels	:	Flat chisel, cross-cut chisel, round-nose chisel, diamondpoint chisel
Hacksaw	:	Tensioning blade, blade for different thicknesses of material
Punches	:	Centre, dotting (prick), pin and hollow or bell punch
Screwdrivers	:	Flat and Phillips (Star)
Pliers	:	General purpose, long nose, pipe, circlip (straight internal/external and curved internal/external)
Spanners	:	Adjustable, chain tongs (pipe), ring/-flat/socket, ratchet and extension pieces, allen keys and Stillson wrench

DIDACTIC GUIDELINES

* No drawing of tools is required in this module, but the emphasis is on the identification, specific uses and care of the tools in industry.

MODULE 4: MEASURING INSTRUMENTS

LEARNING OUTCOME

On completion of this module the student must be able to

4.1 describe the functions, methods of use, reading and representation of measuring instruments by means of drawing scales and how the following measuring instruments should be cared for:

* Outside micrometer, inside micrometer with extension rods and accessories, depth micrometer (scale reading to 0,01 mm, spindle screw thread pitch 0,5 mm)

* Vernier calliper, vernier height gauge (scale reading to 0,02 mm)

* Vernier protractor (scale reading to 5 minutes)

* Dial test indicator (plunger type 0,01 mm graduations)

NOTE: Discuss the above measuring instruments with digital (counter) and electronic digital scale reading features, where applicable.

* Methods to test the accuracy of all the micrometers and to reset the faulty instruments by adjusting the barrel and spindle nut

* Feeler gauge (thickness gauge)

* Telescopic gauge

* Thread pitch gauges

DIDACTIC GUIDELINES

Drawings of tools must be judged on the basis of identification and proportion. The focus is not on drawing skills.

* Identification of tools: the student is tested by means of freehand drawing

* Practical measurement of various manufactured test pieces with measuring instruments

* Students are to reset instruments which are set out to improve their skill and to experience the correct "feeling"

MODULE 5: MARKING-OFF

LEARNING OUTCOME

On completion of this module the student must be able to

5.1 name and give applications of the tools and accessories required for the following marking-off operations: dividers, jenny callipers, centre punch, dotting punch, scriber, combination set, V-blocks, angle plate, G or C-clamps, steel rule, measuring tape, engineer's square, surface gauge;

5.2 name the marking-off media for various surfaces, for example, marking blue, gentian violet mixture, copper sulphate and chalk; and

5.3 describe the methods of and the procedure for the marking-off of the following:

* 4, 5, 6 and 7 Holes on a pipe flange and shaft coupling (by making use of drawings as well)

* Points on a flat surface from a reference face and a given datum line or datum point (to be indicated on a drawing).

DIDACTIC GUIDELINES

* Marking-off of 5 and 7 holes must be obtained by means of the applicable construction.

* Marking-off processes can be practised by students, for example, by constructing different number of holes on a given pitch circle.

MODULE 6: SCREW-THREADS

LEARNING OUTCOME

On completion of this module, the student must be able to

6.1 identify and describe the following screw-thread terminology on a given drawing: nominal diameter, root diameter, pitch diameter, pitch, lead, flank, included angle, helix angle, depth;

6.2 explain what is meant by the following terms:

External thread, internal thread, single and multi-start screw-threads, left hand and right hand screw-threads;

6.3 calculate the depth of a metric screw-thread. ($d = 0,757 \times p$);

6.4 represent the following screw-thread profiles by means of drawings: V-thread, square and acme screw-thread; and

6.5 explain the advantages of the mentioned screw-threads and the reason for application in practice.

DIDACTIC GUIDELINES

Various types of screw-threads must be demonstrated and students must have the opportunity to identify them.

MODULE 7: HAND TAPS, STOCKS AND DIES AND REAMERS

LEARNING OUTCOME

On completion of this module the student must be able to

7.1 name the following:

* The three types of taps
  * Taper tap (first tap)
  * Intermediate tap (second tap)
  * Plug tap (third tap)
* The purpose for which a tap wrench and stocks and dies are used
* The different types of reamers:
  * parallel hand reamer (straight and spiral flutes)
  * machine reamer
  * taper reamer
  * expanding reamer
  * adjustable reamer

7.2 describe the following:

* The correct method of using taps
* How to determine tapping drill size
* The difference between left hand and right hand taps and dies
* How thread cutting faults are caused and the correction of faults
* When and how cutting compounds are used
* How to remove broken taps
* The purpose of hand reamers
* How hand reamers are used

DIDACTIC GUIDELINES

* The descriptions in paragraph 7.2 can be accompanied by simple line drawings.
* Where possible, students should have "hands on" experience.

MODULE 8: FASTENERS

LEARNING OUTCOME

On completion of this module the student must be able to

8.1 identify and explain the practical application and purpose of

* split pins;
* types of washers; (flat, spring, star, tab)
* circlips; (external and internal)
* screws; (thread cutting, self tapping, set, cap, drive, allen, hexagon socket)
* bolts; (black bolt - mild steel and machine bolt - high tensile)
* nuts; (castle, locking, Simmons and Nylock)
* locking fluid; and
* locking wire.

DIDACTIC GUIDELINES

* Students must be able to identify different fasteners from given drawings.
* No drawings of the fasteners are required.
* Examples of these fasteners have to be shown to the students.

MODULE 9: KEYS AND KEYWAYS

LEARNING OUTCOME

On completion of this module the student must be able to

9.1 draw the following key profiles:

* Rectangular key
* Taper gibhead key
* Feather key
* Woodruff key

9.2 describe the keys mentioned in paragraph 9.1 and explain their uses in industry;

9.3 calculate the height and the width of a feather key when given the required information; and

9.4 distinguish between the different machining processes applied to obtain keyways on shafts and in holes, eg. milling machine using milling cutters and slotting drills and slot-cutting machines.

DIDACTIC GUIDELINES

* Students must be shown the different types of keys and keyways.

* Formula: height of key $= \frac{D}{6}$

width of key $= \frac{D}{4}$

where D = nominal diameter of the shaft.

MODULE 10: GRINDING MACHINES (BENCH, PEDESTAL AND PORTABLE ANGLE GRINDING MACHINE)

LEARNING OUTCOME

On completion of this module the student must be able to

10.1 state the safety precautions to be observed when grinding machines are used (bench, pedestal and portable angle grinding machine);

10.2 describe how to select a grinding wheel, stating the six factors to be considered;

10.3 explain how a grinding wheel is changed and mounted, taking the following into account: relation between flange and wheel size, compressible washers, adjustment of tool rest, guard, rotation of the spindle in relation to the turning direction of the locking nut and testing for cracks (using the ring test);

10.4 identify the components of a pedestal grinding machine with the aid of a given drawing and explain the function of the components;

10.5 state the purpose and use of the grinding wheel dresser.

10.6 Explain how ordinary and diamond-tipped wheel dressers are used to true and dress a grinding wheel and state the advantages of the one type compared with the other.

DIDACTIC GUIDELINES

* Discuss the construction, operation and parts of each machine, while students have direct contact with the machine, if available.

* Demonstrate the mounting procedure of a grinding wheel.

MODULE 11: DRILLING MACHINES

LEARNING OUTCOME

On completion of this module, the student must be able to

11.1 state the safety precautions to be observed when drilling machines are being used;

11.2 identify and name the main components of the following drilling machines with the aid of a given drawing:

* Sensitive drilling machines (pedestal and pillar type)
* A radial drilling machine
* Portable hand drilling machine;

11.3 name the parts and angles on a taper shank and straight shank twist drill from a given drawing;

11.4 describe the setting up and clamping of work pieces by means of: machine vice, different clamps, angle plates and "V"-blocks;

11.5 briefly describe a method used for drilling thin plate, taking into account drill size and plate thickness;

11.6 name the points to be observed when a drilling operation is carried out;

11.7 distinguish by means of a drawing between the following drilling processes: countersinking, counterboring and spotfacing;

11.8 discuss the faults that can occur on twist drills and the reason for twist drill failures;

11.9 calculate the cutting speeds in mm/sec and spindle speeds in rev/sec or rev/min for the metals commonly used in a fitting workshop (ferrous and non-ferrous);

11.10 name the use and properties of cutting fluid

DIDACTIC GUIDELINES

To master the contents of this module practical demonstrations are advisable where facilities are available.

MODULE 12: SHAPING MACHINE

LEARNING OUTCOME

On completion of this module the student must be able to

12.1 state the safety precautions to be observed when a shaping machine is used;

12.2 state the uses of a shaping machine;

12.3 identify and name the following components on a given drawing and describe their functions:

* The column
* The ram
* The ram head
* The main slide
* The cross slide of the table
* The vertical slide of the table
* Table cross-feed and vertical feed mechanism
* Compensating link;

12.4 describe how the following is done:

* Setting the length of the stroke
* Positioning of the ram
* Raising and lowering the table
* Automatic feed of the table
* Methods of clamping the work piece
* Methods of setting the machine vice true parallel and at right angles to the movement of the ram
* Principle and functioning of the quick return motion;

12.5 calculate the speed of the ram in strokes/min and the time taken to complete the work.

DIDACTIC GUIDELINES

* No drawings are required in this module.

* Practical demonstration in this module is advisable.

* Correct machine terminology must be used.

* Shaping machine-cutting tools discussed in module 13 may also be incorporated in this module for examination purposes.

MODULE 13: MACHINE-CUTTING TOOLS

LEARNING OUTCOME

On completion of this module the student must be able to

13.1 indicate and name the cutting-, rake- and clearance angles on high-speed cutting tools and tipped tools, using line drawings;

13.2 describe the term "chip breaking";

13.3 draw the following metal cutting tools to show the profiles and application:

13.3.1 for the shaping machine -

* Roughing tool
* Grooving tool
* Finishing tool

13.3.2 for the centre lathe -

* Roughing tool (roundnose and knife tool)
* Parting tool
* Grooving tool
* Finishing tool
* Thread cutting tool;

13.4 identify and name the different types of tool holders and boring bars generally used in a workshop.

DIDACTIC GUIDELINES

* Students must be shown models of the different cutting tools, tool holders and boring bars.

* A demonstration of the grinding of the different cutting tools can be given if facilities are available.

* A demonstration of the cutting action of the metal cutting tools on the shaping machine and the centre lathe.

* No specific angles in degrees are required to be memorized.

MODULE 14: CENTRE LATHE

LEARNING OUTCOME

On completion of this module the student must be able to

14.1 state the safety precautions to be observed when using a centre lathe;

14.2 identify and name the main components of a centre lathe on a given drawing: headstock, tailstock, carriage, cross-slide, compound slide, feed shaft, leadscrew, driving plate, chucks, quick-change gearbox and apron;

14.3 discuss the following briefly:

* The classification of size and bed types
* The principles of operation
* The main purpose of the components
* Uses of the centre lathe (general turning operations, taper turning, screw-thread cutting, external and internal machining operations (boring), facing, drilling and machining irregular objects);

14.4 identify and describe the uses of accessories: ordinary tailstock centre, half, ball, pipe, and revolving centres, fixed steady and travelling steady;

14.5 briefly discuss the purpose of mandrels;

14.6 name the types of chucks used (self-centring three-jaw chuck and independent four-jaw chuck) and state the advantages and disadvantages of each type;

14.7 describe the following screw cutting methods by making use of given drawings:

* V-shaped screw-thread with compound slide set -
  * parallel with the axis of the workpiece; and
  * at half the included angle of the screw-thread
* Single and multiple start external and internal V-shaped and square threads;

14.8 describe as introduction to the Computerised Numerical Control lathe (CNC lathe):

* the working principle

* the main difference between the CNC-lathe and the Numerical Control lathe (NC lathe)

* the main differences between the CNC lathe and the conventional centre lathe;

14.9 identify and name the different parts and accessories of the CNC lathe from a given drawing and explain their functions.

14.10 describe the advantages and disadvantages of the CNC lathe when compared with the conventional centre lathe.

DIDACTIC GUIDELINES

* It will be easier for the student to master the contents of this module if practical demonstrations are used where facilities are available.

* If a college does not have a lathe, a visit to a well-equipped machine workshop is advisable.

* The general characteristics and the functions of the lathe parts and accessories must be discussed while students are brought into direct contact with the lathe.

* No programming of CNC lathe to be done.

* No memorising of the different "G" and "M" codes required.

* No drawings by the students are required in this module.

* Lathe cutting tools discussed in module 13 may also be incorporated in this module for examination purposes.

MODULE 15: MILLING MACHINE

LEARNING OUTCOME

On completion of this module the student must be able to

15.1 state the safety precautions to be observed when using a milling machine;

15.2 state five main uses of a milling machine;

15.3 distinguish between the plain and universal milling machine;

15.4 identify the following components on a given drawing:

* Table
* Overarm
* Apron
* Column (Frame)
* Arbor support
* Arbor
* Universal head
* Base
* Spindle
* Knee
* Saddle
* Table trips
* Bracing arms
* Adjustable tailstock; and

15.5 describe the functions of the components mentioned in paragraph 15.4.

DIDACTIC GUIDELINES

* If the various milling machines are available the parts may be systematically shown and discussed. Otherwise visits to suitable firms can be organised where the demonstration can be done.

* If the various milling cutters are available these can be demonstrated to the students.

* The CNC-principle must also be mentioned in this module.

REPUBLIC OF SOUTH AFRICA

COORDINATOR: ENGINEERING STUDIES

SYLLABUS FOR

FITTING AND MACHINING THEORY

N2

NATIONAL CERTIFICATE

CODE NUMBER: 11022032

IMPLEMENTATION DATE OF
NEW SYLLABUS
APRIL 1995

FIRST EXAMINATION OF
NEW SYLLABUS
AUGUST 1995

FITTING AND MACHINING THEORY N2

NATIONAL CERTIFICATE

1. SUBJECT AIMS

1.1 General subject aims

1.1.1 The student must, on successful completion of Fitting and Machining Theory N2, be equipped with sufficient theoretical knowledge to integrate meaningfully into the training programme of the engineering practice.

1.1.2 The content of the course must be offered in such a manner that a positive approach towards and enthusiasm for the instructional offering is fostered in the student.

1.2 Specific subject aims

The student must

1.2.1 experience application of the theoretical subject content through practical demonstration in the laboratory/workshop and through visual learning experiences;

1.2.2 acquire knowledge about the following subject content: Occupational safety; Couplings; Limit systems and fits; Bearings; Lubrication; Valves; Packing, Stuffing boxes and joints; Waterpipe systems (up to 50 mm diameter); Pumps; Compressors; V-belt drives; Gear drives; Chain drives; Reduction gearboxes; Pneumatics; Hydraulics; Centre lathes; Surface grinding machines and Milling machines.

2. DURATION OF INSTRUCTIONAL OFFERING

2.1 Duration

Full-time:
One trimester

Part-time:
One trimester

3. EVALUATION

3.1 Continuous evaluation

Class tests must be given on a regular basis.

4. EXAMINATION

4.1 Examination sessions

External examinations are written in April, August and

November of each year. An instructional offering is examined in its entirety.

4.2 Examination paper

The duration of the question paper is 3 hours.

Pass requirements: To pass Fitting and Machining Theory N2, the candidate must achieve a final mark of 40 %.

The question paper consists of two sections:

Section A	-	60 marks
Section B	-	40 marks
Total	-	100 marks

In section A all the questions are compulsory, but in section B a choice of relevant questions will be given to accommodate the different fitting trades. In section B questions will be set from which the candidate must make a choise, of which the total will be 40 marks. The reason for setting alternative questions is to eliminate the possibility that students in the different fitting trades are prejudiced. To provide for this, the weight values for section B total 60 of which students answer 40.

Questions set on legislation will also make provision for optional questions on the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993) and the Minerals Act, (Act No. 50 of 1991). See "General Information", paragraph 5.3.

4.3 Level of difficulty

The difficulty level in respect of knowledge, insight, application, analysis and synthesis is important and their weighted value for FITTING AND MACHINING THEORY N2 should be as follows:

LEVEL	KNOWLEDGE	UNDERSTANDING	APPLICATION	ANALYSIS AND SYNTHESIS
N2	± 45 %	± 35 %	± 10 %	± 10 %

5. GENERAL INFORMATION

5.1 Fitting and Machining Theory N2 is applicable to all the relevant fitting trades, which refer to fitting, fitting and turning, fitting including machining, turning including machining and turning.

5.2 On completion of the instructional offering the student must be able to use the applicable SI units, metric systems, recognised symbols, abbreviations and definitions

correctly.

5.3 The legal aspects contained in this instructional offering are covered by the following:

5.3.1 The Occupational Health and Safety Act, 1993 (Act No. 85 of 1993) and applicable Regulations for all students associated with the Metal Industry. Regulations that were applicable to the now repealed Machinery and Occupational Safety Act, 1983 (Act No. 6 of 1983) and later amendments are still valid today in terms of Act No. 85 of 1993.

OR

5.3.2 The Minerals Act, No. 50 of 1991, and applicable Regulations for students associated with the Mining Industry.

5.4 Emphasis is placed on the practical interpretation of the Acts rather than verbatim memorisation. The student should, in other words, be familiar with the spirit rather than the letter of the law. The booklet "Questions and Answers" on Occupational Safety of the National Occupational Safety Association (NOSA), contains relevant information on this section.

5.5 Emphasis must be placed on the correct use of technical language and engineering terminology, especially in the formulation of definitions and concepts.

5.6 All calculations are limited to a maximum of two decimals.

5.7 All calculations presuppose the use of standard formulae.

5.8 Calculations are made only where specified.

5.9 All drawings must be made diagrammatically in pencil and must be supplied with the necessary subtitles (labels).

5.10 Where possible, all demonstrations must be carried out with the aid of actual components or models.

5.11 Considerable emphasis must be placed on practical demonstrations and audio-visual aids.

5.12 The lecturers must differentiate in the class situation in so far as this is practically possible to accommodate the different fitting trades.

5.13 The presentation of this instructional offering should, where possible, be accompanied by a visit(s) to a modern workshop(s).

6. LEARNING CONTENT

6.1 The modules for Fitting and Machining N2 consist of the following (approximate weight value shown on right hand side):

SECTION A: (General practice)

Module	Description	Approximate weight value
1	Occupational safety	5
2	Couplings	6
3	Limit systems and fits	7
4	Bearings	5
5	Lubrication	3
6	Valves	3
7	Packing, stuffing boxes and joints	5
8	Waterpipe systems (up to 50 mm diameter)	4
9	Pumps	6
10	Compressors	4
11	V-Belt drives	3
12	Gear drives	3
13	Chain drives	3
14	Reduction gearboxes	3

SECTION B: (Pneumatics, hydraulics and machines)

15	Pneumatics	10
16	Hydraulics	10
17	Centre lathes	20
18	Surface grinding machines	5
19	Milling machines	15

6.2 The weight value of a module

6.2.1 indicates what percentage of the total content of the syllabus is occupied by the particular module;

6.2.2 gives an indication of what percentage of the available time allocated to the instructional offering must be spent on the module; and

6.2.3 gives an indication of what percentage of the total marks of the examination paper must be allocated to the module.

6.3 The approximate weight values must be seen only as a guideline and may vary slightly from trade to trade.

7. DETAILED SYLLABUS

MODULE 1: OCCUPATIONAL SAFETY

LEARNING OUTCOMES

On completion of this module the student must be able to describe in full the following machine regulations and answer questions on the practical application thereof:

1.1 Regulations applicable to the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993) and later amendments and the general safety precautions as specified by NOSA:

1.1.1 Regulations relating to dangerous places, projecting shaft ends, transmission belts, condition of safety appliances and machinery and grinding wheels.

1.1.2 The importance, classification characteristics and different types of guarding.

1.1.3 The precautionary measures to be taken to protect workers and maintenance crews when working on electrical equipment.

1.1.4 The basic rules for the safe use of ladders.

1.1.5 The basic rules for preventing mechanical handling accidents.

1.1.6 Pressure vessels or air receivers: information on manufacturer's plate and safety devices.

1.1.7 Standard colours of oxygen and acetylene cylinders and hoses.

1.1.8 Rules for safe handling and storing of compressed gas cylinders.

1.1.9 Basic safety measures applicable to pneumatic and hydraulic tools, equipment and machinery.

1.1.10 Safety checks to be carried out in order to operate pneumatic tools where compressed air is the power source.

1.1.11 Safety checks to be made before using portable electical equipment, including extension cords.

1.1.12 Basic rules for preventing manual handling accidents.

1.2 Regulations applicable to the Minerals Act, No. 50 of 1991.

1.2.1 Precaution against fire

* Fire prevention (11.3.1 up to 11.3.6; 11.3.8)

1.2.2 Lighting, safety lamps and contraband

* Lights to be carried (15.1), machinery to be illuminated (15.3.1), approved lamps in fiery mines and new coal mines (15.5.1) and contraband (15.9.1).

1.2.3 Traction

* Drivers of self-propelled mobile machines (18.1.1) and riding on machinery (18.3.1).

1.2.4 Machinery: Special safety measures

* Danger to be reported (20.2), dangerous places to be fenced (20.3.1 and 20.3.2), loose clothing (20.4), fencing (20.5), repairing and oiling machinery in motion (20.6), shifting driving belts (20.7.2), safety precautions (20.7.3), safety of persons (20.8), condition of safety appliances (20.9.1) and safety measures during repairs (20.9.3.1).

1.2.5 Electical installations in coal mines

* Unprotected cables (21.15.3).

1.2.6 Boilers

* Inspection and testing of boilers (22.15.5).

1.2.7 First aid rescue brigades

* First aid certificates (24.7).

1.2.8 Accidents and enquiries

* Place of accidents to be left undisturbed (25.4).

DIDACTIC GUIDELINES

* This module differentiates between students associated with the Metal Industry (Occupational Health and Safety Act, 1993) and Mining Industry (Minerals Act, 1991).

* An elective question will be set on this module during examinations.

* No verbatim memorisation of the regulations and regulation numbers is required.

* The booklet "Questions and Answers" on Occupational Safety of NOSA may be used by lecturers and students for further information.

* Make use of wall charts, pamphlets and videos.

* Safety precautions regarding certain modules covered in this syllabus (namely V-belt drives, gear drives and chain drives) will be dealt with in the corresponding module, but may also be included in this module for examination purposes.

MODULE 2: COUPLINGS

LEARNING OUTCOMES

On completion of this module the student should be able to:

2.1 Briefly explain the difference in application between a coupling and a clutch.

2.2 Classify the different couplings covered in this syllabus into three main groups, namely permanent (fixed), self-aligning and flexible couplings.

2.3 With the aid of given drawings, describe the following couplings, state their main characteristics and explain where they could be used in industry and for what reason:

* Conventional couplings, for example flange, marine, Raffard and universal (Hooke's) couplings
* Nylon sleeve couplings
* Chain couplings
* Gear couplings
* Pin and rubber bush type couplings (or leather washers)
* Rubber belt couplings (Fenner flexitype)
* Spider couplings
* Metal disc couplings
* Fluid drive couplings
* Resilient couplings.

2.4 Identify, name and describe the main function(s) of the basic components of each coupling mentioned in paragraph 2.3.

DIDACTIC GUIDELINES

* Examples of couplings used in industry must be demonstrated in order to indicate the applicable uses.

* The main parts of each coupling must be labelled by the students in a given drawing.

MODULE 3: LIMIT SYSTEMS AND FITS

LEARNING OUTCOMES

On completion of this module the student should be able to:

3.1 Explain the principles, value and functions of the ISO system of limits and fits, as well as the symbols and classification of fits.

3.2 Define and explain the following terms and represent them on a drawing where applicable:

* Basic size; nominal size; high and low limits on holes and shafts; maximum limit of size; unilateral tolerance; bilateral tolerance; allowance (maximum and minimum); shaft basis and hole basis systems.

3.3 Discuss the following:

* The interchangeability of parts

3.4 Give examples of, and name methods to obtain the following fits: shrink, press, drive, push, running and sliding fit.

3.5 Explain clearance, transition and interference fits by way of a brief description of the tolerance zone and factors which influence clearance, transition and interference fits.

3.6 Determine the sizes of the different fits mentioned in paragraph 3.5 from given measurements, drawings and tables.

DIDACTIC GUIDELINES

* Students must be shown different objects that represent the different types of fits.

* Tables are not to be memorized.

* Conventional representation by means of a drawing of the different fits (hole and shaft) is applicable.

MODULE 4: BEARINGS

LEARNING OUTCOMES

On completion of this module the student must be able to

4.1 Explain the function(s) of a bearing.

4.2 Identify and name the following types of plain (sliding) bearings (assemblies) from a given drawing:

* Pedestal bearing; plain split bearing; plumber-block bearing; taper bearing; hanger bearing; single and multi-collar thrust bearings; footstep bearing; Mitchell thrust bearing and machine slides.

4.3 Distinguish between the terms: solid bearing, split bearing, part bearing and bushes.

4.4 Describe the main parts, practical uses, mounting procedures, adjustment and operation of the plain bearings mentioned in paragraph 4.2, where applicable.

4.5 Explain the maintenance of plain bearings by referring to the following:

* Causes of failures and overheating of plain bearings
* Procedures for taking up wear in bearings and slides.

4.6 Distinguish between an ordinary bush and a split bush with or without shoulders and explain the function thereof.

4.7 Categorize the plain bearings mentioned in paragraph 4.2 as bearings which support the following loads:

* Radial loads
* Thrust loads (axial)
* Combined loads.

4.8 Briefly describe:

* The properties and applications of the materials for plain bearings, namely cast iron, bronze, white metal, nylon and tufnol
* The lubrication of plain bearings by means of oil holes and oil grooves
* The re-metalling of a split bearing (referring to the basic method only).

4.9 State the advantages and disadvantages of plain (sliding) bearings

4.10 Identify and name the following rolling bearings (antifriction bearings) from a given drawing:

* Single and double row radial ball bearings
* Single and double row radial cylindrical roller bearings
* Thrust ball and roller bearings (single and double direction)
* Single row angular-contact ball bearings
* Spherical (barrel) roller bearings
* Tapered roller bearings
* Self-alignment bearings (ball and rollers)
* Needle (roller) bearing

4.11 Discuss ordinary rubber seals, metal seals and prepacked bearings, where applicable, for the bearings mentioned in paragraph 4.10.

4.12 Identify and name the main components of the anti-frictional bearings mentioned in paragraph 4.10.

4.13 Describe:

* The operation, general maintenance and uses of the different types of bearings mentioned in paragraph 4.10.

4.14 Describe the installation of anti-friction bearings under the following headings:

* Fitting procedure (including lubrication)
* Mounting methods
* Bearing failures
* Cleaning of the bearings.

4.15 Distinguish between the different types of bearings to support the following loads:

* Radial load
* Thrust load
* Angular load

4.16 Name the advantages and disadvantages of anti-friction bearings

DIDACTIC GUIDELINES

* Demonstrate the various types of bearings with the aid of demonstration boards on which all the various bearing types are mounted. A demonstration board can also be obtained from manufacturers of rolling bearings.

* Make use of video recordings on bearings where the care, mounting and general theory are presented thoroughly and professionally.

* Invite representatives of the bearing manufacturers to give a lecture which can by supplemented with video recordings to convey valuable information to the students.

* Demonstrate samples of the various bearing materials used in the manufacturing process of plain bearings. The different properties can possibly be illustrated by machining the various metals.

MODULE 5: LUBRICATION

LEARNING OUTCOMES

On completion of this module the student must be able to:

5.1 Classify lubricants into THREE main types (solid, semi-solid, liquid) and discuss their suitability and application for the purpose and conditions under which they are used.

5.2 Explain the following lubrication terms: rubbing pressure; rubbing speed, temperature with regard to flash-point, burning point and cold point, viscosity; adhesion and cohesion.

5.3 Discuss the following briefly:

* Hydrodynamic lubrication
* Properties that lubricants should have
* Choice of a lubricant
* Functions of lubricants

5.4 Identify, name and categorize the following lubricating devices and explain the working principles of each:

5.4.1 Force (pressure-feed) lubrication

* Oil or grease-gun

5.4.2 Gravity feed

* Siphon-wick lubricator
* Sight-feed lubricator
* Needle lubricator

5.4.3 Grease lubrication

* Stauffer grease-cup
* Tell-tale grease-cup

5.4.4 Splash lubrication (oil bath) using the following components:

* Scoop
* Worm
* Gear
* Oil-ring

5.4.5 Full-pressure lubrication system

5.5 Explain the reasons for using cutting fluids and cutting oil.

DIDACTIC GUIDELINES

* Show students different lubricants, cutting fluids and lubricating devices.

MODULE 6: VALVES

LEARNING OUTCOMES

On completion of this module the student must be able to:

6.1 Explain the function of a valve.

6.2 Show by means of a simple line drawing and explanation the basic working principle of a valve.

6.3 Identify, name, label and describe the main parts of the following valves applicable to water, gas, steam and high air-pressure installations, with the aid of given drawings, and stating where and why they are commonly used in industry in specific conditions.

* Gate valve
* Diaphragm valve
* Safety valves for gas and steam pipelines
* Relief valve for liquids
* Non-return valve
* Butterfly valve
* Ball valve
* Foot valve

6.4 Describe the working principle of the valves mentioned in paragraph 6.3.

DIDACTIC GUIDELINES

No drawings of the different valves mentioned in paragraph 6.3 are required from students in this module.

MODULE 7: PACKING, STUFFING BOXES AND JOINTS

LEARNING OUTCOMES

On completion of this module the student must be able to:

7.1 Name the basic functions of packing and seals.

7.2 Name and give a brief description of each of the following types of packing, packing materials and seals for water, air and steam:

* rubber; neoprene; nylon; teflon; graphite coated braided continuous square-shaped strand made from raw natural materials; non-reinforced or reinforced cotton or asbestos material; aluminium and white metal (babitt metal).

7.3 Briefly describe the installation of seals and O-rings in hydraulic and pneumatic systems, and in piston and cylinder assemblies.

7.4 Briefly describe the method of packing a stuffing box

* with soft packing (including a lantern ring)
* with soft packing (excluding a lantern ring)
* with metallic packing for a steam assembly

7.5 Identify, name, label the main parts and state where the following joints and bends are used in industry:

* Flanged joints
* Expansion joints
* Continuous expansion bends
* Packed expansion sliding joint
* Corrugated expansion joint

7.6 State the reasons for

* using jointing materials
* the failure of flanged joints
* the lagging (insulation) of water and steam pipe lines

DIDACTIC GUIDELINES

* No drawings of the different joints and bends mentioned in paragraph 7.5 are required from students in this module.

* Examples of the different types of packings, seals and joints must be shown to the students.

MODULE 8: WATER PIPE SYSTEM (UP TO 50 MM DIAMETER)

LEARNING OUTCOMES

On completion of this module the student must be able to:

8.1 Indicate the following pipe size terms on a given drawing:

* Outside diameter
* Inside diameter
* Wall thickness
* Pipe length.

8.7 Identify and name the following types of pipe fittings and state their applications:

* 90 ° elbow
* Pipe union
* Plug
* Cap
* Nipple
* T-piece
* Cross piece
* Socket
* Reducing bush
* Reducing socket

8.3 Explain the following joining methods for -

8.3.1 Steel water pipes:

* Bell-and-spigot
* Welded
* Soldered or brazed
* Screwed (threaded)
* Flanged

8.3.2 Plastic water pipes:

* Butt-and-strap joint
* Fillet welding
* Screwed (threaded)
* Flanged

8.4 Distinguish between:

8.4.1 Thermoplastic piping, for example Polyvinyl Chloride (PVC) and Polyethylene (PE).

8.4.2 Thermosetting plastic piping, for example epoxies and polyester.

8.5 Discuss the advantages and disadvantages of plastic piping.

8.6 Briefly describe how pipe cutters and reamers are used.

8.7 Briefly describe the materials used to seal threaded pipes, for example copper jointing compound, sisal string, Teflon and PVC tape.

DIDACTIC GUIDELINES

* Examples of the different types of pipe fittings and materials mentioned in this module must be shown to the students.

MODULE 9: PUMPS

LEARNING OUTCOMES

On completion of this module the student must be able to:

9.1 Explain the function of pumps.

9.2 Identify, classify and name the pumps, label the main parts (components) of each pump and explain the function(s) of the parts in the assembly from a given drawing:

NOTE: The main parts (components) to be considered are in brackets

9.2.1 Centrifugal pumps

* **Single stage pump** (impeller; casing [indicate inlet and outlet]; shaft; stuffing box; bearing(s)).

* **Multi-stage pump** (impellers; casing and different stage segments [indicating inlet and outlet]; shaft; stuffing box; balancing disc; bearing(s)).

9.2.2 Rotary pumps

* **Gear pump** (driver and driven gears [spur, helical and herringbone gears]; casing [indicate inlet and outlet]; shaft(s); endplate(s); bearings or bushes).

* **Helical screw gear pump** (screw rotor [driver]; screw rotor(s) [driven {idler}]; casing [indicate inlet and outlet]; shaft; bearings or bushes).

* **Vane type pump** (ordinary and spring-loaded impeller vanes; slotted rotor; casing (indicate inlet and outlet]; spring(s); endplate(s); bearing or bushes).

* **Flexible impeller pump** (impeller [flexible rubber]; casing [indicate inlet and outlet]; shaft; endplate(s); bearings or bushes).

9.2.3 Reciprocating pumps

* **Piston pump** (piston with ring(s); casing; valves [inlet and outlet]; stuffing box; piston-rod; cylinder housing; air vessel; bushes).

* **Plunger pump** (plunger [with or without packing]; casing; valves [inlet and outlet]; stuffing

box; rod; air vessel; bushes).

* **Steam- and air-driven reciprocating pumps** (piston(s) with ring(s); connecting rod; plunger(s); stuffing boxes, valves [inlet and outlet]; cross-head; cylinder housing(s); endplates).

9.3 Explain the following reciprocating pump terminology:

* Simplex and duplex pumps
* Single acting and double acting pumps

9.4 Compare and explain the working principle of the pumps mentioned in paragraph 9.2.

9.5 Differentiate between positive and non-positive displacement pumps and give examples of where each is preferably used.

DIDACTIC GUIDELINES

* No drawings of the different pumps and main pump parts mentioned in or applicable to 9.2.1 - 9.2.3 are required from students in this module.

* It will be easier for the student to master the contents of this module if the various pumps are available and can be demonstrated and discussed.

* Examples of single parts, for example impellers, pistons and small valves will also simplify the content of this module. Videos, posters and other information can also be of great help.

MODULE 10: COMPRESSORS

LEARNING OUTCOMES

On completion of this module the student must be able to:

10.1 Explain the function of compressors.

10.2 Identify, classify and name the compressors, label the main parts (components) of each compressor from a given drawing and explain the function(s) of the parts in the assembly:

10.2.1 **Reciprocating piston compressors**

* Single-stage and multi-stage compressors
* Single- and double-acting compressors

NOTE: Parts to be considered are the following:

* Piston; piston rings; low and high pressure cylinders; connecting rod with cotter; crankshaft; inlet and outlet valves (feather type, disc type and channel type); inter-cooler and after-cooler (air-cooled and water-cooled); crosshead; eccentric sheave and strap; bearings.

10.2.2. **Rotary compressors**

NOTE: The main parts to be considered are in brackets:

* **Vane compressor** (housing [casing] with inlet and outlet, sliding vanes, slotted rotor, drive-shaft)

* **Rotary screw compressor** (housing [casing] with inlet and outlet, two rotors or lobes - concave [female] and convex [male], gears and bearings)

* **Lobe compressor** (housing [casing] with inlet and outlet, impellers with 2, 3 or 4 lobes, gears and bearings)

* **Single- and multi-stage centrifugal compressor** (housing [casing] with inlet and outlet, impeller, drive-shaft and bearings).

10.3 Name the components of a compressed air system not mentioned in paragraph 10.2 and state the function of each component, for example

* air filter, air reservoir (receiver), pressure gauge, safety valve, water separator, start-stop control and motor.

10.4 Compare and explain the working principle of the compres-

sors mentioned in paragraph 10.2.

DIDACTIC GUIDELINES

* A compressor layout must be used to show the components functioning in a compressed air system.

* A diagrammatic representation or a poster can be of great help.

MODULE 11: V-BELT DRIVES

LEARNING OUTCOMES

On completion of this module the student must be able to:

11.1 Discuss or list the safety precautions to be observed when working on or around V-belt drives.

NOTE: Also see Transmission Belts in module 1, 'Occupational Safety', paragraph 1.1.1.

11.2 Explain the application of V-belts.

11.3 List the advantages and disadvantages of V-belt drives when compared with chain drives and gear drives.

11.4 Identify, name and indicate the following V-belt drive terms from a given drawing:

* Driver, idler and driven pulleys
* Pulley pitch diameter (Effective diameter)
* Belt pitch length (Belt length)
* Centre distance between pulleys
* Arc of contact
* Speed ratio

11.5 Explain the belt drive terms mentioned in paragraph 11.4.

11.6 Name the most common of V-belts and state their uses (standard group, represented by the letters A, B, C, D and E and the high capacity belts), as well as special V-belts (double angle or hexagon shaped and adjustable or linked types).

11.7 Represent the composition of a V-belt by means of a labelled sectional drawing.

11.8 Distinguish between a V-pulley for a single-belt or multiple-belt drive pulley by means of a simple drawing.

11.9 Briefly describe the following:

* The checking of V-belt size and lengths
* Maintaining V-belt drives and practising faultfinding
* Lining-up, tensioning and matching of V-belts
* Installing V-belts

11.10 Describe deflection of belts.

DIDACTIC GUIDELINES

* Show students different V-pulleys and V-belts.

* Various sizes and lenghts of V-belts must be demonstrated.

* Demonstrate lining-up and tensioning devices if models are available.

MODULE 12: GEAR DRIVES

LEARNING OUTCOMES

On completion of this module the student must be able to:

12.1 Discuss or list the safety precautions to be observed when working on or around gear drives.

12.2 Explain the application of gear drives.

12.3 List the advantages and disadvantages of gear drives when compared with V-belt drives and chain drives.

12.4 Distinguish by using line drawings, the difference between the cycloid and an involute geartooth profile.

12.5 Explain the principle of velocity ratios and mechanical advantage using different sized gears in a gear assembly.

12.6 Explain the purpose of intermediate gears, e.g. changing direction of rotation.

12.7 Name the factors which determine the correct meshing of gear teeth.

12.8 Distinguish between a simple geartrain and compound geartrain by making use of line drawings.

DIDACTIC GUIDELINES

* Students must have the opportunity to see gears in operation (e.g. change gears on the lathe), proper meshing of teeth and the effect of intermediate gears on the rotation of the driven gear.

* An acceptable profile of the involute gear tooth must be illustrated. No construction of the involute profile is required.

MODULE 13: CHAIN DRIVES

LEARNING OUTCOMES

On completion of this module the student must be able to:

13.1 Discuss or list the safety precautions to be observed when working on or around chain drives.

13.2 Explain the application of chain drives.

13.3 List the advantages and disadvantages of chain drives when compared with V-belt drives and gear drives.

13.4 Identify, name and indicate the following chain drive terms from a given drawing:

* Driver, idler and driven sprockets
* Sprocket pitch diameter (Effective diameter)
* Chain length
* Centre distance between sprockets
* Chain pitch

13.5 Explain the chain drive terms mentioned in paragraph 13.4.

13.6 Identify and name the most common types of chains used in chain drives:

* Single and multiple strand roller chains
* Double pitch roller chains
* Silent chains
* Leaf chains

13.7 Indicate the following components on a given drawing to explain the construction of a roller chain:

* Pin link plate (outer link plate)
* Roller link plate (inner link plate)
* Rollers
* Bushing
* Pins

13.8 Distinguish between the following types of sprockets:

* Solid sprocket
* Solid sprocket with spokes
* Split sprocket with spokes

13.9 Briefly describe the following:

* Maintaining chain drives and practising faultfinding
* Aligning sprockets and tensioning chains

13.10 Describe deflection of chains.

DIDACTIC GUIDELINES

* Show the different chain types and sprockets to the students.

* Demonstrate the maintenance of chain drives, alignment of sprockets and tensioning procedures of chains.

MODULE 14: REDUCTION GEARBOXES

LEARNING OUTCOMES

On completion of this module the student must be able to

14.1 Discuss or list the safety precautions to be observed when working on gearboxes.

14.2 Explain the application of gearboxes and reduction gearboxes.

14.3 Identify, name and label the main parts (components) of the following reduction gearboxes from a given drawing:

NOTE: The main parts to be considered are in brackets:

* **A single and double reduction gearbox** (casing; drive gear and driven gear(s) [spur or helical]; input shaft; output shaft; bearings).

* **A worm and worm wheel reduction gearbox** (casing; worm; worm wheel; input shaft; output shaft; bearings).

14.4 Briefly describe and compare the operation of the following, using applicable line drawings:

* A single reduction gearbox

* A worm and worm wheel gearbox.

DIDACTIC GUIDELINES

* A sectional gearbox must be used to show the working principle and different parts.

* Videos, posters and other information can be of great help.

* The dividing head can also be used to explain the principle of reduction.

MODULE 15: PNEUMATICS

LEARNING OUTCOMES

On completion of this module the student must be able to:

15.1 State the two most factors in the functioning of a pneumatic system, i.e. pressure and area (the units must be stated).

15.2 Name the five basic components in a pneumatic system and state their functions, e.g.

* compressor
* air receiver
* piping
* valves (pressure relief, control, sequence, non-return)
* actuating unit (motor, cylinder)

15.3 State the factors which cause the force in the actuator and the speed at which the actuator moves, i.e. pressure, volume.

15.4 Explain the daily maintenance of a pneumatic system.

15.5 Recognise, draw and name the symbols of components used in a pneumatic system, as contained in this module.

15.6 Design a simple pneumatic circuit using components mentioned in this module.

DIDACTIC GUIDELINES

* Examples of the different components mentioned in this module must be shown to the students.

* Demonstration boards with different pre-compiled circuits must be available to students where possible.

MODULE 16: HYDRAULICS

LEARNING OUTCOMES

On completion of this module the student must be able to:

16.1 State the three main functions of oil in a hydraulic system.

16.2 State the two most important factors in the functioning of a hydraulic system, i.e. pressure and area (the units must be stated).

16.3 Name the five basic components in a hydraulic system and state their functions, i.e.

* pump
* reservoir
* piping
* valves (pressure relief, control, regulator, pressure reduction, sequence, non-return)
* actuating unit (motor, cylinder)

16.4 State the function(s) of the velves mentioned in paragraph 16.3.

16.5 Recognise, draw and name the symbols of components used in a hydraulic system, as contained in this module.

16.6 Design a simple hydraulic circuit using components mentioned in this module.

DIDACTIC GUIDELINES

* Examples of the different components mentioned in this module must be shown to the students.

* Demonstration boards with different pre-compiled circuits must be available to students where possible.

MODULE 17: CENTRE LATHES

LEARNING OUTCOMES

On completion of this module the student must be able to:

17.1 Briefly describe the advantages of using mandrels and give examples of when they would be used.

17.2 Explain why different clearance angles are necessary on different lathe cutting tools.

17.3 Describe the following uses of a fixed and travelling steady with practical applications, where necessary, when

* supporting long workpieces on a centre lathe
* turning a long small-diameter shaft on a centre lathe
* supporting a square bar on a centre lathe

17.4 Describe methods of setting the tailstock of a centre lathe over by the dial test indicator and the graduated sleeve method to cut a taper, with special reference to the advantages and disadvantages of each method.

17.5 Calculate the correct set-over of the tailstock of a centre lathe and adjustment of the compound slide using given information applicable to a centre lathe for cutting a taper.

17.6 Calculate the angles on the lathe cutting tool when the required information given is applicable to square screw threads:

* The helix angle
* The leading angle of the lathe cutting tool
* The following angle of lathe cutting tool

17.7 Calculate the cutting speed, spindle speed and cutting feed of a centre lathe.

17.8 Name the THREE basic instructional forms applicable to a Computerised Numerical Control lathe (CNC lathe), namely:

* G commands (codes)
* M commands (codes)
* Positional data (movement on X and Y axis)

17.9 Explain briefly and distinguish between the following TWO types of programming:

17.9.1 Absolute
17.9.2 Incremental

17.10 Explain the basic principles that apply to the programming of a CNC lathe to be able to machine a work piece with a simple profile.

DIDACTIC GUIDELINES

* It will be almost impossible for the student to master the contents of this module unless practical demonstrations are used.

* If a college does not have a lathe, a visit must be made to a well-equipped machine workshop.

* The students must be brought into contact with the lathe when the general properties and functioning of the lathe parts and lathe accessories are discussed.

* The machining of tapers and a simple V-screw thread must be demonstrated to the students.

* More advanced screw-cutting operations can also be demonstrated.

* No actual programming is applicable in this module.

MODULE 18: SURFACE GRINDING MACHINES

LEARNING OUTCOMES

On completion of this module the student must be able to:

18.1 Describe the reasons for surface grinding as well as the following with practical applications, where needed:

* Types of surface grinding machines
* Horizontal spindle reciprocating table
* Vertical spindle rotary table.

18.2 Explain the types of grinding, i.e. off-hand grinding and precision grinding.

18.3 Identify and select grinding wheels for specific materials.

18.4 Explain the following terms which apply to grinding wheels:

* Grit size
* Letters designating grade
* Grain spacing or structure
* Structure number.

18.5 Describe briefly the different types of bonds and discuss grinding wheel markings.

18.6 Discuss the uses of, and identify or represent the profiles of the following grinding wheels by making use of simple line drawings:

Disc grinding wheel (straight wheel), cup grinding wheel, flaring (flared) cup grinding wheel, double cup grinding wheel.

18.7 Describe the following grinding faults:

* Scratching of work piece
* Chatter marks on work piece
* Burning of work piece
* Loading of grinding wheel (grinding surface)
* Glazing of grinding wheel (grinding surface).

DIDACTIC GUIDELINES

* Demonstrate grinding wheel types and the selection and mounting of grinding wheels.

* Grinding wheel manufacturers can be approached for samples, videos, posters and other relevant information.

MODULE 19: MILLING MACHINES

LEARNING OUTCOMES

On completion of this module the student must be able to:

19.1 State the function and uses of dividing heads.

19.2 Identify the following components from a given drawing of a dividing head and explain their function:

* The index plate
* The crank handle
* The adjustable plunger (index pin)
* The sector-arms.

19.3 State the purpose and give a description of the following types of indexing: rapid, simple, angular and differential indexing.

19.4 Explain the difference between the Cincinnati index plates and the Brown & Sharpe index plates.

19.5 Calculate the following indexing with practical applications, for example

* 6 divisions
* 12 divisions
* 40° 15'
* 139 divisions.

19.6 Identify from given drawings and briefly describe the uses of the following milling cutters:

* Plain helical slab milling cutter
* Side and face cutter
* End mill
* Slot drill
* Slotting cutter
* Slitting saw
* T-slot cutter
* Dovetail cutter.

19.7 State the reasons for the use of the smallest diameter milling cutter and nicked helical cutter.

19.8 State the advantages of coarse-toothed milling cutters.

19.9 Indicate the angles on milling cutters by means of given line drawings: primary clearance, secondary clearance, rake angle and land.

19.10 Calculate milling speeds and feeds.

19.11 Represent the following machining processes by means of simple line drawings: