

REPUBLIC OF SOUTH AFRICA

SYLLABUS

FOR

MECHANOTECHNOLOGY N3

CODE NUMBER: 08190373

Examination Instruction no. 14/97

IMPLEMENTATION DATE
May 1997

DATE OF FIRST EXAMINATION
August 1997

MECHANOTECHNOLOGY N3**NATIONAL CERTIFICATE****1. SUBJECT AIMS****1.1 General subject aims**

- 1.1.1 The student must, on successful completion of Mechano-technology N3, be equipped with sufficient knowledge to pursue further studies and to integrate meaningfully into the training programme of the mechanical engineering field.
- 1.1.2 The content 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 learning content through practical demonstration in the laboratory/workshop and through visual learning experiences:
- 1.2.2 Acquire knowledge about the following learning content:
- * Power Transmission
 - * Brakes
 - * Bearings
 - * Water Pumps, Cooling and Lubrication
 - * Hydraulics and Pneumatics
 - * Internal Combustion Engines
 - * Cranes and Lifting Machines
 - * Material and Material Processes
 - * Industrial Organisation and Planning
 - * Entrepreneurship

2. DURATION OF INSTRUCTIONAL OFFERING**2.1 Duration**

Full-time: One trimester
Part-time: One trimester

3. EVALUATION**3.1 Continuous evaluation**

Candidates must be evaluated continuously.

4. EXAMINATION

4.1 Examination sessions

External examinations are written. An instructional offering is examined in its entirety.

4.2 Examination paper

The duration of the question paper is three (3) hours.

Pass requirements: To pass Mechanotechnology N3, the candidate must achieve a minimum mark of 40 %.

4.3 Level of difficulty

The difficulty level in respect of knowledge, insight, application, analysis and synthesis is important and their weighted value for Mechanotechnology N3 should be as follows:

| LEVEL | KNOWLEDGE | UNDERSTANDING | APPLICATION | ANALYSIS AND SYNTHESIS |
|-------|-----------|---------------|-------------|------------------------|
| N3 | ± 50 % | ± 20 % | ± 20 % | ± 10 % |

5. GENERAL INFORMATION

- 5.1 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.
- 5.2 Emphasis must be placed on the correct use of technical language and engineering terminology, especially in the formulation of definitions and concepts.
- 5.3 All calculations are limited to a maximum of two decimals.
- 5.4 All calculations presuppose the use of standard formulae.
- 5.5 Calculations are made only where specified.
- 5.6 All drawings must be made diagrammatically in pencil and must include the necessary subtitles (labels).
- 5.7 Where possible, all demonstrations must be carried out with the aid of actual components or models.
- 5.8 Considerable emphasis must be placed on practical demonstrations and audio-visual aids.
- 5.9 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 Mechanotechnology N3 consist of the following (approximate weight value shown on right hand side):

| Module Description | Approximate weight value |
|---|--------------------------|
| 1. Power Transmission | 20 |
| 2. Brakes | 5 |
| 3. Bearings | 10 |
| 4. Water pumps, cooling and lubrication | 15 |
| 5. Hydraulics and pneumatics | 10 |
| 6. Internal combustion engines | 5 |
| 7. Cranes and lifting machines | 8 |
| 8. Material and material processes | 7 |
| 9. Industrial organisation and planning | 12 |
| 10. Entrepreneurship | 8 |

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: POWER TRANSMISSION

LEARNING OUTCOMES

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

1.1 BELTS AND CHAIN DRIVES

- 1.1.1 Explain the difference between a V (vee) and wedge belt (endless and segment type) in terms of power transmission and construction of the belt
- 1.1.2 Discuss the difference between wedge belt and chain drives in respect to pulleys, sprocket, slip, tension, maintenance, lubrication and centre distance
- 1.1.3 Select wedge belts by means of (a) basic calculations (b) using a catalogue in terms of the following:
 - 1.1.3.1 Speed ratio
 - 1.1.3.2 Safety factor (service factor)
 - 1.1.3.3 Design power
 - 1.1.3.4 Belt section
 - 1.1.3.5 Minimum pulley diameter
 - 1.1.3.6 Pulley pitch diameter
 - 1.1.3.7 Belt length
 - 1.1.3.8 Centre distance between pulleys
 - 1.1.3.9 Correction factor
 - 1.1.3.10 Basic power per belt
 - 1.1.3.11 Number of belts
- 1.1.4 Explain the installation procedure of wedge belt drives and chain drives

1.2 GEARS DRIVES

- 1.2.1 Explain the following terms:
 - 1.2.1.1 Pitch circle diameter (effective diameter)
 - 1.2.1.2 Addendum
 - 1.2.1.3 Dedendum
 - 1.2.1.4 Module
 - 1.2.3.5 Circular pitch
 - 1.2.3.6 Circular tooth thickness
- 1.2.2 Identify and name from given drawings the following gear types:
 - 1.2.2.1 Spur
 - 1.2.2.2 Helical
 - 1.2.2.3 Double helical (herringbone)
 - 1.2.2.4 Worm and wheel
 - 1.2.2.5 Bevel
 - 1.2.2.6 Rack and pinion

- 1.2.3 Distinguish between the gear drives listed above in terms of constructional features and applications
- 1.2.4 Differentiate between simple, compound and planetary epicyclic trains from given drawings
- 1.2.5 Explain the relationship between speed reduction and torque multiplication

1.3 COUPLING OF SHAFTS

- 1.3.1 Identify from given drawings and list the following categories and types of couplings:
 - 1.3.1.1 Permanent (Fast) Couplings
 - (i) Muff couplings
 - (ii) Flange couplings
 - 1.3.1.2 Flexible Couplings
 - (i) Pin-type with leather or rubber band
 - (ii) Rubber type coupling (flexible tyre coupling)
 - (iii) Bibby type coupling (Steelgrid)
 - 1.3.1.3 Self Aligning Couplings
 - (i) Oldham coupling
 - (ii) Universal coupling
- 1.3.2 Describe the features of the type of couplings mentioned in paragraph 1.3.1 above
- 1.3.3 Identify and label the basic parts of the given couplings mentioned in paragraph 1.3.1

1.4 CLUTCHES

- 1.4.1 Identify, name and list from given drawings the following categories and types of clutches:
 - 1.4.1.1 Positive
 - (i) Claw clutch
 - (ii) Spiral clutch
 - 1.4.1.2 Friction
 - (i) Single disc
 - (ii) Multidisc clutch
 - (iii) Cone clutch

1.4.1.3 Centrifugal

(i) Loose weight

1.4.1.4 Hydraulic

1.4.2 Briefly describe the basic working principle of the following categories of clutches:

1.4.2.1 Positive

1.4.2.2 Hydraulic

1.4.2.3 Friction

1.4.2.4 Centrifugal

1.4.3 Compare the features of the two positive types of clutches mentioned in 1.4.1.1

1.4.4 Compare the features of the three friction types of clutches mentioned in 1.4.1.2

1.4.5 Label (from a given drawing) the basic parts of all the clutches mentioned in paragraph 1.4.1

1.4.6 State the advantages and disadvantages of all the clutches mentioned in paragraph 1.4.1

1.5 Discuss and compare the factors that will be taken into consideration in the application of each of the transmission methods mentioned in paragraph 1.1 to 1.4

DIDACTICAL GUIDELINES

Students must be exposed with a variety of catalogues from different belt manufacturers in the class situation.

MODULE 2: BRAKES**LEARNING OUTCOMES**

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

- 2.1 Describe the purpose of a brake
- 2.2 Describe the activating and the de-activating action in respect to the following brake operating principles:
 - 2.2.1 Electromagnetic
 - 2.2.2 Hydraulic
 - 2.2.3 Air (spring)
 - 2.2.4 Mechanical
- 2.3 Describe the advantages and disadvantages of each of the braking systems mentioned in paragraph 2.2 above
- 2.4 Compare the advantages and disadvantages of the following braking units:
 - 2.4.1 Disc brake
 - 2.4.2 Internal drum and shoe brake
 - 2.4.3 External drum and band brake
 - 2.4.4 Cone brake

DIDACTICAL GUIDELINES

Excursion to training centres in the industry where the different braking systems are used to enlighten the learning content in this module.

MODULE 3: BEARINGS**LEARNING OUTCOMES**

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

- 3.1 Explain the difference between friction bearings (bush type) and anti-friction bearings (rolling bearings)
- 3.2 Identify and name the following anti-friction bearings from a given drawing:
 - 3.2.1 Single and double row radial ball bearing
 - 3.2.2 Single and double row radial cylindrical roller bearing
 - 3.2.3 Thrust ball and thrust roller bearing (single and double direction)
 - 3.2.4 Single row angular contact bearing
 - 3.2.5 Tapered roller bearing
 - 3.2.6 Needle roller bearing
 - 3.2.7 Spherical roller bearing
- 3.3 Describe bearing failures and preventions thereof
- 3.4 Name the three main types of loads and the specific type of load applicable to the bearings mentioned in paragraph 3.2
- 3.5 State the factors (in relation to paragraph 3.4) that have a detrimental effect on the bearings mentioned in paragraph 3.2
- 3.6 Select the correct type and size bearing with the aid of a manufacturer's catalogue (no calculations).

DIDACTIC GUIDELINES

- * Make use of recent local manufactures catalogues to show students how to read off information to be used in paragraph 3.6.
- * Make use of video recordings on bearings where the different types, loads, failures and preventions are shown.
- * Demonstrate the different types of bearings to students.

MODULE 4: WATER PUMPS, COOLING AND LUBRICATION

LEARNING OUTCOMES

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

4.1 WATER PUMPS

4.1.1 Describe the difference between a centrifugal (non positive displacement) water pump and a reciprocating (positive displacement) water pump with regard to the working principle

4.1.2 Identify the main parts from a given drawing and explain the functions of the main parts for the pumps mentioned in paragraph 4.1.1

4.1.2.1 Reciprocating water pumps - single and double acting (piston and plunger types)

Main parts:

- inlet valve, outlet valve, piston with rings, plunger with or without packing, mechanical seal, stuffing box, air vessel, and piston

4.1.2.2 Centrifugal water pumps (single and multi-stage types)

Main parts:

- impeller, casing, (inlet and outlet), shaft, mechanical seal, stuffing box, balancing disc and stages.

4.1.3 Explain the following regarding water pumps:

- Reading of basic pump curves
- Maximum suction head with respect to atmospheric pressure $\pm 10\text{m}$
- Incapability to pump hot water

4.1.4 Describe the stopping and starting procedures of a centrifugal water pump for positive and negative suction

4.1.5 Identify from a given drawing basic components in a water pump system

4.1.6 Explain the reasons for good, planned maintenance procedures under the following headings:

- service, inspection (maintenance plan, maintenance requirements), repair (planning), reconditioning (overhauling plan) and testing.

- 4.1.7 Interpret the functions of maintenance control sheets such as a fluid record, fluid inspection plan, discrepancy report and a data test sheet

DIDACTICAL GUIDELINES

- * Use wall charts which can illustrate pumps in more detail.
- * It is not necessary for students to make drawings of the different pumps or main parts of the pumps.
- * Demonstration models of various pumps and or main parts of the various pumps can be used to make students more familiar with the practical environment.

4.2 COOLING

- 4.2.1 Describe the need for cooling of the following:
- 4.2.1.1 Internal combustion engines (petrol and diesel)
 - 4.2.1.2 Compressors
 - 4.2.1.3 Electric motors
 - 4.2.1.4 Welding machines (AC and DC)
- 4.2.2 Discuss and compare the advantages and disadvantages of the following air cooling systems:
- 4.2.2.1 Direct cooling
 - 4.2.2.2 Indirect cooling
- 4.2.3 Compare the advantages and disadvantage of the following water (coolant) cooling systems:
- 4.2.3.1 Thermosyphon (siphon) cooling system
 - 4.2.3.2 Impeller assisted cooling systems
- 4.2.4 Describe the principle and function of:
- 4.2.4.1 Heat exchangers
 - 4.2.4.2 Oil coolers
- 4.2.5 Explain the causes, dangers and prevention of:
- 4.2.5.1 Overcooling
 - 4.2.5.2 Overheating

4.3 LUBRICATION

4.3.1. Describe the need for lubrication of the following:

- 4.3.1.1 Bearings
- 4.3.1.2 Gearboxes (including reduction gearboxes)
- 4.3.1.3 Compressors
- 4.3.1.4 Internal combustion engines (petrol and diesel engines)

4.3.2 Discuss the purpose of oil filtering

4.3.3 Explain the working concept and applications of the following lubrication methods:

- 4.3.3.1 Lubrication by mixing oil and petrol
- 4.3.3.2 Splash lubrication
- 4.3.3.3 Siphon wick lubrication
- 4.3.3.4 Sight feed lubrication (gravity feed)
- 4.3.3.5 Force-feed lubrication
- 4.3.3.6 Dry-sump lubrication
- 4.3.3.7 Manual feed

DIDACTIC GUIDELINES

Make use of wall charts, pamphlets and videos relating to this module.

MODULE 5: HYDRAULICS AND PNEUMATICS**LEARNING OUTCOMES**

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

5.1 HYDRAULICS

5.1.1 Explain the following important factors to consider in a hydraulic system:

- 5.1.1.1 Pressure
- 5.1.1.2 Flow rate
- 5.1.1.3 Area

5.1.2 Describe the functions of the following basic components in a hydraulic system:

- 5.1.2.1 Motor
- 5.1.2.2 Pump
- 5.1.2.3 Reservoir
- 5.1.2.4 Valves
- 5.1.2.5 Pipes
- 5.1.2.6 Actuator
- 5.1.2.7 Fluid (water or oil)
- 5.1.2.8 Accumulators

5.1.3 Identify the following symbols in a basic hydraulic system:

- 5.1.3.1 Motor (vane, gear and piston type)
- 5.1.3.2 Pump
- 5.1.3.3 Pressure gauge
- 5.1.3.4 Pressure relief valve (directional control and flow control)
- 5.1.3.5 4 port 2 position directional control valve
- 5.1.3.6 Actuator (cylinder, motor)
- 5.1.3.7 Reservoir
- 5.1.3.8 Filters
- 5.1.3.9 Accumulators

5.1.4 Arrange a basic hydraulic circuit by using the components given in paragraph 5.1.3

5.1.5 State the three characteristics of the fluid in a hydraulic system

5.1.6 Calculate the pressure, area and force in a hydraulic system from given information

5.2 PNEUMATICS

5.2.1 Explain the following important factors to consider in a pneumatic system:

- 5.2.1.1 Pressure
- 5.2.1.2 Flow rate
- 5.2.1.3 Area

- 5.2.2 Describe the functions of the following basic components in a pneumatic system.
 - 5.2.2.1 Compressor
 - 5.2.2.2 Air receiver
 - 5.2.2.3 Pressure gauge
 - 5.2.2.4 Relief valve
 - 5.2.2.5 Service unit
 - 5.2.2.6 4 Port 2 directional control valve (DCV)
 - 5.2.2.7 Pipes
 - 5.2.2.8 Actuator (motor, cylinder)

- 5.2.3 Identify the following symbols in a basic pneumatic system:
 - 5.2.3.1 Compressor
 - 5.2.3.2 Air receiver
 - 5.2.3.3 Pressure gauge
 - 5.2.3.4 Relief valve
 - 5.2.3.5 Service unit
 - 5.2.3.6 4 Port 2 directional control valve (DCV)
 - 5.2.3.7 Actuator (motor, cylinder)

- 5.2.4 State the main difference between a pneumatic and a hydraulic system

- 5.2.5 Arrange a basic pneumatic circuit by using the components given in paragraph 5.2.2

DIDACTICAL 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 6: INTERNAL COMBUSTION ENGINES

LEARNING OUTCOMES

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

- 6.1 Describe, from given drawings, the basic operation of the four stroke petrol engine and the four stroke diesel engine with respect to:
 - 6.1.1 The inlet stroke
 - 6.1.2 The compression stroke
 - 6.1.3 The power stroke and
 - 6.1.4 The exhaust stroke
- 6.2 Compare the four stroke petrol engine to the four stroke diesel engine with respect to:
 - 6.2.1 Method of fuel supply (petrol: carburettor and fuel injection)
 - 6.2.2 General maintenance costs
- 6.3 Describe, from given drawings, the basic operation of the two stroke petrol engine and the two stroke diesel engine with blower and exhaust valves
- 6.4 Compare the advantages and disadvantages of the two stroke petrol engine and the two stroke diesel engine
- 6.5 Make diagrammatical layouts of the fuel system of the four stroke petrol engine (carburettor and fuel injection) and the four stroke diesel engine
- 6.6 Compare the application of the petrol and diesel engines as stationary engines for open, confined and hazardous (flammable) areas with respect to:
 - 6.6.1 Exhaust fumes
 - 6.6.2 Noise
 - 6.6.3 General maintenance

DIDACTICAL GUIDELINES

- * Working models of the different types of engines will enhance the explanation of its operation.
- * Wall charts of cooling systems, fuel supply and lubricating systems should be applied.

MODULE 7: CRANES AND LIFTING MACHINES**LEARNING OUTCOMES**

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

- 7.1 Explain the purpose of a crane is in respect to mechanical advantage (load/effort)
- 7.2 Distinguish, from given drawings, between the following types of cranes:
 - 7.2.1 Overhead travelling
 - 7.2.2 Tower (fixed and climbing)
 - 7.2.3 Wharf
 - 7.2.4 Mobile (Jib and telescopic)
- 7.3 State the general purpose, advantages and disadvantages of the cranes mentioned in paragraph 7.2
- 7.4 Explain what is meant by the "drop" in a rope and list the advantages when increasing the number of drops
- 7.5 List the advantages of the infra-red signal remote control when comparing it to the drivers' cabin on the overhead travelling crane
- 7.6 Explain the basic purpose of the load limiter on cranes
- 7.7 State the advantages and disadvantages of the following ways in which tower cranes can be mounted:
 - 7.7.1 Static on a concrete base
 - 7.7.2 On a bogie on a rail
 - 7.7.3 The climbing-type tower crane
- 7.8 State the general safety precautions while in operation for the cranes mentioned in paragraph 7.2
- 7.9 List important factors in choosing a steel rope with special reference to the relevant codes
- 7.10 Explain slinging requirements
- 7.11 Explain the factors to bear in mind when inspecting steel ropes and the upkeep of a log book
- 7.12 Identify and name hand signals from given drawings

DIDACTIC GUIDELINES

- * Make use of wall charts, brochures (from crane hiring companies) and videos relating to this module.

- * Visiting of a building site, docks or cargo handling depot to observe the operation of cranes, signals used and the behaviour of slings and drops is advisable.

MODULE 8: MATERIAL AND MATERIAL PROCESSES**LEARNING OUTCOMES**

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

8.1 State the purpose of colour coding and identify metals such as low and high carbon steels according to the colour coding system

8.2 Explain the differences between the following:

8.2.1 Iron and an alloy

8.2.2 Ferrous and non-ferrous metals

8.3 Briefly describe the following properties of metals:

8.3.1 Toughness

8.3.2 Tensile strength

8.3.3 Malleability

8.3.4 Ductility

8.3.5 Elasticity

8.3.6 Hardness

8.3.7 Plasticity

8.4 Briefly describe the purpose of the following heat treatment processes:

8.4.1 Case hardening

8.4.2 Hardening

8.4.3 Tempering

8.4.4 Annealing

8.4.5 Normalising

8.5 Briefly compare the general behaviour during

8.5.1 forming using a hammer

8.5.2 cutting by means of a hacksaw

8.5.3 arc welding and gas (oxy-acetylene) welding

of the following metals:

* Low carbon steel

* Aluminium

* Copper

* Grey cast iron

* Austenitic stainless steel

8.6 Differentiate between the following main groups of polymers:

8.6.1 Thermoplastics

8.6.2 Thermosets

8.7 Identify and differentiate between the basic characteris-

tics of the following polymers, based on non-laboratory tests (touch, sound, surface hardness, flame and adour):

- 8.7.1 Polyethylene (PE)
- 8.7.2 Polypropylene (PP)
- 8.7.3 Polyvinylchloride (PVC)
- 8.7.4 Polystyrene (PS)
- 8.7.5 Acrylonitrile Butadiene Styrene (ABS)
- 8.7.6 Polymethylmethacrylate (PMMA) (Perspex)
- 8.7.7 Polyamide (PA)
- 8.7.8 Phenol Formaldehyde (PF)
- 8.7.9 Unsaturated Polyesters (UP)
- 8.7.10 Natural Rubber (NR)
- 8.7.11 Styrene Butadiene Rubber (SBR)
- 8.7.12 Nitrite Rubber (NBR)

DIDACTICAL GUIDELINES

A "feel" for the different types of plastics and rubbers have to be developed by the students.

MODULE 9: INDUSTRIAL ORGANISATION AND PLANNING

LEARNING OUTCOMES

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

9.1 Briefly describe:

9.1.1 Effective communication skills in a multi cultural environment with regard to:

9.1.1.1 Writing and compiling reports and memorandums

9.1.1.2 Verbal and non verbal skills

9.1.1.3 Application of listening skills

9.2 Discuss organisational communication with respect to the following communication channels (routes):

9.2.1 Vertical line

9.2.2 Horizontal line

9.2.3 Diagonal line

9.3 Briefly describe the basic outlines of the following Acts:

9.3.1 Labour Relations Act with respect to:

9.3.1.1 Grievance procedures

9.3.1.2 Disciplinary handling procedures

9.3.1.3 Code of conduct

9.3.1.4 Conditions of employment

9.3.1.5 Rights and duties

9.3.2 Occupational Health and Safety Act with respect to:

9.3.2.1 Reports and incidents

9.3.2.2 General duties of employer and employees

9.3.2.3 First aid

9.3.2.4 Records and registers

9.4 Describe the purpose of an administration system

9.5 Briefly describe the purpose of each of the following documents:

9.5.1 Clock cards

9.5.2 Job cards

9.5.3 Requisition cards

9.5.4 Production flow charts

9.5.5 Maintenance schedules

9.6 Describe the purpose of budgeting and controlling of expenses

9.7 Describe labour efficiency to improve and increase pro-

ductivity

DIDACTICAL GUIDELINES

- * Obtain copies of clock cards, job cards, requisition cards, production flow charts and maintenance schedules from small, medium and large companies for demonstration.
- * Visit a workshop to observe the general administration performed daily.

MODULE 10: ENTREPRENEURSHIP

LEARNING OUTCOMES

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

- 10.1 Explain in basic terms the concepts:
 - 10.1.1 Entrepreneurship
 - 10.1.2 Small business enterprise
- 10.2 Name and briefly describe FIVE characteristics of an entrepreneur and complete a self-analysis
- 10.3 Name and explain the process of generating ideas for establishing a small business
- 10.4 Describe the general resources necessary for the small business entrepreneur
- 10.5 Name and briefly describe the factors that will influence the location of a small business enterprise.

DIDACTICAL GUIDELINES

- * Lecturers should strongly emphasize to students the role of entrepreneurship in the future South African economy.
- * Invite speaker(s) from Small Business Development Corporation and other relevant organisations to address students on a specific learning outcome.