MECHANICAL DRAUGHTING AND TECHNOLOGY (CAD)
LEVEL 4

CONTENTS

INTRODUCTION
1. DURATION AND TUITION TIME
2. SUBJECT LEVEL FOCUS
3. ASSESSMENT REQUIREMENTS
   3.1 Internal assessment
   3.2 External assessment
4 WEIGHTED VALUES OF TOPICS
5 CALCULATION OF FINAL MARK
6 PASS REQUIREMENTS
7 SUBJECT AND LEARNING OUTCOMES
   7.1 Design process.
   7.2 Screw threads and springs
   7.3 Gears and keys
   7.4 Cam
   7.5 Assembly drawing
   7.6 Detail drawing
8 RESOURCE NEEDS FOR THE TEACHING OF MECHANICAL DRAUGHTING AND TECHNOLOGY (CAD) – LEVEL 4
   8.1 Physical resources
   8.2 Human resources
   8.3 Other resources
INTRODUCTION

A. What is Mechanical Draughting and Technology (CAD) about?
Mechanical Draughting and Technology (CAD) Level 4 introduces students to the principles of design. The subject deals with the screw threads, springs, gears, keys / keyways, cams, assembly and detail drawings generating all drawing work with a computer using CAD applications as the drawing tool.

B. Why is Mechanical Draughting and Technology (CAD) in the Drawing Office Practice learning programme?
Drawing is the language of communication that is widely used and understood in Engineering. The thoughts about components to be manufactured and constructions to be made are expressed in the form of drawings and graphics before the actual work on the project starts. The understanding and interpretation of drawings and graphics is crucial in the engineering world of work.

C. The link between Mechanical Draughting and Technology (CAD) Learning Outcomes and the Critical and Developmental Outcomes
The subject improves students’ problem solving skills through the use of computer-assisted technology, by constructing and developing comprehensive drawings of components. It enhances ethical behaviour of students because they learn to adhere to the prescribed code of practice for engineering drawing applications.

D. Factors that contribute to achieving Learning Outcomes
- Thorough preparation for teaching and learning activities
- An environment conducive to teaching and learning through effective student support, motivation, commitment, a positive attitude and interest in the subject
- Student exposure to the construction environment
1 DURATION AND TUITION TIME

This is a one-year instructional programme comprising 200 teaching and learning hours. The subject may be offered on a part-time basis provided the student meets all the assessment requirements.

Students with special education needs (LSEN) must be catered for in a way that eliminates barriers to learning.

2 SUBJECT LEVEL FOCUS

On completion of this course, the student should be equipped with draughting skills needed to interpret and produce mechanical drawings. The emphasis is on “draughtsmanship” and will assist the student to plan and execute drawings in accordance with best practices and in accordance with codes of practice and specifications. Given sufficient drawing office practical experience (probably 18 months), the Level 4 graduate could be expected to draw up various computer generated drawings and supervise minor projects.

Exit Level Outcome 1: Explain different models used in the engineering design process.

Associated Assessment Criteria:

☐ The design process and models used in the process is investigated and explained.

Exit Level Outcome 2: Describe and draw types of screw threads used in industry.

Associated Assessment Criteria:

☐ Different screw threads, internal and external square threads as well as the helical spring are explained and drawn.

Exit Level Outcome 3: Explain and construct different types of gears, keys andcams.

Associated Assessment Criteria:

☐ Different types of gears, keys and keyways used in industry are explained, designed and constructed.

☐ The conventional representations of gears are drawn.

> Range: spur gear, bevel gear, involute rack and worm gear.

☐ The uses of cams and cam followers, the construction of both profile and motion diagrams are explained and applied.

Exit Level Outcome 4: Draw an assembly and detail drawings of different engineering components in first and third angle orthographic projection.

Associated Assessment Criteria:

☐ Assembly and detailed drawings are produced using the correct techniques according to instructions.

Exit Level Outcome 5: Explain and produce 3D drawings using basic and advanced commands.

Associated Assessment Criteria:

☐ The main concepts, workspace, tools and commands for 3D modeling are explained and used.

☐ Different types of drawings of 3D objects are created and edited using basic and advanced 3D commands.
3 ASSESSMENT REQUIREMENTS

3.1 Internal assessment (50 percent)

3.1.1 Theoretical component
The theoretical component forms 40 percent of the internal assessment mark.

Internal assessment of the theoretical component in Mechanical Draughting and Technology (CAD) Level 4 takes the form of observation, class questions, group work, informal group competitions with rewards, individual discussions with students, class, topic and semester tests and internal examinations. Lecturers can observe students when marking exercises from the previous day and asking class questions.

Assignments, case studies and tests can be completed at the end of a topic. Tests and internal examinations must form part of the internal assessment.

3.1.2 Practical component
The practical component forms 60 percent of the internal assessment mark.

Practical components include applications and exercises. All practical components must be indicated in a Portfolio of Evidence (PoE).

Internal assessment of the practical component in Mechanical Draughting and Technology (CAD) Level 4 takes the form of assignments, practical exercises, case studies and practical examinations in a simulated business environment.

Students may complete practical exercises daily. Assignments and case studies can be completed at the end of a topic. Practical examinations can form part of internal practical assessment.

- Some examples of practical assessments include, but are not limited to:
  A. Presentations (lectures, demonstrations, group discussions and activities, practical work, observation, role-play, independent activity, synthesis and evaluation)
  B. Exhibitions by students
  C. Visits undertaken by students based on a structured assignment task
  D. Research
  E. Task performance in a “Structured Environment”

- Definition of the term “Structured Environment”
For the purposes of assessment, “Structured Environment” refers to a simulated workplace or workshop environment. Activities in the simulated workplace or environment must be documented in a logbook with a clear listing of the competencies to be assessed. The following information must be contained in the logbook:
  - Nature of department or environment in which practical component was achieved
  - Learning Outcomes
  - Activities in the environment with which to achieve the Learning Outcomes
  - Time spent on activities
  - Signature of facilitator or supervisor and student

For the logbook to be regarded as valid evidence, it must be signed by an officially assigned supervisor.

- Evidence in practical assessments
All evidence pertaining to evaluation of practical work must be reflected in the students’ Portfolio of Evidence. The assessment instruments used for the purpose of conducting these assessments must be part of the evidence contained in the PoE.

3.1.3 Processing of internal assessment mark for the year
A year mark out of 100 is calculated by adding the marks of the theoretical component and the practical component of the internal continuous assessment (ICASS).
3.1.4 Moderation of internal assessment mark
Internal assessment is subjected to internal and external moderation procedures as set out in the National Examinations Policy for FET College Programmes.

3.2 External assessment (50 percent)
A national examination is conducted annually in October or November by means of a paper(s) set and moderated externally. The practical component will also be assessed.

External assessment details and procedures are set out in the Assessment Guidelines: Mechanical Draughting and Technology (CAD) Level 4

4 WEIGHTED VALUES OF TOPICS

<table>
<thead>
<tr>
<th>TOPICS</th>
<th>WEIGHTED VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Principles of design</td>
<td>10%</td>
</tr>
<tr>
<td>2. Screw thread sand springs</td>
<td>15%</td>
</tr>
<tr>
<td>3. Gears and keys</td>
<td>15%</td>
</tr>
<tr>
<td>4. Cams</td>
<td>15%</td>
</tr>
<tr>
<td>5. Assembly drawing</td>
<td>25%</td>
</tr>
<tr>
<td>6. Detail drawing</td>
<td>20%</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

5 CALCULATION OF FINAL MARK
Internal assessment mark: Student’s mark/100 x 50 = a mark out of 50 (a)
Examination mark: Student’s mark/100 x 50 = a mark out of 50 (b)
Final mark: (a) + (b) = a mark out of 100

All marks are systematically processed and accurately recorded to be available as hard copy evidence for, amongst others, reporting, moderation and verification purposes.

6 PASS REQUIREMENTS
A student must obtain at least 50 percent in ICASS and 50 percent in the examination to achieve a pass in this subject.

7 SUBJECT AND LEARNING OUTCOMES
On completion of Mechanical Draughting and Technology (Cad) Level 4, the student should have covered the following topics:

Topic 1: Principles of design
Topic 2: Screw threads and springs
Topic 3: Gears and keys
Topic 4: Cams
Topic 5: Assembly drawing
Topic 6: Detail drawing
7.1 Topic 1: Principles of design

7.1.1 Subject Outcome 1: Explain the engineering design process

Learning Outcomes
The student should be able to:
- Describe the design process.
- List and explain the main steps in the design process.
- Explain the effects of not complying with acceptable design processes.

7.1.2 Subject Outcome 2: Explain different types of models used in the engineering design process

Learning Outcomes
The student should be able to:
- Identify different models used in the engineering design process.
- Investigate the nature of each model used in the engineering design process.
- Discuss the role of each model used in the engineering design process.

7.2 Topic 2: Screw threads and springs

7.2.1 Subject Outcome 1: Describe and draw screw threads and spring

Learning Outcomes
The student should be able to:
- Identify and explain the use of different screw threads in industry.
  Range: square thread; v-screw threads; Acme screw thread; Buttress screw thread; ISO metric pipe thread
- Explain the terminology which is used for screw threads.
  Range: ISO metric screw thread; external thread; internal thread; nominal diameter(major/outside diameter); root diameter; pitch diameter; right-hand thread; left-hand thread; pitch (P); lead;
- Sketch a freehand drawing of the basic profile of an isometric screw thread
  Range: nominal diameter; ISO metric screw thread; nominal diameter(major/outside diameter); root diameter; pitch diameter; pitch (P); lead;

7.2.2 Subject Outcome 2: Construct a helical screw thread and spring

Learning Outcomes
The student should be able to:
- Draw the internal and external square thread.
  Range: True helical curves; full representation; conventional representation; left-hand; right-hand; outside views; sectional views
- Draw the helical spring.
  Range: True helical curves; full representation; conventional representation; conventional representation in section; schematic representation; left-hand; right-hand; round material; square material

7.3 Topic 3: Gears and keys

7.3.1 Subject Outcome 1: Types of gears and keys used in industry

Learning Outcomes
The student should be able to:
- Identify and explain the application of different types of gears used in industry.
• Explain terminology used for gears
  Range: outside diameter; root diameter; pitch-circle diameter (PCD); pitch-circle; circular pitch (P); diametrical pitch (Pd); addendum; dedendum; base circle; pressure angle; module (m); circular tooth thickness (t); chordal thickness; line of action; path of contact; fillet radius

• Identify different types of keys and keyways used in industry.
  Range: rectangular keys, feather, taper woodruff, gib head, parallel

• Calculate the circular pitch (P), diametrical pitch; circular tooth thickness; addendum; dedendum of gears.

• Calculate the width, length and depth of keys and keyways.

• Sketch a freehand drawing of a gear tooth profile to show the terms used on gears.

7.3.2 Subject Outcome 2: Construction of gears
**Learning Outcomes**
The student should be able to:
• Construct an involute profile of single spur gear tooth
  Range: show two to three teeth with the remainder of the gear profile in conventional representation
• Construct a pinion in mesh with a gear
  Range: show two to three teeth in mesh with the remainder of the gear profile in conventional representation
• Construct an involute gear in mesh with an involute rack.
  Range: show two to three teeth in mesh with the remainder of the gear and rack profile in conventional representation
• Draw a conventional representation of a single spur gear.
  Range: outside views; full-sectional views; half sectional views
• Draw a conventional representation of a single bevel gear.
  Range: outside views; full-sectional views; half sectional views
• Draw a conventional representation of a bevel gear system.
  Range: outside views; full-sectional views; half sectional views
• Draw a conventional representation of a single worm gear.
  Range: outside views; full-sectional views; half sectional views
• Draw a conventional representation of a worm gear system.
  Range: outside views; full-sectional views; half sectional views

7.4 Topic 4: Cams
7.4.1 Subject Outcome 1: Types of cams and cam followers in industry
**Learning Outcomes**
The student should be able to:
• Identify and explain the uses of different cam types
  Range: radial; face; toe/wiper; yoke/positive motion; cylindrical groove; end cam
• Identify and explain the uses of different cam followers
  Range: Knife-edge follower; roller follower; flat-end follower

7.4.2 Subject Outcome 2: Cam profile and motion
**Learning Outcomes**
The student should be able to:
• Identify and explain the different types of cam motions
• Construct motion and displacement diagrams of cams
• Explain terminology used in cam profiles.
• Draw the cam profile from displacement diagram
  Range: Constant velocity (CV; simple harmonic motion (SHM); uniform acceleration and retardation (UAR), and combination of motions

7.5 Topic 5: Assembly drawing

7.5.1 Subject Outcome 1: Conventions of sectioning of engineering drawings using different methods

Learning Outcomes
The student should be able to:
• Identify different methods of sectioning
• Section the assembled drawing according to the given instruction
  Range: Techniques refer but not limited to 30°; 45°; 60° staggered and scrap sectioning
• Identify and explain drawing conventions on an assembly drawing
  Range: bolts; nuts; studs; drilled and threaded holes; webs; ribs; shafts; keys

7.5.2 Subject Outcome 2: Assemble different components to construct engineering drawings

Learning Outcomes
The student should be able to:
• Draw an assembly drawing in a first or third angle orthographic projection of different items.
  Range: Assembly drawing consisting of at least 10 items
• Section the assembly drawing according to the given instruction.
• Insert item numbers to the different components on the assembly drawing.
• Draw a table for parts list of the assembly drawing.

7.6 Topic 6: Detail drawing

7.6.1 Subject Outcome 1: Produce detailed drawings from the given assemblies

Learning Outcomes
The student should be able to:
• Identify and separate items of an assembly drawing.
  Range: detail drawing consisting of at least 8 items
• Produce detail drawings in first or third angle orthographic projection.
• Insert dimensions to the detail drawing using the correct techniques
• Section the detail drawing according to the given instruction
  Range: full-sectional views; half-sectional views

8 RESOURCE NEEDS FOR THE TEACHING OF MECHANICAL DRAUGHTING AND TECHNOLOGY (CAD) – LEVEL 4

8.1 Physical resources
Lecture room(s) equipped with:
• A computer room with desk top computers, data projector, printers and plotters (latest technology recommended) and appropriate computer software for CAD
• Store room for consumables
• Suitable venue for experiments
• Teaching aids and pre-designed models
• Work tables and chairs
• Chalkboards
• Overhead projector

8.2 Human resources
The educator for Mechanical Draughting and Technology (CAD) level 4 must be:
• A subject matter expert
• Competent lecturer
• Certificated as an assessor with ETDP SETA
• Registered with an ETQA or CETA / MERSETA
• A life-long student
• In possession of an NQF level 5 teaching qualification
• Conversant with OBE methodologies
• Instructor qualified in the field of study
• Have skills in facilitating learning programmes development
• A trade test will be an added advantage

It is of paramount importance that educators working in this environment attend seminars and upgrading workshops in order to be updated and re-skilled with the latest developments in technology.

8.3 Other resources
Funds, from learning provider or funding bodies for the procurement of consumables tools and equipment be readily made available for the effective operation of a workplace involved in a training programme and students individually equipped with necessary tools.

8.4 Learning and teaching materials
Learning materials must conform to approved training and industrial standard requirements and articulate to Higher Education.

The following zones should be considered in augmenting the learning material:
• Academic
• Practical

Academic
Academic resources required to be in place in this field of learning are:
• Literature necessary to address the tasks in the learning material fully
• Computer literacy
• Learning materials using projection equipment
• Promotion of researching information
• Educational tours to relevant learning venues
• Educational and motivational talks from industry
• Visual and audio-visual material.

Practical
• Workshop manuals and documentation for the theoretical knowledge.
• Models and demonstrations