VUT
Vaal University of Technology

SCIENTIA ET ARTE

Faculty of Engineering and Technology
Department of Metallurgical Engineering

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1. WORD OF WELCOME

Welcome to the Faculty of Engineering at the Vaal University of Technology.

The guidelines as set out in this document lend themselves to benefiting all parties concerned with the co-operative education partnership (learner, university, and employer) in developing and introducing effective education/learning schemes and by being adaptable to technological developments within a relatively short period of time.

The guidelines are specifically intended to assist employers in structuring WIL programmes for learners/technologists who have completed or who are still undergoing their theoretical education/learning for the National Diploma in Engineering. The guidelines are drawn up in a generalised manner to cater for the industry at large. The content detail, however, can be added to or changed to suit the requirements of individual employers.

We trust that all learners will make full use of this opportunity to develop their talents, equip themselves to take up their places as citizens of the country and contribute to the wellbeing of society and as such be loyal alumni that should be the proud bearers of the university message in their future careers.

The university looks forward to a continuous and pleasant period of liaison with employers with the confidence that the objectives of co-operation will be successfully achieved.

2. CONTACTS PERSONS

Title and Surname	Office number	Telephone number and e-mail address
HoD: Prof. P. Mendonidis	RE105	950 6741 peter@vut.ac.za
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3. RATIONALE

On successfully completing this WIL module, the learners will be able to: Apply metallurgical knowledge and skill within an industrial environment, with due understanding of the social, economic and environment impact of industrial activities.

4. PREREQUISITES

The candidate will have, preferably, completed all the theoretical modules of the diploma in metallurgical engineering.

5. LEARNING MATERIAL

There are no prescribed books for this module. Learning materials will depend on the specific work place to which each candidate may be assigned.

6. MODULE DESCRIPTION

6.1. PURPOSE OF WORK INTEGRATED LEARNING (WIL)

In terms of university policy, Universities of Technology are able to make a considerable contribution to relieving the manpower shortage that is being experienced in the technical fields in particular. The primary task of Universities of Technology is to provide education (instruction and learning) in order to equip persons with certain skills and sufficient technological knowledge of industry for the labour market.

Universities of Technology aim to train persons that are immediately ready to function in an occupation. To meet this objective, it is of utmost importance that this career education model provides for a well-structured partnership with employers towards education and learning to really satisfy the expectations of industry and to keep pace with the rapidly changing demands of the times.

The purpose of WIL is to provide the learner with an opportunity of applying and developing the knowledge received at the university, in industrial problem situations and to expose the learner to typical organisational culture, human relations and working conditions. However, to this end it is required that the employers in industry observe their responsibility in respect of relevant WIL programmes during the learner's period of study. With suitable guidance and supervision, the learner is taught responsibility to work independently and to develop an awareness of the ethics and requirements of industry.

6.2 WORK INTEGRATED LEARNING SYLLABUS

The exposure of the student should be as broad as possible within the specific industrial environment in which the has been placed. The topics listed below include most of the topics covered by the theoretical modules of the diploma. However, no single plant/mine/factory can provide exposure to all the topics. Therefore, it is sufficient for the student to be exposed to as many as possible within the available facilities during WIL; hence the need for approval of every company that provides WIL opportunities for students (see section 6.4 below). Essential topics to which all students must be exposed are labelled as compulsory in the list below.

6.2.1 SAFETY MEASURES (Compulsory)

The main purpose of safety measures is to know the general safety condition of the plant or mine or factory, which will include:

a Attending safety meetings;
b Have an understanding of the OHS Act as applied to the plant, factory or mine;
c NOSA course is recommended;
d Accompanying the Safety Officer once or twice on safety inspection.

The learner shall be trained in **as many as possible** of the following during his/her WIL period, which will be determined by his/her employer.

6.2.2 COMMUNITION

The learner should familiarise him/herself with the general plant layout and the equipment used and should include the following:

a Primary and secondary crushing
b Milling and start-up
c Conveying systems
d Storage systems
e Mass flow measurement (wet and dry)
f Mass balances
g Problem solving

6.2.3 **SCREENING AND CLASSIFICATION**

The learner should be able to

a Calculate screen efficiencies
b Calculate cyclone efficiencies

6.2.4 CONCENTRATION PROCESSES

The learner should be trained in any one or more of the following processes:

a Shaking tables, spirals, cyclones, etc., mass balances, adjustments
b Froth flotation, mass balance, adjustments to reagent requirements and problem solving
c Dense medium separation, efficiencies, and problem solving
d Magnetic and high-tension separation.

6.2.5 DEWATERING

The learner should gain understanding of the following:

a Basic design of thickeners and filters
b Pump and piping requirements
c Problem solving
d Start-up

6.2.6 CALCINATION AND ROASTING

The learner should be trained in the operation of the equipment including the following key aspects:

- a Basic chemistry involved
- b Control of the process
- c Air and heat requirements
- d Mass balances
- e Acid plant
- f Problem solving

6.2.7 SMELTING AND REFINING

The learner should be trained according to the type of equipment used including the following key aspects:

- a Construction of furnace
- b Refractories used
- c Energy requirements (Electric, gas, etc.)
- d Basic chemistry
- e Mass balances
- f Molten metal handling
- g Slag handling and treatment
- h Metal casting

6.2.8 ELECTROLYSIS

The learner should gain knowledge of the following:

- a Cell construction
- b Electrolyte composition
- c Factors affecting deposition
- d Effect of impurities
- e Basic chemistry
- f Cathode preparation
- g Mass balancing and energy requirements
- h Problem solving and control

6.2.9 HYDROMETALLURGY

The learner should gain knowledge of the general plant layout as well as the equipment used. This should include the following:

- a Pulp requirements
- b Reagents required
- c Agitation methods
- d Flow rates and retention times
- e Piping and pumping
- f Heating requirements (steam generation)
- g Mass balances
- h Basic chemistry
- i Metal recovery methods
- j Security arrangements
- h Problem solving

6.2.10 LABORATORY AND QUALITY CONTROL

The learner should spend some time in the laboratory environment, chemical as well as metallurgical. The following should be looked at:

a. Familiarise the learner with all instrumentation
b. Familiarise the learner with all laboratory equipment
c. Sampling procedures
d. Conducting of tests.

6.2.11 **FABRICATION AND JOINING**

The learner should be familiarised with the following plant processes and the operation of the specific equipment for each:

a. Forming operations
b. Casting operations
c. Welding processes
d. Materials testing
e. Heat treatment
f. Surface coatings.

6.2.12 PROJECT WORK (Complusory)

The learner should be subjected to very basic projects in any of the above operations.

All tasks should be done initially in collaboration with a competent mentor that can give the learner the necessary guidance. The degree of difficulty of these projects should increase as the learner gains experience. All projects should be complimented by a written report to the plant superintendent, the mentor and the university after completion of the project or learning session.

6.2.13 OTHER

The learner should be exposed to other in-house learning courses such as computer literacy, leadership, supervision, technical writing and also attend seminars and symposia.

7. MONITORING OF LEARNERS DURING WORK INTEGRATED LEARNING

The Engineering Council of South Africa (ECSA) requires that learners be continually monitored throughout their experiential learning period. (Refer to the WIL policy, section 2.4.2). A staff member from the Vaal University of Technology will visit both learner and mentor at least once per annum. Should any problems or questions arise regarding the WIL/university education, learners and mentors are encouraged to discuss this during such a visit or otherwise, to contact the department. (See appendix for an example of the form, which will be used during such a visit). Learners and employers should at all times adhere to the general Faculty regulations regarding WIL as set out in the Faculty policies, procedures and guidelines.

8. PROGRAMME APPROVAL

In learning people for an occupational directed career the interaction between the learner, the employer and the educational institution is of utmost importance.

A company with a structured learning programme/schedule must submit this schedule to the Vaal University of Technology for assessment in terms of the under mentioned criteria:

The learning has to be structured and should provide for learners to get exposure and experience in the different fields specified in the syllabi for experiential training.

Personnel overseeing the learning of learners are to be adequately trained and must have relevant experience to act as mentors. They should preferably also be registered with the Engineering Council (ECSA).

Learners have to be supervised and evaluated on a continual basis by mentors (supervisors).

Adequate facilities must be available so as to give learners hands-on experience in the workplace.

The assessment of the learner's WIL is to be carried out in accordance with the guidelines, norms and criteria laid down by the Vaal University of Technology.

The organisation has to actively take part in the co-operative education programmes of the Vaal University of Technology.

9. ASSESSMENT METHOD

Assessment aimed at determining whether the student has met the required outcomes of the WIL module and acquired the necessary attributes comprises three components:

9.1 Assessment of the student's on-site performance by the work place supervisor(s): This should be done on the assessment form for the evaluation of work integrated learning, according the rubric provided in Appendix A.

9.2 Assessment of a final report by the student that provides a detailed account of the student's on-site activities for the duration of the WIL within a framework of the operations of the plant/mine/factory. This report should demonstrate that the student has a broad understanding of the operation of the whole plant/mine/factory as well a detailed knowledge and operational skills of specific processes on the plant/mine/factory. This final report is to be assessed by both the workplace supervisor and a member of the academic department (Appendix A).

9.3 Assessment of one ore more project reports. The project(s) should be small enough so that can be completed within the duration of the WIL period. The project report(s) must demonstrate that the student is capable of (1) undertaking investigations (empirical and/or theoretical) for the purposes of monitoring and/or optimising operations, (2) applying theoretical knowledge to the planning of a project, interpreting the results of the project, and making feasible recommendations on the basis of the project result, and (3) writing a technical report. The project report(s) will be assessed by the on-site supervisor and an academic staff member (Appendix A).

VAAL UNIVERSITY OF TECHNOLOGY

FACULTY OF ENGINEERING AND TECHNOLOGY

METALLURGICAL ENGINEERING

ASSESSMENT OF WORK INTEGRATED LEARNING

LEARNER INITIALS & SURNAME	

STUDENT NUMBER		IDENTITY NUMBER	
PHONE NUMBER		EMAIL ADDRESS	

LEARNING PERIOD PER SEMESTER	FROM		TO	

COMPANY	

COMPANY ADDRESS			
		TEL.NR.	

This document must be completed by the learner and the employer for the WIL he/she has done and must be certified as correct by the employer

1. SUMMARY OF WIL ACTIVITIES AND ON-SITE EVALUATION OF STUDENT PERFORMANCE

1.1 SUMMARY OF WORK INTEGRATED LEARNING:

WORK INTEGRATED LEARNING (Duration 26 Weeks/semester)	Duration in weeks	EVALUATION MARK (%) (see below)	SIGNATURE (Supervisor)
Safety Measures			
Communition			
Screening and Classification			
Concentration processes			
Dewatering			
Calcination and Roasting			
Smelting and Refining			
Electrolysis			
Hydrometallurgy			
Fabrication and joining			
Laboratory and Quality Control			
Project work			
Other:			

Explanation of the evaluation scale:

POOR	UNSATISFACTORY	SATISFACTORY	GOOD	EXCELLENT
<40%	40% - 49%	50% - 59%	60% - 79%	80% - 100%

← **Fail** → ← **Pass** →

1.2 EVALUATION OF THE FUNCTIONAL ELEMENTS OF LEARNER:

ELEMENT	EVALUATION MARK (%) (see previous page)	SIGNATURE (Supervisor)
1.Technological knowledge		
2. Manipulative skills		
3. Mental skills		
4. Communication skills		
5. Personal and Interpersonal skills		
6. Supervisory and Management skills		
7. Professional growth		
8. Judgement		
9. Working pace		
10. Punctuality		
11. Dress		
12. Attendance		

REMARKS ON THE LEARNER'S PROFESSIONAL GROWTH AND DEVELOPMENT

FINAL MARK ON-SITE EVALUATION OF STUDENT PERFORMANCE: ………….%

TO BE COMPLETED BY THE ON-SITE SUPERVISOR:

It is hereby declared that the information contained in this document is correct and that the learner has done the prescribed learning for the period indicated.

NAME ……………………………………………….

DESIGNATION ……………………………………………….

SIGNATURE ……………………………………………….

DATE ……………………………………………….

OFFICIAL STAMP

SIGNATURE OF LEARNER: ………………………………….

2. STUDENT WIL REPORT

This is a report by the student that provides a detailed account of the student's on-site activities for the duration of the WIL within a framework of the operations of the plant/mine/factory. This report should demonstrate that the student has a broad understanding of the operation of the whole plant/mine/factory as well a detailed knowledge and operational skills of specific processes on the plant/mine/factory. This final report is to be assessed by both the workplace supervisor and a member of the academic department.

MARK SHEET:
(some aspects to consider are listed in parentheses)
The mark allocations for each topic are indicated in the relevant table cells.

TOPIC	**ON-SITE SUPERVISOR'S EVALUATION**	**UNIVERSTY'S MODERATOR EVALUATION**
Executive summary (Succinctness, completeness)	**/5**	**/5**
Plant description (complete overview, flow diagrams)	/15	/15
Specific operational details of pertinent aspects of the plant (Equipment descriptions, diagrams, explanations, safety aspects)	/45	/45
Report on actual activities on the various parts of the plant and the learning that took place (check correlation between this section and the supervisor's report in terms of activities and duration)	/20	/20
Report structure and neatness	/5	/5
Linguistic clarity	/10	/10
TOTAL MARK	**/100**	**/100**

GENERAL REMARKS BY THE ON THE LEARNER'S WIL REPORT:

ON-SITE SUPERVISOR	**UNIVERSITY MODERATOR**

3. PROJECT REPORT(S)

The project(s) should be small enough so that can be completed within the duration of the WIL period. The project report(s) must demonstrate that the student is capable of (1) undertaking investigations (empirical and/or theoretical) for the purposes of monitoring and/or optimising operations, (2) applying theoretical knowledge to the planning of a project, interpreting the results of the project, and making feasible recommendations on the basis of the project result, and (3) writing a technical report. The project report(s) will be assessed by the on-site supervisor and an academic staff member.

MARK SHEET:
(some aspects to consider are listed in parentheses)
The mark allocations for each topic are indicated in the relevant table cells.

TOPIC	ON-SITE SUPERVISOR'S EVALUATION	UNIVERSTY'S MODERATOR EVALUATION
Abstract (must briefly explain what was done, why it was done, how it was done, what results were determined, and what the implications are.	/5	/5
Introduction (must include the aims and objectives of the project and the scope and limitations. must show that the student understands the plant/practical/financial context of the project)	/10	/10
Literature study (must show that the student understands the theoretical context of the project)	/10	/10
Methods used (must show that the student knows how to undertake the project work and understands the rigour and limitations of the methods used)	/15	/15
Results (must be described objectively, neatly and systematically tabulated and graphically depicted)	/25	/25
Discussion of results (the results must be interpreted and explained in terms of the relevant theories. The implications in terms of the objectives must be explicitly described)	/25	/25
Conclusions (must be a concise of the results and their implications in terms of the project objectives)	/10	/10
TOTAL MARK	**/100**	**/100**

GENERAL REMARKS BY THE ON THE LEARNER'S PROJECT REPORT(S):

ON-SITE SUPERVISOR	UNIVERSITY MODERATOR

4. FINAL MARK

EVALUATION BY SUPERVISOR

	Mark allocated by supervisor
1. On-site evaluation of the student's performance	
2. Students WIL report	
3. Average mark of the Students project reports	
Final mark (average of the above three)	

EVALUATION BY UNIVERSITY MODERATOR

	Mark allocated by supervisor
1. Students WIL report	
2. Average mark of the Students project reports	
Final mark (average of the above two)	

GRADUATE ATTRIBUTES

Indicate which of the underlying tabulated graduate attributes have been addressed by this WIL programme and have been achieved by the student. Definitions of these attributes are attached to this document.

Graduate Attribute	**Yes/No**	**Graduate Attribute**	**Yes/No**
Problem solving		Sustainability and Impact of Engineering Activity	
Application of scientific and engineering knowledge		Individual, Team and Multidisciplinary Working	
Engineering Design		Independent Learning Ability	
Investigations, experiments and data analysis		Engineering Professionalism	
Engineering methods, skills and tools, including Information Technology		Workplace practices	
Professional and technical communication			

SIGNATURES

	On-site supervisor	**University moderator**
Name		
Designation		
Contact number		
Date		
Signature		

FINAL MARK:

……………%

……………………………… ……………………….

HEAD OF DEPARTMENT **DATE**

Extract from ECSA document E-02-PN: Qualification Standard for Diploma in Engineering: NQF Level 6

7. Skills and Applied Competence

The graduate is able to demonstrate competence in the graduate attributes 1 to 11. The Graduate Attributes are stated generically and may be assessed in various engineering disciplinary or cross-disciplinary contexts in a provider-based or simulated practice environment. Words and phrases having specific meaning are defined in this document or in the ECSA document E-01-P.

Note: ***General Range Statement:*** The competencies defined in the ten graduate attributes may be demonstrated in a provider-based and / or simulated workplace context.

Graduate Attribute 1: Problem solving

Apply engineering principles to systematically diagnose and solve *well-defined* engineering problems.

Level Descriptor: ***Well-defined engineering problems*****:**

a. Can be solved mainly by practical engineering knowledge, underpinned by related theory;

and have one or more of the characteristics:

b. are largely defined but may require clarification;

c. are discrete, focussed tasks within engineering systems;

d. are routine, frequently encountered, may be unfamiliar but in familiar context;

and have one or more of the characteristics:

e. can be solved in standardized or prescribed ways;

f. are encompassed by standards, codes and documented procedures; requires authorization to work outside limits;

g. information is concrete and largely complete, but requires checking and possible supplementation;

h. involve several issues but few of these imposing conflicting constraints and a limited range of interested and affected parties.

Graduate Attribute 2: Application of scientific and engineering knowledge

Apply knowledge of mathematics, natural science and engineering sciences to applied engineering procedures, processes, systems and methodologies to solve *well-defined* engineering problems.

Range Statement: See section 6.2.

Graduate Attribute 3: Engineering Design

Perform procedural design of components, systems, works, products or processes to meet requirements, normally within applicable standards, codes of practice and legislation.

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Range Statement: Design problems used in assessment must conform to the definition of *welldefined*

engineering problems:

1. A design project should be used to provide evidence of compliance with this outcome;
2. The problem would be typical of that which the graduate would participate in a typical employment situation shortly after graduation;
3. The selection of components, systems, engineering works, products or processes to be designed is dependent on the sub-discipline;
4. A design project should include one or more of the following impacts: social, economic, legal, health, safety, and environmental;

Graduate Attribute 4: Investigations, experiments and data analysis

Conduct investigations of *well-defined* problems through locating and searching relevant codes and catalogues, conducting standard tests, experiments and measurements.

Range Statement: The balance of investigation should be appropriate to the discipline. An investigation should be typical of those in which the graduate would participate in an

employment situation shortly after graduation.
Note: An investigation differs from a design in that the objective is to produce knowledge and understanding of a phenomenon.

Graduate Attribute 5: Engineering methods, skills and tools, including Information Technology
Use appropriate techniques, resources, and modern engineering tools including information technology for the solution of *well-defined* engineering problems, with an awareness of the limitations, restrictions, premises, assumptions and constraints.
Range Statement: A range of methods, skills and tools appropriate to the discipline of the program including:
1. Sub-discipline-specific tools processes or procedures;
2. Computer packages for computation, simulation, and information handling;
3. Computers and networks and information infrastructures for accessing, processing, managing, and storing information to enhance personal productivity and teamwork;
4. Basic techniques from economics, management, and health, safety and environmental protection.

Graduate Attribute 6: Professional and technical communication
Communicate effectively, both orally and in writing within an engineering context.
Range Statement: Material to be communicated is in a simulated professional context:
1. Audiences are engineering peers, academic personnel and related engineering persons using appropriate formats;
2. Written reports range from short (minimum 300 words) to long (a minimum of 2 000 words excluding tables, diagrams and appendices), covering material at the exit level;
3. Methods of providing information include the conventional methods of the discipline, for example engineering drawings, physical models, bills of quantities as well as subject specific methods.

Graduate Attribute 7: Sustainability and Impact of Engineering Activity
Demonstrate knowledge and understanding of the impact of engineering activity on the society, economy, industrial and physical environment, and address issues by defined procedures.
Range Statement: The combination of social, workplace (industrial) and physical environmental factors is appropriate to the sub-discipline of the qualification. Evidence may include case studies typical of the technical practice situations in which the graduate is likely to participate.
Issues and impacts to be addressed:
1. Are encompassed by standards and documented codes of practice.
2. Involve a limited range of stakeholders with differing needs.
3. Have consequences that are locally important and are not far reaching.
4. Are *well-defined* and discrete and part of an engineering system.

Graduate Attribute 8: Individual, Team and Multidisciplinary Working
Demonstrate knowledge and understanding of engineering management principles and apply these to one's own work, as a member and leader in a technical team and to manage projects.
Range Statement:
1. The ability to manage a project should be demonstrated in the form of the project indicated in graduate attribute 3.
2. Tasks are discipline specific and within the technical competence of the graduate.
3. Projects could include: laboratories, business plans, design, etc.;
4. Management principles include:
4.1 Planning: set objectives, select strategies, implement strategies and review achievement;
4.2 Organising: set operational model, identify and assign tasks, identify inputs, delegate responsibility and authority;
4.3 Leading: give directions, set example, communicate, motivate;
4.4 Controlling: monitor performance, check against standards, identify variations and take remedial action.

Graduate Attribute 9: Independent Learning Ability
Engage in independent and life-long learning through well-developed learning skills.
Range Statement: The learning context is well-structured with some unfamiliar elements.

Graduate Attribute 10: Engineering Professionalism
Understand and commit to professional ethics, responsibilities and norms of engineering technical practice.
Range Statement: Evidence includes case studies, memorandum of agreement, code of conduct, membership of professional societies etc. typical of engineering practice situations in which the graduate is likely to participate.

Graduate Attribute 11: Workplace practices
Demonstrate an understanding of workplace practices to solve engineering problems consistent with academic learning achieved.
Range Statement: Tasks to demonstrate this outcome should be designed to connect academic learning with workplace practice and may be performed in one or more of the following types of work-integrated learning:
1. Work-directed theoretical learning: in which theoretical forms of knowledge are introduced and sequences in ways that meet both academic criteria and are applicable and relevant to the career-specific components.
2. Problem-based learning: where students work in small self-directed groups to define, carry out and reflect on a task which is usually a real-life problem.
3. Project-based learning: that brings together intellectual enquiry, real world problems and student engagement in meaningful work.
4. Workplace based learning: where students are placed in a professional practice or simulated environment within a training programme.
5. Simulated learning.

Note: While attribute 11 is specific to workplace practices, other attributes may be demonstrated simultaneously.