Revised Academic Framework for Registration of the South African Geomatics Council (SAGC)

Mine Surveying Branch

Approved:

March 2024

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GLOSSARY

academic framework	A specification of the minimum credits per knowledge area, which is used to "determine which educational programmes or qualifications relating to geomatics, registered or to be registered with the NQF by the South African Qualifications Authority in terms of that Act, would be recognised for the purposes of subsection (4)(a), (b)(i), (c)(i) and (d)(i)" (Geomatics Profession Act 19 of 2013), that is, for the purposes of registration with the SAGC.
branch	As per the Geomatics Profession Act 19 of 2013, branch "means a specific specialisation field of geomatics, including land surveying, topographical surveying, engineering surveying, mine surveying, geo-spatial information science, hydrographic surveying and photogrammetric surveying or any other specialisation field which may be determined by the Minister by notice in the Gazette". Examples of branches are Engineering Surveying, Land Surveying, Mine Surveying, and Geographical Information Science.
category	As per the Geomatics Profession Act 19 of 2013, a person may be registered in one or more of the categories within a branch. These categories are: candidate geomatics practitioner, geomatics technician, geomatics technologist, and geomatics professional. For brevity in this report, the last three categories are referred to as Technician, Technologist, and Professional abbreviated to GTc, GTg, GPr.
credit	"A measure of the volume of learning required for a qualification or part-qualification, quantified as the number of notional study hours required for achieving the learning outcomes specified for the qualification or part qualification. One credit is equated to ten (10) notional hours of learning." (NQF Standard Glossary of Terms, published by SAQA, 2017).
curriculum	"A statement of the training structure and expected methods of learning and teaching that underpin a qualification or part-qualification to facilitate a more general understanding of its implementation in an education system." (NQF Standard Glossary of Terms, published by SAQA, 2017).
EAC	Education Advisory Committee of the SAGC
GISc	geographical information science, synonymous with geographic information science, geo-spatial information science, geospatial information science and geo-information science.
GPA	Geomatics Profession Act 19 of 2013
GPr	Geomatics Professional
GTc	Geomatics Technician
GTg	Geomatics Technologist
knowledge area (KA)	A set of themes and keywords that describes related content in the SAGC academic framework. *Note: A knowledge area is not necessarily aligned with courses or modules in a curriculum; its contents may be covered by multiple courses or modules over multiple years of study.*

notional hour	"The agreed estimate of the learning time that it would take an average learner to meet the defined learning outcomes; it includes consideration of contact time, research, completion of assignments, time spent in structured learning in the workplace, individual learning and assessment. Ten notional hours equate to one credit." (NQF Standard Glossary of Terms, published by SAQA, 2017).
SAGC	South African Geomatics Council
voluntary association	"any association, organisation, institute or other body of registered persons recognised by the Council in terms of section 18" (Geomatics Profession Act No.19 of 2013).

1 Introduction and Purpose of the Review

The South African Geomatics Council (SAGC) approved a review of the SAGC Academic Framework at its meeting on 11-12 February 2020. The review was to be done for the following branches*: Land Surveying, Engineering Surveying, GISc* and *Mine Surveying*. Topographical surveying (mentioned in the Geomatics Profession Act 19 of 2013) is no longer used as a separate branch of registration. In industry, education, and for registration purposes, topographical surveying is understood to be part of the Engineering Surveying branch. The review was proposed by the Education Advisory Committee (EAC).

The scope of the work is a comprehensive review of the current academic framework for the four branches identified above and in each of their categories of registration. This has been done based on future trends in the profession, both in South Africa and in other countries.

2 Structure of the Review Process

2.1 Structure of panels

The EAC set up the Review panels for the review process. A panel was set up for each of the four branches of registration and the Panel Conveners who would coordinate the review in each panel were nominated by the EAC. This was to ensure a thorough process of review by practitioners in that branch. The Panel of Conveners was chaired by the Chairperson of the EAC. The following are the roles and responsibilities of **each** Review Panel as extracted from the Terms of Reference:

2.1.1 Chairperson of the Conveners' Panel

The review shall be led by the **Chairperson of the Education Advisory Committee (EAC)**, who will:

a. Coordinate the review process, provide guidance to conveners and their panels and the necessary oversight.
b. Chair the convener meetings.
c. Liaise with voluntary associations regarding the nomination of panel members, and appoint panel members.
d. Arrange consultation workshops with SAGC members.
e. Attend some of the meetings of the four panels.
f. Consolidate the recommendations from individual panels into a final report.
g. Coordinate the process of sharing the revised academic frameworks with the voluntary associations and universities, processing the comments received with the respective panels, and drafting final recommendations.
h. Present the revised academic framework to the EAC and Council for approval.

2.1.2 Panel Convener

The EAC nominated a **convener** for each branch. Each convener will lead a panel. The convener will:

a. Attend convener meetings and consultation workshops.
b. Lead and coordinate the review of the academic framework for a specific branch and its categories of registration, amongst others, assigning tasks to panel members in line with the brief of work for the panel and setting timelines and milestones together with the panel members.

c. Coordinate the revision of the academic framework for the specific branch and its categories of registration.
d. Review comments from the voluntary associations and universities.
e. Draft final revised academic framework.
f. Present the revised academic framework to the Chairperson for coordinating EAC and Council approval.

2.1.3 Panel Members

In consultation with the voluntary associations and universities, **Panel members** were appointed for each panel.

a. Are either academics at a South African university or registered with the SAGC in the branch for which their panel is responsible.
b. Attend panel meetings and consultation workshops.
c. Actively contribute to the research for and review of the academic framework for a specific branch.

The list of panel members who participated in the review process is provided in Appendix 1, organised by Branch.

The Engineering Surveying (ES) and Land Surveying (LS) panels worked jointly from the earliest stages to the end of the review process because of the significant overlap between the two branches. The Conveners for the two branches co-chaired the joint meetings of the panels.

2.1.4 The Registrar's Office

The **Registrar's Office** will support the review process by

a. Taking care of the logistics of meetings and workshop arrangements, including but not limited to managing expenses on the allocated budget.
b. Provide collation and editing of documentation as required by conveners and the Chairperson.

2.2 The Review Process

The review considered:

a. Current minimum academic requirements for each branch and category, as specified in the SAGC academic framework.
b. Tertiary qualifications in other countries relevant to each branch and category.
c. Academic requirements for registration or licensing in each branch and category in other countries.
d. Feedback and suggestions in reports from previous accreditation visits.
e. Relevant legislation and regulations, such as the Mine Health and Safety Act, Land Survey Act and Spatial Data infrastructure Act.
f. The review will also consider comments received from EAC and SAGC members.

The review shall follow the steps in the process outlined in section 2.4.

2.3 Outcomes of the Review Process

The outcome of the review is a revised SAGC Academic Framework for Registration that:

a. *Identifies the foundational knowledge* that is common to all branches.

b. Is *flexible* enough so that it can be readily adjusted to new developments.

c. *Specifies the minimum academic requirements* for each branch in terms of knowledge and skills taking cognisance of tasks, work activities and legislation.

d. *Specifies the amount of unspecified content per category and branch*, providing higher education institutions with some degree of academic autonomy and allowing them to specialize and differentiate their offering in order to be at the forefront of developments and to provide leadership and forward thinking in the profession.

e. Necessitated the need to clarify the definitions within the branches and categories, resulting in the development of the 'Definitions' document included in Appendix 4.

2.4 Schedule of Work

The schedule of work for the panels is outlined in the Terms of Reference. A summary is included here but the detailed schedule is in the TORs in Appendix 2.

The main aspects of the schedule of work for the review were *five-fold*. *Firstly*, to constitute the Panels for the respective Branches under review by requesting representation from voluntary associations and universities and the Chief Surveyor General's (CSG) office. *Secondly,* the panels began their work of reviewing the framework by branch. This process involved research using both local and international sources, collation and integration aided by robust debate. The *third* aspect is the alignment and collation of the content by the Panel of Conveners before sending the revised academic framework out to the voluntary associations and universities for comment. The *fourth* aspect is the review of the proposed framework by the voluntary associations and universities. The *fifth* aspect is the update, final review and adoption of the revised framework by the SAGC.

During the revision process it became necessary to clarify the differentiation between the Geomatics branches and categories for purposes of interpretation of the academic framework. It therefore became necessary to develop a document detailing the definitions for branches and their categories based on existing legislation. The document is outlined in Appendix 4

3 Summary of the Revised Academic Frameworks by Branch

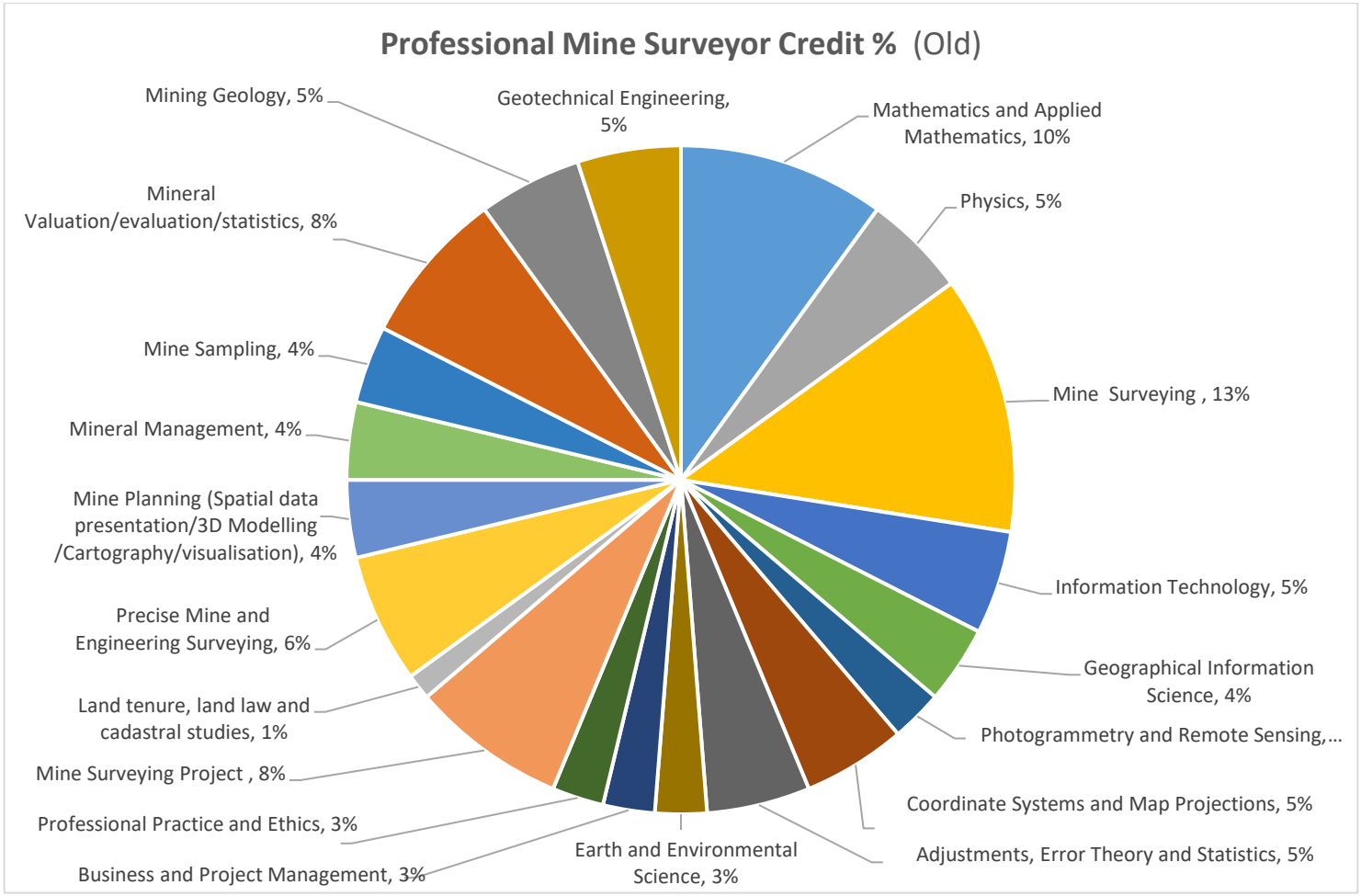
Summaries of the Revised Academic Frameworks for each branch and its related categories are outlined in this section to provide an overview of the overall process. The summary frameworks are presented showing the distribution of credits for the knowledge areas (KAs) in the '*New*' and '*Old*' frameworks as well as the NQF level for each registration category. The detailed Revised Academic Frameworks are found in Appendix 3. Section 4 of the report, along with Appendix 3, falls within the scope of the Review – it therefore requires acceptance or rejection by the Council.

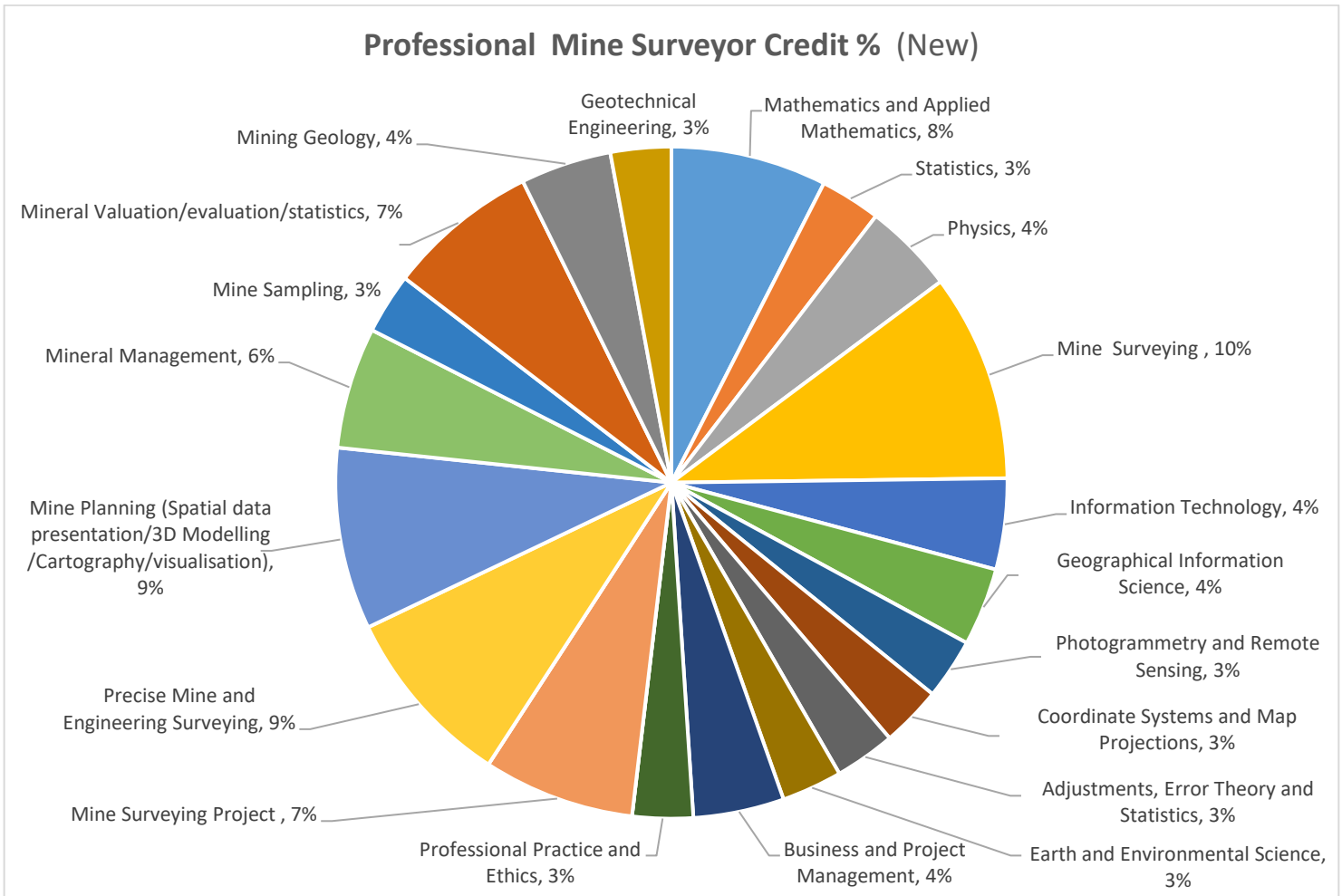
South African Geomatics Council (SAGC)

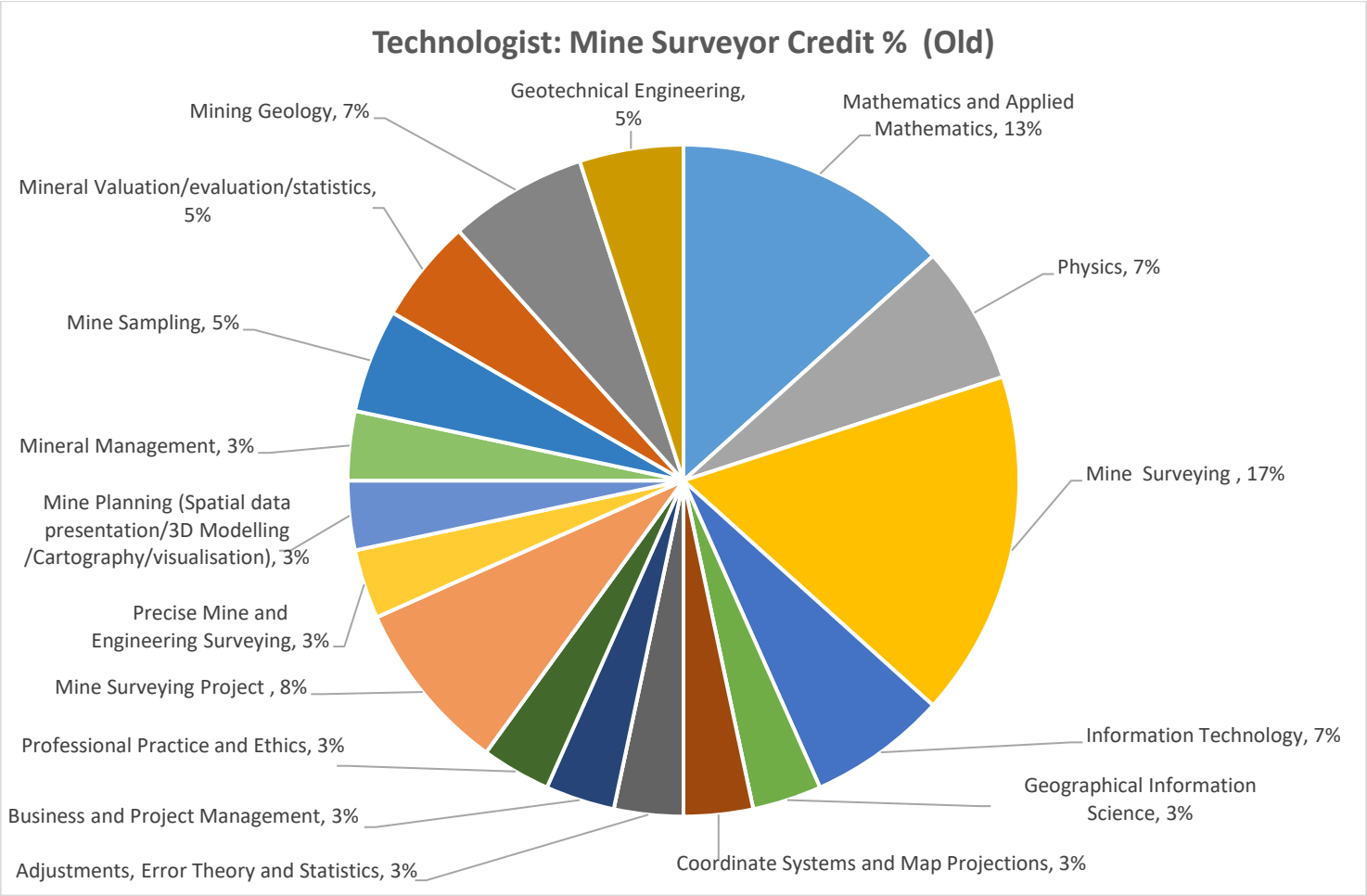
GUIDELINES FOR MINIMUM QUALIFICATION REQUIREMENTS FOR MINING SURVEYOR REGISTRATION

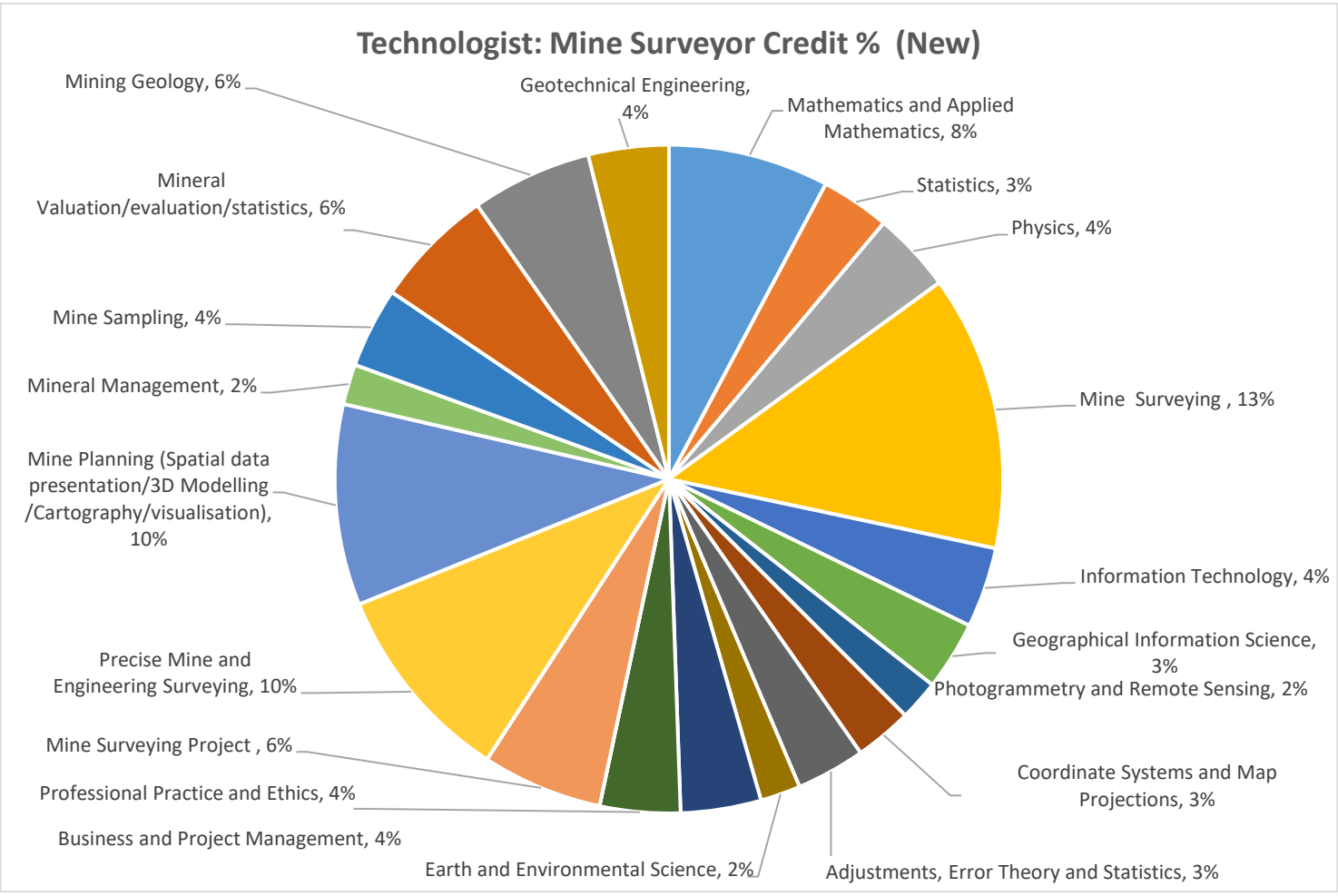
To be used in conjunction with knowledge area content specifications
One credit is considered to be 10 hours of notional learning
A knowledge area is not necessarily aligned with courses or modules in a curriculum; its content may be covered by multiple courses or modules over multiple years of study.
A knowledge area for which credits are not specified is assessed qualitatively, e.g., as a graduate attribute or overall degree outcome based on outcomes embedded in all the knowledge areas in the curriculum.
10% leeway per knowledge area is allowed as long as there is no material impact on the qualification

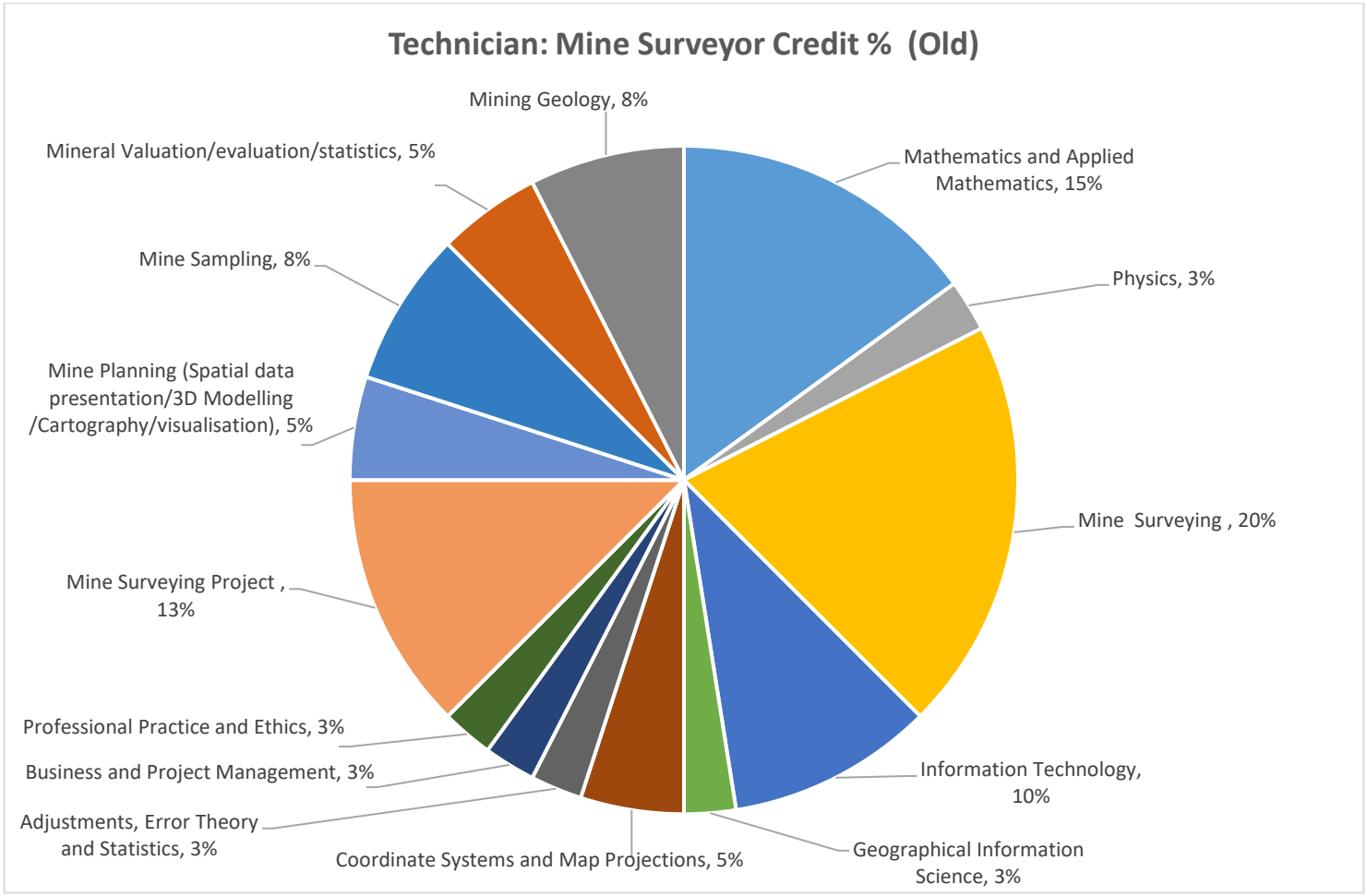
	Professional: Mine Surveyor NQF LEVEL 8				Technologist: Mine Surveyor NQF LEVEL 7				Technician: Mine Survey NQF LEVEL 6			
KNOWLEDGE AREA (KA)	**Old credits**	**% of 480**	**New Credits**	**% of 480**	**Old credits**	**% of 360**	**New Credits**	**% of 360**	**Old credits**	**% of 240**	**New Credits**	**% of 240**
Mathematics and Applied Mathematics	48	10	36	8	48	13%	28	8	36	15	28	12
Statistics	0	0	14	3	0	0	12	3	0	0	7	3
Physics	24	5	21	4	24	7	14	4	6	3	14	6
Mine Surveying	60	13	48	10	60	17	48	13	48	20	48	20
Information Technology	24	5	21	4	24	7	14	4	24	10	7	3
Geographic Information Science	18	4	18	4	12	3	12	3	6	3	7	3
Photogrammetry and Remote Sensing	12	3	14	3	0	0	7	2	0	0	0	0
Coordinate Systems and Map Projections	24	5	14	3	12	3	10	3	12	5	7	3
Adjustments, Error Theory and Statistics	24	5	14	3	12	3	12	3	6	3	7	3
Earth and Environmental Science	12	3	14	3	0	0	7	2	0	0	7	3
Business and Project Management	12	3	21	4	12	3	14	4	6	3	14	6
Professional Practice and Ethics	12	3	14	3	12	3	14	4	6	3	7	3
Professional communication			embedded in all KAs				embedded in all KAs				embedded in all KAs	
Mine Surveying Project	36	8	35	7	30	8	21	6	30	13	14	6
Land tenure, land law and cadastral studies	6	1	0	0	0	0	0	0	0	0	0	0
Precise Mine and Engineering Surveying	30	6	42	9	12	3	35	10	0	0	7	3
Mine Planning (Spatial data presentation/3D Modelling /Cartography/Visualisation)	18	4	42	9	12	3	35	10	12	5	21	9
Mineral Management	18	4	28	6	12	3	7	2	0	0	3	1
Mine Sampling	18	4	14	3	18	5	14	4	18	8	14	6
Mineral Valuation/evaluation/statistics	36	8	35	7	18	5	21	6	12	5	14	6
Mining Geology	24	5	21	4	24	7	21	6	18	8	14	6
Geotechnical Engineering	24	5	14	3	18	5	14	4	0	0	0	0
Total	**480**	**100%**	**480**	**100%**	**360**	**100%**	**360**	**100%**	**240**	**100%**	**240**	**100%**

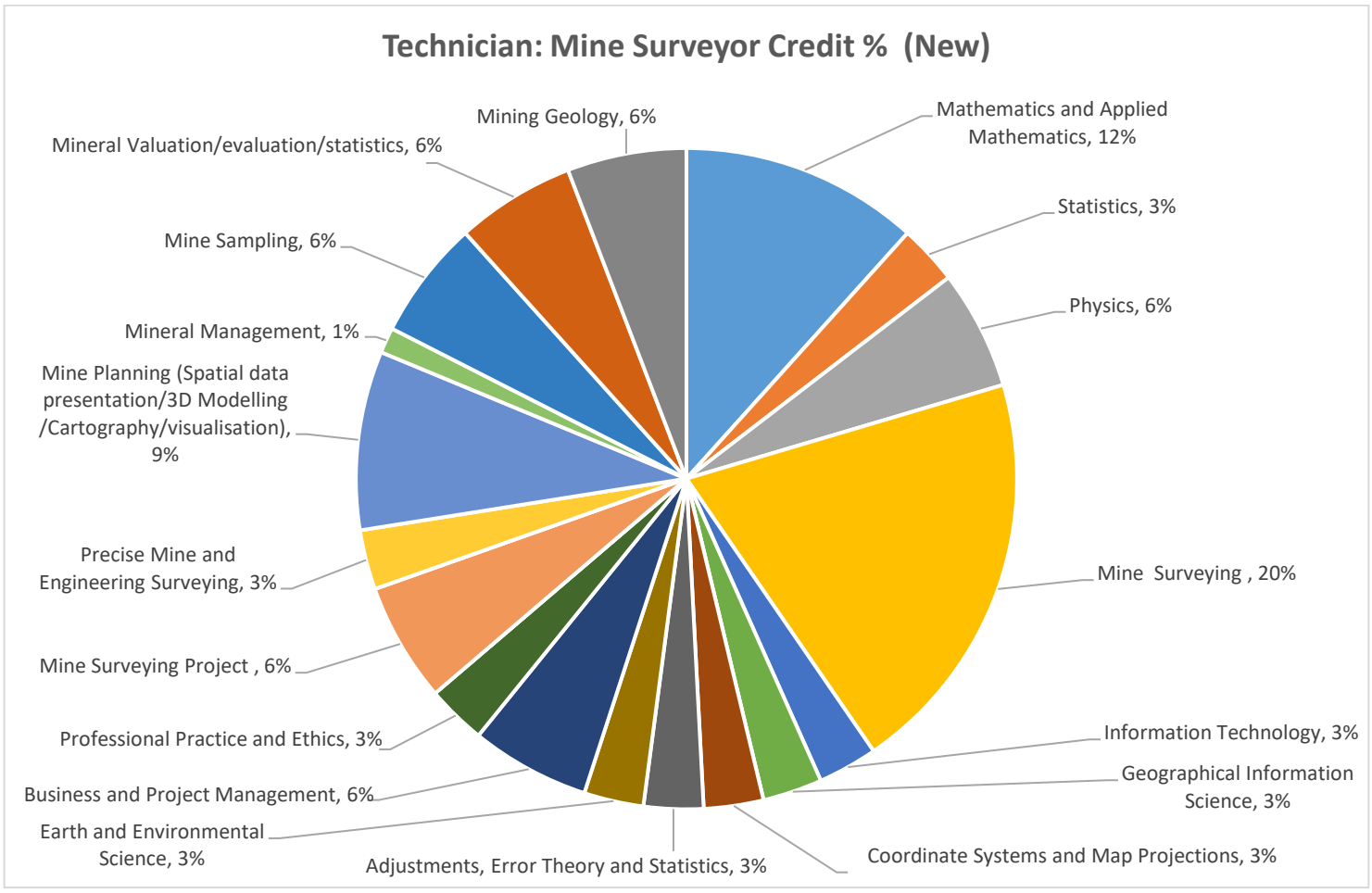

Professional Mine Surveyor Credit % (Old)
Mining Geology, 5%
Geotechnical Engineering, 5%
Mathematics and Applied Mathematics, 10%
Mineral Valuation/evaluation/statistics, 8%
Physics, 5%
Mine Sampling, 4%
Mine Surveying , 13%
Mineral Management, 4%
Mine Planning (Spatial data presentation/3D Modelling /Cartography/visualisation), 4%
Information Technology, 5%
Precise Mine and Engineering Surveying, 6%
Geographical Information Science, 4%
Land tenure, land law and cadastral studies, 1%
Photogrammetry and Remote Sensing,…
Mine Surveying Project , 8%
Coordinate Systems and Map Projections, 5%
Professional Practice and Ethics, 3%
Adjustments, Error Theory and Statistics, 5%
Business and Project Management, 3%
Earth and Environmental Science, 3%


Professional Mine Surveyor Credit % (New)
Geotechnical Engineering, 3%
Mathematics and Applied Mathematics, 8%
Mining Geology, 4%
Statistics, 3%
Mineral Valuation/evaluation/statistics, 7%
Physics, 4%
Mine Sampling, 3%
Mine Surveying , 10%
Mineral Management, 6%
Information Technology, 4%
Mine Planning (Spatial data presentation/3D Modelling /Cartography/visualisation), 9%
Geographical Information Science, 4%
Photogrammetry and Remote Sensing, 3%
Precise Mine and Engineering Surveying, 9%
Coordinate Systems and Map Projections, 3%
Adjustments, Error Theory and Statistics, 3%
Mine Surveying Project , 7%
Earth and Environmental Science, 3%
Professional Practice and Ethics, 3%
Business and Project Management, 4%


Technologist: Mine Surveyor Credit % (Old)
Geotechnical Engineering, 5%
Mining Geology, 7%
Mathematics and Applied Mathematics, 13%
Mineral Valuation/evaluation/statistics, 5%
Physics, 7%
Mine Sampling, 5%
Mineral Management, 3%
Mine Surveying , 17%
Mine Planning (Spatial data presentation/3D Modelling /Cartography/visualisation), 3%
Precise Mine and Engineering Surveying, 3%
Mine Surveying Project , 8%
Information Technology, 7%
Professional Practice and Ethics, 3%
Geographical Information Science, 3%
Business and Project Management, 3%
Coordinate Systems and Map Projections, 3%
Adjustments, Error Theory and Statistics, 3%


Technologist: Mine Surveyor Credit % (New)
Mining Geology, 6%
Geotechnical Engineering, 4%
Mathematics and Applied Mathematics, 8%
Mineral Valuation/evaluation/statistics, 6%
Statistics, 3%
Physics, 4%
Mine Sampling, 4%
Mineral Management, 2%
Mine Surveying , 13%
Mine Planning (Spatial data presentation/3D Modelling /Cartography/visualisation), 10%
Information Technology, 4%
Geographical Information Science, 3%
Precise Mine and Engineering Surveying, 10%
Photogrammetry and Remote Sensing, 2%
Mine Surveying Project , 6%
Coordinate Systems and Map Projections, 3%
Professional Practice and Ethics, 4%
Business and Project Management, 4%
Earth and Environmental Science, 2%
Adjustments, Error Theory and Statistics, 3%


Technician: Mine Surveyor Credit % (Old)
Mining Geology, 8%
Mineral Valuation/evaluation/statistics, 5%
Mathematics and Applied Mathematics, 15%
Mine Sampling, 8%
Physics, 3%
Mine Planning (Spatial data presentation/3D Modelling /Cartography/visualisation), 5%
Mine Surveying , 20%
Mine Surveying Project , 13%
Professional Practice and Ethics, 3%
Business and Project Management, 3%
Information Technology, 10%
Adjustments, Error Theory and Statistics, 3%
Coordinate Systems and Map Projections, 5%
Geographical Information Science, 3%


Technician: Mine Surveyor Credit % (New)
Mining Geology, 6%
Mineral Valuation/evaluation/statistics, 6%
Mathematics and Applied Mathematics, 12%
Statistics, 3%
Mine Sampling, 6%
Physics, 6%
Mineral Management, 1%
Mine Planning (Spatial data presentation/3D Modelling /Cartography/visualisation), 9%
Precise Mine and Engineering Surveying, 3%
Mine Surveying , 20%
Mine Surveying Project , 6%
Information Technology, 3%
Professional Practice and Ethics, 3%
Geographical Information Science, 3%
Business and Project Management, 6%
Earth and Environmental Science, 3%
Coordinate Systems and Map Projections, 3%
Adjustments, Error Theory and Statistics, 3%

Revised Academic Framework (Detailed) for MINE SURVEYING:

South African Geomatics Council (SAGC)

GUIDELINES FOR MINIMUM QUALIFICATION REQUIREMENTS FOR MINE SURVEYOR REGISTRATION

To be used in conjunction with knowledge area (KA) content specifications
One credit is considered to be 10 hours of notional learning
A knowledge area is not necessarily aligned with courses or modules in a curriculum; its content may be covered by multiple courses or modules over multiple years of study.
A knowledge area for which credits are not specified is assessed qualitatively, e.g., as a graduate attribute or overall degree outcome based on outcomes embedded in all the knowledge areas in the curriculum.
10% leeway per KA is allowed as long as there is no material impact on the qualification

		Professional: Mine Surveyor		**Technologist: Mine Surveyor**		**Technician: Mine Surveyor**	
Knowledge area (KA)	**Outcomes**	**Themes and key words**	**Credits**	**Themes and key words**	**Credits**	**Themes and key words**	**Credits**
Mathematics and Applied Mathematics	Ability to apply fundamental mathematical principles in solving mine survey problems	Areas, volumes, and arc length. Trigonometric functions, hyperbolic functions. Co-ordinate geometry; Euclidian and analytical geometry. Simultaneous Equations, Matrix algebra, Dot product, cross product. Determine the eigenvalue and eigenvectors of a given matrix. Series and polynomials. Vectors: Intersection of three-dimensional lines and planes. Differential and integral calculus of functions of one variable, differential equations, partial derivatives, Taylor series. Mean value theorem. Solving systems of linear and non-linear equations. Numerical analysis.	36	Analyse a given problem and apply the correct theorems and methods to solve the problem. Areas, volumes, and arc length. Trigonometry. Co-ordinate, Euclidian, and analytical geometry. Simultaneous Equations. Matrix algebra. Determine the eigenvalue and eigenvectors of a given matrix. Vectors: intersection of lines/planes, distance from points to lines and planes. Calculus: differentiation; partial differentiation; first order differential equations; integration. Solving systems of linear and non-linear equations.	28	Areas, volumes, and arc length. Trigonometry (functions). Co-ordinate and analytical geometry. Matrix algebra. Simultaneous equations. Introduction to vectors. Calculus: differentiation; partial differentiation; first order differential equations; integration.	28

Knowledge area (KA)	Outcomes	Professional: Mine Surveyor: Themes and key words	Credits	Technologist: Mine Surveyor Themes and key words	Credits	Technician: Mine Surveyor Themes and key words	Credits
Statistics	Ability to apply fundamental statistical principles in solving mine survey problems	Inverse distance estimation techniques. Polygonal, sectional and area weighting. Semi-variograms, Structural analysis. Sichels tables. Kriging, Cressie's "goodness of fit" test. Measures of Central Tendency in Normal and Log-normal distributions Sampling theory. Weighting of measurements. Sampling units to Mining units (variance) Students T-Test, Fishers F-Test. Normal and Log-normal distributions - Frequency distributions, Histograms, Ogives. Normal and Log-normal distributions - Confidence limits, confidence intervals. Normal and Log-normal distributions - Regression, distribution, and correlation. Precision and Accuracy. Tolerance. Law of propagation of errors, gross errors, systematic errors, random errors.	14	Measures of Central Tendency in a Normal distribution. Sampling theory. Weighting of measurements. Students T-Test, Fishers F-Test, Chi Square Test. Precision and Accuracy. Tolerance. Frequency distributions, Histograms, Ogives. Confidence limits. Measures of Central Tendency in a Log-Normal distributions. Regression, distribution, and correlation.	12	Measures of Central Tendency in a Normal distribution. Sampling theory. Weighting of measurements. Precision and Accuracy. Tolerance. Frequency distributions, Histograms, Ogives. Measures of Central Tendency. Regression and correlation.	7
Physics	Demonstrate understanding of the principles of physics in mine survey practice, instrumentation, and technology	Newton’s laws of motion, work, energy, power. Rotational dynamics, torque, angular momentum, simple harmonic motion. Gravity. Interference, wave motion. Diffraction, refraction, and reflection. Doppler effect. Magnetic field. Electromagnetic spectrum and signals (including visible light, infrared, radio, microwave, sound), codes and modulation (amplitude, frequency, phase). Optics.	21	Newton’s Laws of motion, work, energy, power. Rotational dynamics, torque, angular momentum, periodic motion. Gravitation. Diffraction, refraction, and reflection. Doppler effect. Magnetism. Electromagnetic spectrum. Optics.	14	Newton’s Laws of motion, work, energy, power. Rotational dynamics, torque, angular momentum, periodic motion. Gravitation. Diffraction, refraction, and reflection. Doppler effect. Magnetism. Electromagnetic spectrum. Optics.	14

Knowledge area (KA)	Outcomes	Professional: Mine Surveyor: Themes and key words	Credits	Technologist: Mine Surveyor Themes and key words	Credits	Technician: Mine Surveyor Themes and key words	Credits
Mine Surveying	Demonstrate the ability to manage advanced mine surveying operations	Theory and principles of mine surveying. Units of measure. Solution of triangles. Area and volume determination. Survey instruments, their use and adjustment. Traversing, balancing of traverse. Bowditch levelling, balancing of observations, Cut and Fill calculations, gradient calculations, cross- and longitudinal sections. Tacheometry. distance and direction from coordinates. Position determination using observed angles, directions, distances or any combinations. Setting out of pre-determined positions, heighting. Design of horizontal and vertical curves. Control and topographic surveys. Triangulation and trilateration. Resections (Collin's Q-point and Tienstra). Missing data calculations. Satellite stations. Shaft surveying. Gyroscopic techniques. GNSS systems.	48	Theory and principles of mine surveying. Units of measure. Solution of triangles. Area and volume determination. Survey instruments, their use and adjustment. Traversing, balancing of traverse. Bowditch levelling, balancing of observations, Cut and Fill calculations, Gradient calculations, Cross- and Longitudinal sections. Tacheometry. Distance and angular measurement. Distance and direction from coordinates. Position determination using observed angles, directions, distances, or any combinations. Setting out of pre-determined positions, heighting. Design of horizontal and vertical curves. Control and topographic surveys. Triangulation and trilateration. Resections (Collin's Q-point and Tienstra). Missing data calculations. Satellite stations. GNSS systems.	48	Theory and principles of mine surveying. Units of measure. Solution of triangles. Area and volume determination. Survey instruments, their use and adjustment. Traversing, balancing of traverse. Bowditch levelling, balancing of observations, Cut and Fill calculations, Gradient calculations, Cross- and Longitudinal sections. Tacheometry. Distance and angular measurement. Distance and direction from coordinates. Position determination using observed angles, directions, distances, or any combinations. Setting out of pre-determined positions, heighting. Design of horizontal and vertical curves. Control and topographic surveys. Triangulation and trilateration. Resections (Collin's Q-point and Tienstra). Missing data calculations. Satellite stations. GNSS systems	48

Knowledge area (KA)	Outcomes	Professional: Mine Surveyor: Themes and key words	Credits	Technologist: Mine Surveyor Themes and key words	Credits	Technician: Mine Surveyor Themes and key words	Credits
Information Technology	Demonstrate the ability to apply Information technology in standard mine survey applications	Fundamental computer literacy (spreadsheets, presentations, word processing, e-mail, file management, Internet). Geomatics software (Application of information technology in surveying). Mine valuation and planning software to evaluate a resource and do 3D planning. Data communications (connectivity, limitations, Local and wide area cover networks, Web services). Development of spreadsheets, macros or code (basic programming skills) to solve and analyse engineering related problems. IT infrastructure (e.g. networks, data centres and servers). Databases and database management systems (data formats, data transfer). Security of systems and information.	21	Fundamental computer literacy (spreadsheets, presentations, word processing, e-mail, file management, Internet). Geomatics software (application of information technology in surveying). Data communications (connectivity, limitations, Local and wide area cover networks, Web services). Development of spreadsheets and macros to solve and analyse engineering related problems. IT infrastructure (e.g. networks, data centres and servers). Databases and database management systems (data formats, data transfer). Security of systems and information.	14	Fundamental computer literacy (spreadsheets, presentations, word processing, internet). Using geomatics software. Data communications (local and wide area cover networks). Development of spreadsheets to solve and analyse engineering related problems.	7
Geographic Information Science	Demonstrate the ability to apply Geo Spatial Information science technology in managing standard mine survey operations	Computer Aided Drawing (CAD) applications. Nature of geo-spatial information in planning and decision-making. Spatial data management. Components of a GIS including people, hardware, software, spatial data, procedures. GIS Data acquisition and manipulation. Spatial referencing, data quality and data sharing in GIS. Data structures (vector, raster, hybrid) and data modelling. Geo-spatial databases and DBMS. Applications of geo-spatial data using spatial data analysis (Mine Information Management). Spatial modelling, Geographic reality; Topology, Spatial relationships. Spatial statistics. Representation of third dimension in GIS. Visualisation, Presentation and Dissemination of geo-spatial information (including digital cartography).	18	Computer Aided Drawing (CAD) applications. Spatial referencing, data quality and data sharing in GIS. Data structures (vector, raster, hybrid) and data modelling. Geo-spatial databases and DBMS. Nature of geo-spatial information in planning and decision-making. Spatial data management. Components of a GIS including people, hardware, software, spatial data, procedures. GIS Data acquisition and manipulation. Maps and Mine Plans. Cartographic design principals. Spatial interpolation. Visualisation of GIS and plans. Presentation and Dissemination of geo-spatial information (including digital cartography).	12	Computer Aided Drawing (CAD) applications. Geospatial information systems. Maps and types of maps. Cartographic design principals. Spatial interpolation. Visualisation of GIS and plans.	7

Knowledge area (KA)	Outcomes	Professional: Mine Surveyor: Themes and key words	Credits	Technologist: Mine Surveyor Themes and key words	Credits	Technician: Mine Surveyor Themes and key words	Credits
Photogram-metry and Remote Sensing	Demonstrate the ability to apply the principles of photogrammetry and remote sensing in the mining environment	Earth observation satellites. Principles of remote sensing (Electromagnetic spectrums, earth observing satellites, classification). Geometry of sensors and sensor systems (airborne, UAV, spaceborne and terrestrial). Structure from motion, camera calibration, acquisition of images (including flight planning). Principles of analogue and digital photography. Ortho-rectification, mosaicking and georeferencing, digital elevation models. Ground Control. Quality Control, Quality Assurance. Accuracy requirements. RPAS legislation specifically relevant to Mine sites (CAA Section 101)	14	Earth observation satellites. Principles of remote sensing (Electromagnetic spectrums, earth observing satellites, classification). Geometry of sensors and sensor systems (airborne, UAV, spaceborne and terrestrial). Structure from motion, camera calibration, acquisition of images (including flight planning). Principles of analogue and digital photography. Ortho-rectification, mosaicking and georeferencing, digital elevation models. Ground Control. Quality Control, Quality Assurance. Accuracy requirements. RPAS legislation specifically relevant to Mine sites (CAA Section 101)	7	None	0
Coordinate Systems and Map Projections	Demonstrate the ability to understand the principles of co-ordinate systems and map projections in the mine environment	Two- and three-dimensional coordinate systems. Grid reference systems (WGS LO) and Geographical coordinate systems. Mine specific datum (1828.797m) and co-ordinate systems (LO and Goldfields). Mathematical representations of the Earth, including reference ellipsoids. Gauss conformal projection and other types of map projections with their properties. Reference datums and common ellipsoids. South African National datums (Cape datum, Hartebeesthoek94 datum). Meridian convergence. Reduction of observations to projection plane including scale factors, sea Level projections, convergence. UTM system. Two-dimensional co-ordinate transformations (Helmert, LO to LO).	14	Two- and three-dimensional coordinate systems. Grid reference systems (WGS LO) and Geographical coordinate systems. Mine specific datum (1828.797m) and co-ordinate systems (LO and Goldfields). Mathematical representations of the Earth, including reference ellipsoids. Gauss conformal projection and other types of map projections with their properties. Reference datums and common ellipsoids. South African National datums (Cape datum, Hartebeesthoek94 datum). Meridian convergence. Reduction of observations to projection plane including scale factors, sea level projections, convergence. Two-dimensional co-ordinate transformations (Helmert, LO to LO)	10	Two- and three-dimensional coordinate systems. Grid reference systems (WGS LO). Mine specific datum (1828.797m) and co-ordinate systems (LO and Goldfields). Gauss conformal projection. South African National datums (Cape datum, Hartebeesthoek94 datum). Reduction of observations to projection plane including. Scale factors, sea level projections.	7

Knowledge area (KA)	Outcomes	Professional: Mine Surveyor: Themes and key words	Credits	Technologist: Mine Surveyor Themes and key words	Credits	Technician: Mine Surveyor Themes and key words	Credits
Adjustments, Error Theory and Statistics	Demonstrate the ability to recognise and adjust observational errors in the mining environment	The nature of observations and data acquisition. Management of instrument errors, calibration and expected precision. Law of error propagation. Quality control, Quality Assurance, Repeatability, Reliability. Standards of Accuracy (Mine Health and Safety Act), site specific standards. Closures and breakthrough calculation. Levelling adjustment. Traverse network adjustment. Error detection, the types of errors. Error statistics described by means, norms, probability, confidence intervals, distributions, and probability density functions. Least Squares adjustments of survey observations (parametric and condition equations) Auto- and cross-correlation, Hypothesis testing. Design of networks and adjustment. Statistical analysis of results and interpretation of data.	14	The nature of observations and data acquisition. Management of instrument errors, calibration and expected precision. Law of error propagation Quality control, Quality Assurance, Repeatability, Reliability. Standards of Accuracy (Mine Health and Safety Act), site specific standards. Closures and breakthrough calculation. Levelling adjustment. Traverse adjustment.	12	The nature of observations and data acquisition. Management of instrument errors, calibration and expected precision. Law of error propagation. Standards of Accuracy (Mine Health and Safety Act), site specific standards. Levelling adjustment. Traverse adjustment.	7
Earth and Environmental Studies	Demonstrate the ability to contribute to the environmental management of a mine	Earth's natural environment and systems. Human settlement and activities. Environmental management plans and environmental impact assessment. Environmental pitfalls in Minerals exploration and Mining. Water management. Pollution from mining operations (Air, Noise, Light and Water). Environment impact assessment. Compiling an Environmental Management Programme (EMPR).	14	Earth's natural environment and systems. Human settlement and activities. Environmental management plans and environmental impact assessment. Environmental pitfalls in Minerals exploration and Mining. Pollution from mining operations (Air, Noise, Light and Water).	**7**	Earth's natural environment and systems. Human settlement and activities. Environmental management plans and environmental impact assessment. Environmental pitfalls in Minerals exploration and Mining. Pollution from mining operations (Air, Noise, Light and Water).	7

Knowledge area (KA)	Outcomes	Professional: Mine Surveyor: Themes and key words	Credits	Technologist: Mine Surveyor Themes and key words	Credits	Technician: Mine Surveyor Themes and key words	Credits
Business and Project Management	Demonstrate the ability to communicate and work in a project team within a mining environment	Management functions (planning, controlling, organising, staffing and directing). Human resource management, financial management and management accounting. Business plan and cash flow projections. Entrepreneurship and small and medium enterprise development. Business communication. Project Management, project planning and project finance. Project control and reporting.	21	Management functions (planning, controlling, organising, staffing and directing), Human resource management, financial management and management accounting. Business plan and cash flow projections. Entrepreneurship and small and medium enterprise development. Business communication. Project Management, project planning and project finance. Project control and reporting.	14	Management functions (planning, controlling, organising, staffing and directing). Human resource management, financial management and management accounting. Business plan and cash flow projections. Entrepreneurship and small and medium enterprise development. Business communication. Project Management, project planning and project finance. Project control and reporting.	14
Professional Practice	Demonstrate the ability to practice safely within the mining industry's legal requirements	Safety culture. Professionalism, professional ethics, Client relationships, social responsibility; Relationship and communication with Government agencies. Registration with Geomatics Profession Council (including legislation and rules). Legislation MHSA, MPRDA, SAMREC and regulations.	14	Safety culture. Professionalism, professional ethics, Client relationships, social responsibility; Relationship and communication with Government agencies. Registration with Geomatics Profession Council (including legislation and rules). Legislation MHSA, MPRDA, SAMREC and regulations.	14	Safety Culture. Professionalism, professional ethics, Client relationships, social responsibility; Registration with Geomatics Profession Council (including legislation and rules). Legislation MHSA only, MPRDA, SAMREC and Regulations.	7

Knowledge area (KA)	Outcomes	Professional: Mine Surveyor: Themes and key words	Credits	Technologist: Mine Surveyor Themes and key words	Credits	Technician: Mine Surveyor Themes and key words	Credits
Mine Planning	Demonstrate the ability to perform complex mine planning skills	Mine Planning Terminology and plan reading. Mine Ventilation constraints (gasses, airflow, Health and Safety Act requirements), Environmental control - airflow, cooling. Calculation of areas, volumes, tonnage, and mineral content of narrow tabular and massive type ore bodies. Design of mine development to allow safe holing on gradient. Mine design, layout and sequence related to the different types of mining methods such as Deep, intermediate, shallow, single reef/seam, multi reef/seam, wide reef/seam, irregular ore body, pipe deposits, massive ore bodies, stopes, tunnels, large excavations. Financial valuation of an orebody. Produce a report on the resource evaluation and content for a specific mining method and commodity type. Cartographic communication, symbology (point, line, area, pictorial, 2D and 3D), generalisation, colour, cartographic design. Mine Health and Safety Act Chapter 17 requirements, types of plans, scale, title block information, signatures, legend. Storage, updates, and backups. Data custody "may not withhold plans on non-payment." Rescue and Forensic plans (incident investigation plans). Plan reading, scale, grid, conventions, orientation. Digital plans and maps, and computer-aided mapping (e.g. 2D, 3D CAD). Representation from 3D data (e.g. point clouds, 3D mesh, Building Information Modelling (BIM)). Data and product quality, privacy, and societal impact.	42	Mine Planning Terminology and plan reading. Mine Ventilation constraints (gasses, airflow, Health and Safety Act requirements), Environmental control - airflow, cooling. Calculation of areas, volumes, tonnage and mineral content of narrow tabular and massive type ore bodies. Design of mine development to allow safe holing on gradient. Mine design, layout and sequence related to the different types of mining methods. Basic financial valuation of an orebody. Cartographic communication, symbology (point, line, area, pictorial, 2D and 3D), generalisation, colour, cartographic design. Mine Health and Safety Act Chapter 17 requirements, types of plans, scale, title block information, signatures, legend. Storage, updates, and backups. Data custody "may not withhold plans on non-payment". Rescue and Forensic plans (incident investigation plans). Plan reading, scale, grid, conventions, orientation. Digital plans and maps, and computer-aided mapping (e.g. 2D, 3D CAD). Representation from 3D data (e.g. point clouds, 3D mesh, Building Information Modelling (BIM)). Data and product quality, privacy, and societal impact.	35	Mine Planning Terminology and plan reading. Mine Ventilation constraints (gasses, airflow, Health and Safety Act requirements), Environmental control - airflow, cooling. Calculation of areas, volumes, tonnage and mineral content of narrow tabular and massive type ore bodies. Design of mine development to allow safe holing on gradient. Mine design, layout and sequence related to the different types of mining methods. Basic financial valuation of an orebody. Cartographic communication, symbology (point, line, area, pictorial, 2D and 3D), generalisation, colour, cartographic design. Mine Health and Safety Act Chapter 17 requirements, types of plans, scale, title block information, signatures, legend. Storage, updates, and backups. Data custody "may not withhold plans on non-payment". Rescue and Forensic plans (incident investigation plans). Plan reading, scale, grid, conventions, orientation. Digital plans and maps, and computer-aided mapping (e.g. 2D, 3D CAD). Representation from 3D data (e.g. point clouds, 3D mesh, Building Information Modelling (BIM)). Data and product quality, privacy, and societal impact.	21

Knowledge area (KA)	Outcomes	Professional: Mine Surveyor: Themes and key words	Credits	Technologist: Mine Surveyor Themes and key words	Credits	Technician: Mine Surveyor Themes and key words	Credits
Precise Mine and Engineering Surveying	Demonstrate the ability to apply precise surveying techniques to resolve complex mining activities	Specialized surveying and monitoring equipment. Geotechnical monitoring, Network establishment (level, triangulation, resection, traverse). Analysis of data, presentation of data. Standards of accuracy.	42	Specialized surveying and monitoring equipment. Network establishment (level, triangulation, resection, traverse). Analysis of data, presentation of data. Standards of accuracy.	35	Specialized surveying and monitoring equipment. Standards of accuracy.	7
Professional communication	Demonstrate the ability to use graphic and verbal forms of communication to ensure timeous, efficient, professional and safe instructions when working in a multidisciplinary team	Business communication literacy including all mediums including professional communication via electronic communication and social media; grammar, spelling, and formatting of documents. Information literacy including finding, accessing, understanding, collating, interpreting, and referencing information. Etiquette and social interaction including verbal and non-verbal communication, presentation, assertiveness, and social sensitivity. Communicating, negotiation and reporting in multidisciplinary teams. Client confidentiality including intellectual property and data, non-disclosure of information and ethics in reporting. Technical and professional project report writing such as preparing a Competent person's report. Communicating technical content with non-technical persons. Communicating technical and legal site instructions, mining layouts, Holing warnings, Stop work notices. Storage, documentation, and legal requirements. Safety briefings, toolbox talks, safety instructions to crews and teams. Risk assessment.	Embedded	Business communication literacy including all mediums including professional communication via electronic communication and social media; grammar, spelling, and formatting of documents. Information literacy including finding, accessing, understanding, collating, interpreting, and referencing information. Etiquette and social interaction including verbal and non-verbal communication, presentation, assertiveness, and social sensitivity. Communicating, negotiation and reporting in multidisciplinary teams. Communicating technical and legal site instructions, mining layouts, Holing warnings, Stop work notices. Storage, documentation, and legal requirements. Safety briefings, toolbox talks, safety instructions to crews and teams. Risk assessment.	Embedded	Business communication literacy including all mediums including professional communication via electronic communication and social media; grammar, spelling, and formatting of documents. Information literacy including finding, accessing, understanding, collating, interpreting, and referencing information. Etiquette and social interaction including verbal and non-verbal communication, presentation, assertiveness, and social sensitivity. Communicating, negotiation and reporting in multidisciplinary teams. Communicating technical and legal site instructions, mining layouts, Holing warnings, Stop work notices. Storage, documentation, and legal requirements. Safety briefings, toolbox talks, safety instructions to crews and teams. Risk theory and assessment.	Embedded

Knowledge area (KA)	Outcomes	Professional: Mine Surveyor: Themes and key words	Credits	Technologist: Mine Surveyor Themes and key words	Credits	Technician: Mine Surveyor Themes and key words	Credits
Mine Surveying Project	Demonstrate the ability to form a research question, perform literature searches to inform a survey campaign to develop an understanding in a specific technical aspect	Research methodology, Referencing techniques and Formats. Literature search methods. Report writing and Formatting of reports. The student must engage with a mine surveying, mine valuation, or mine planning related problem, research and report findings. The project may include a design, analysis and research component and include reporting and presentation of final results. A written report on a technical aspect such as field work or a portfolio of evidence can be in the form of a technical paper, report, or Competent Person's report. The project should include an oral presentation to peers and panel. Modalities may vary	35	Surveying or mine valuation project demonstrating practical skills required by a Mine Surveyor to prepare a mine plan or mine design. Submit a basic project report for mine valuation, or planning, or mine surveying. Referencing techniques and formats. Written report on a technical aspect such as field work or a portfolio of evidence. Oral presentation of report and findings. Modalities may vary.	21	Basic project report for mine valuation, or planning, or mine surveying. Report writing, formatting. Fundamental Research methodology, referencing, literature search. Written report on a technical aspect such as field work or a portfolio of evidence. Oral presentation of report and findings. Modalities may vary.	14
Mineral Management	Demonstrate the ability to demonstrate mineral management skills as required at a mine	Mining rights with reference to land use systems and types. Mining Titles Registration Act (No. 16 of 1967) and Regulations. Mineral and Petroleum Resources Development Act (28 of 2002). Mine Health and Safety Act (No. 29 of 1996) and regulations. SAMREC and SAMVAL codes.	28	Mining rights with reference to land use systems and types. Mineral and Petroleum Resources Development Act (28 of 2002), Mine Health and Safety Act (No. 29 of 1996) and regulations. Introduction to the implication of the SAMREC and SAMVAL codes.	7	Mine Health and Safety Act (No. 29 of 1996) and regulations with direct impact on the safe management of a mine survey office	3

Knowledge area (KA)	Outcomes	Professional: Mine Surveyor: Themes and key words	Credits	Technologist: Mine Surveyor Themes and key words	Credits	Technician: Mine Surveyor Themes and key words	Credits
Mine Sampling	Demonstrate the ability to apply sampling theory at a mine production unit	Sampling theory and procedures, sampling methods; Sampling reports; Averaging and weighing of sampling results; regular and irregular sampling intervals; Calculation of tonnage and mineral content; ore flow; pay limits; grade control; life of mine; valuation of a mineral deposits; management control factors; present values and compound interest; taxation; borehole valuation; statistical valuation (distribution, probability, and regression) sampling and valuation computer applications. Reporting.	14	Sampling theory and procedures, sampling methods; Sampling reports; Averaging and weighing of sampling results; regular and irregular sampling intervals; Calculation of tonnage and mineral content; ore flow; pay limits; grade control; life of mine; valuation of a mineral deposits; management control factors; present values and compound interest; taxation; borehole valuation; statistical valuation (distribution, probability, and regression) sampling and valuation computer applications. Reporting.	14	Sampling theory and procedures, sampling methods; Sampling reports; Averaging and weighing of sampling results; regular and irregular sampling intervals; Calculation of tonnage and mineral content; ore flow.	14
Mineral Valuation / Evaluation / Geostatistics	Demonstrate the ability to produce and manage mineral reserves for a mine	Sampling and assay errors Ore flow; pay limits; grade control; life of mine; valuation of mineral deposits. Financial mine planning, classical statistics, non-spatial estimation techniques, data analysis, classical estimation methods, geostatistical estimation methods. Kriging methods, log normal distributions, correlation, grade tonnage curves.	35	Sampling and assay errors Ore flow; pay limits; grade control; life of mine; valuation of mineral deposits. Financial mine planning, classical statistics, non-spatial estimation techniques, data analysis, classical estimation methods, geostatistical estimation methods.	21	Sampling and assay errors. Grade control; life of mine; pay limits; valuation of a mineral deposits; management control factors.	14
Mining Geology	Demonstrate the ability to apply geology knowledge in the management of sampling, survey data and valuation	Mineralogy, petrology, physical geology, structural geology, historical geology, economic geology, prospecting methods, geological maps. Representation from 3D data, structural geology.	21	Mineralogy, petrology, physical geology, structural geology, historical geology, economic geology, prospecting methods, geological maps.	21	Mineralogy, petrology, physical geology, economic geology, prospecting methods, geological maps.	14

Knowledge area (KA)	Outcomes	Professional: Mine Surveyor: Themes and key words	Credits	Technologist: Mine Surveyor Themes and key words	Credits	Technician: Mine Surveyor Themes and key words	Credits
Geotechnical Engineering	Demonstrate the ability to apply rock engineering knowledge in mine planning and monitoring in a mining unit	Purpose of rock engineering, elastic theory, stresses and strains - compression, tension, shear, Young's Modulus, Poisson's Ratio, strength of support materials - rock types etc, convergence, distribution of stress around openings, fracture around openings, effects of geology, factors governing rock behaviour, energy release rate, excess shear stress.	14	Purpose of rock engineering, elastic theory, stresses and strains - compression, tension, shear, Young's Modulus, Poisson's Ratio, strength of support materials - rock types etc, convergence, distribution of stress around openings, fracture around openings, effects of geology, factors governing rock behaviour, energy release rate, excess shear stress.	14	None	0
		Total:	**480**		**360**		**240**