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

Engineering 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

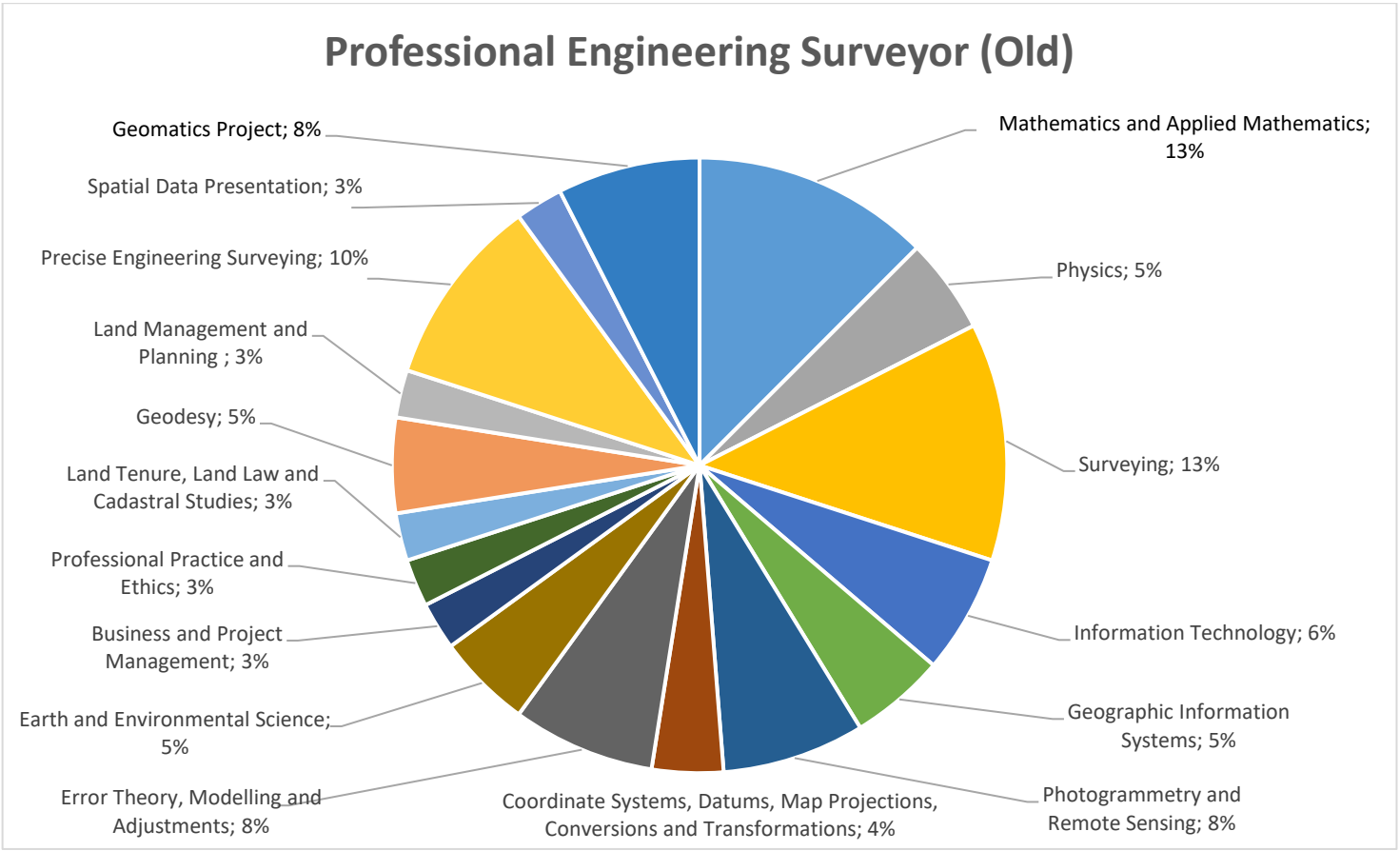
Summaries of the Revised Academic Frameworks for each branch and its related categories are outlined in this section to provide an overview of the overall process. The summary frameworks are presented showing the distribution of credits for the knowledge areas (KAs) in the '*New*' and '*Old*' frameworks 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.

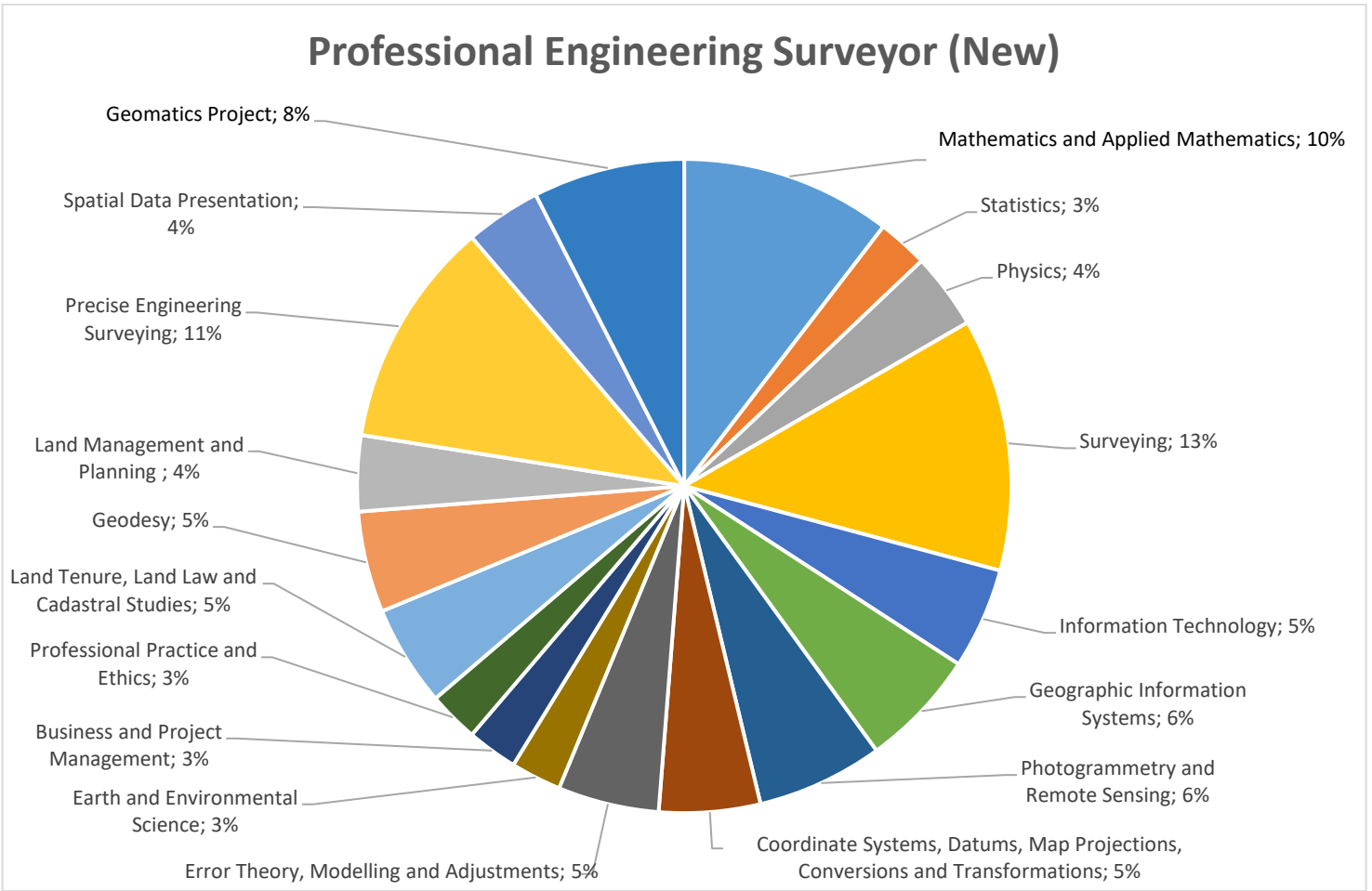
South African Geomatics Council (SAGC)

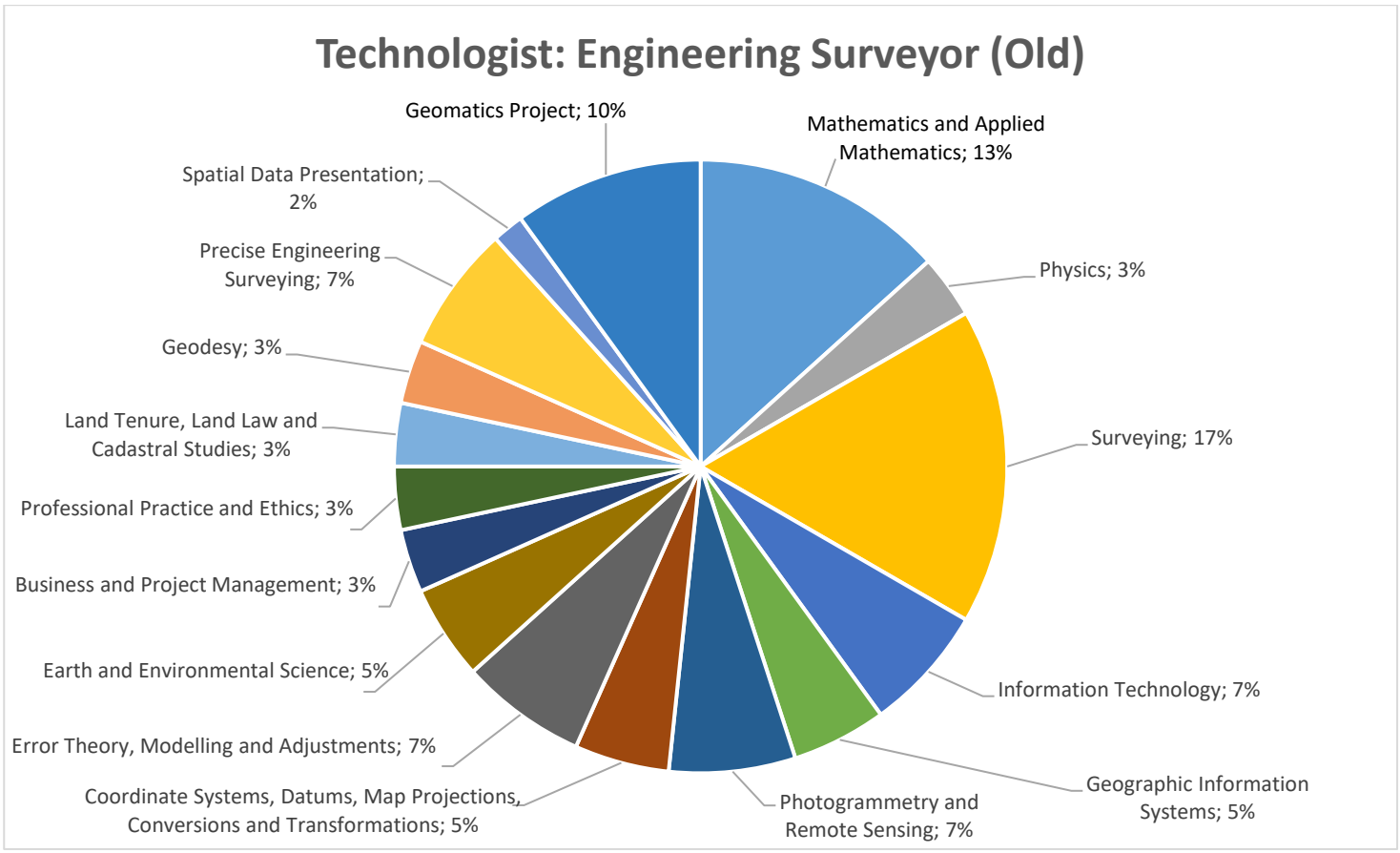
GUIDELINES FOR MINIMUM QUALIFICATION REQUIREMENTS FOR ENGINEERING SURVEYOR REGISTRATION

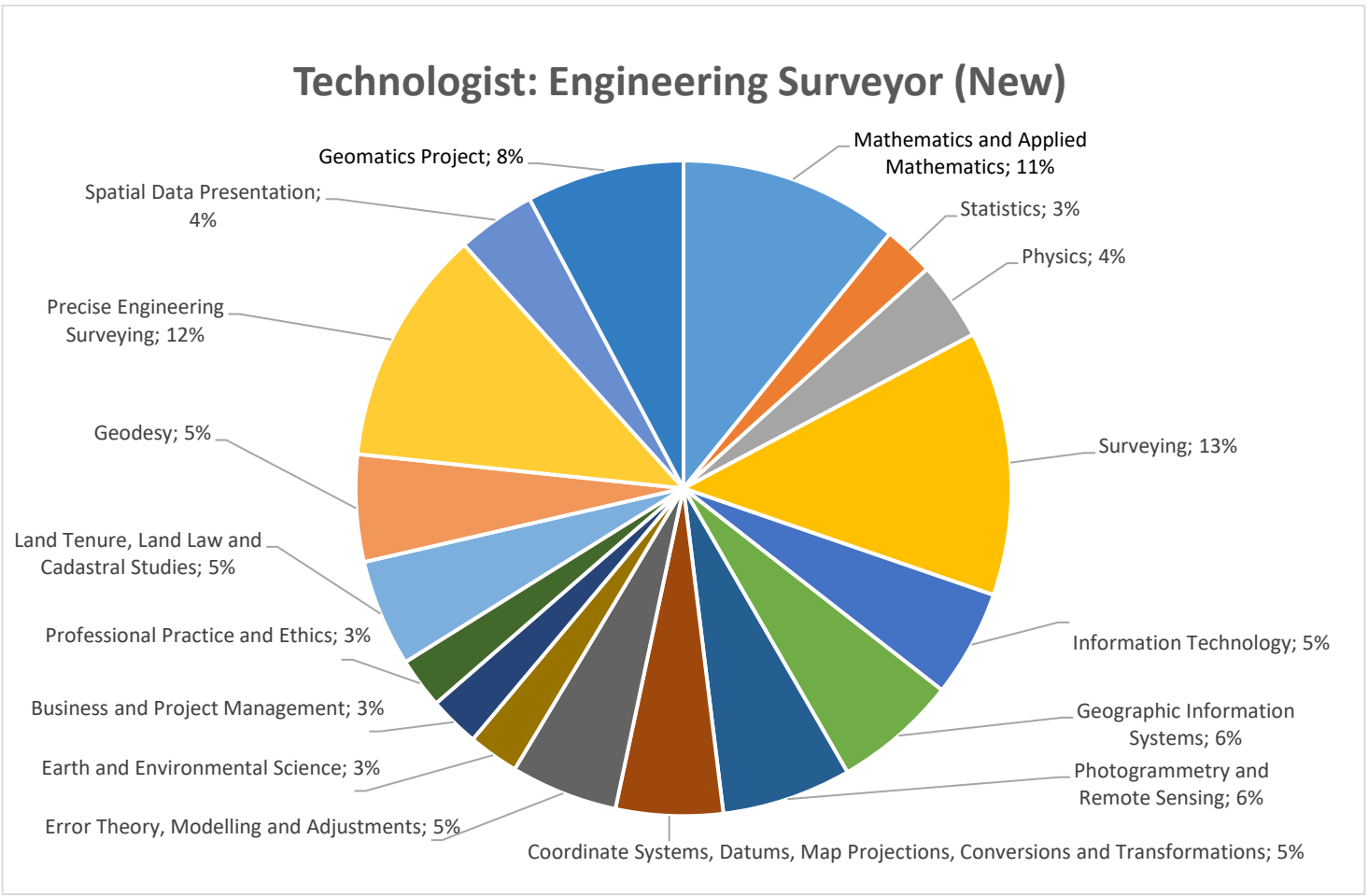
To be used in conjunction with knowledge area content specifications
One credit is considered to be 10 hours of notional learning
A knowledge area is not necessarily aligned with courses or modules in a curriculum; its content may be covered by multiple courses or modules over multiple years of study.
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

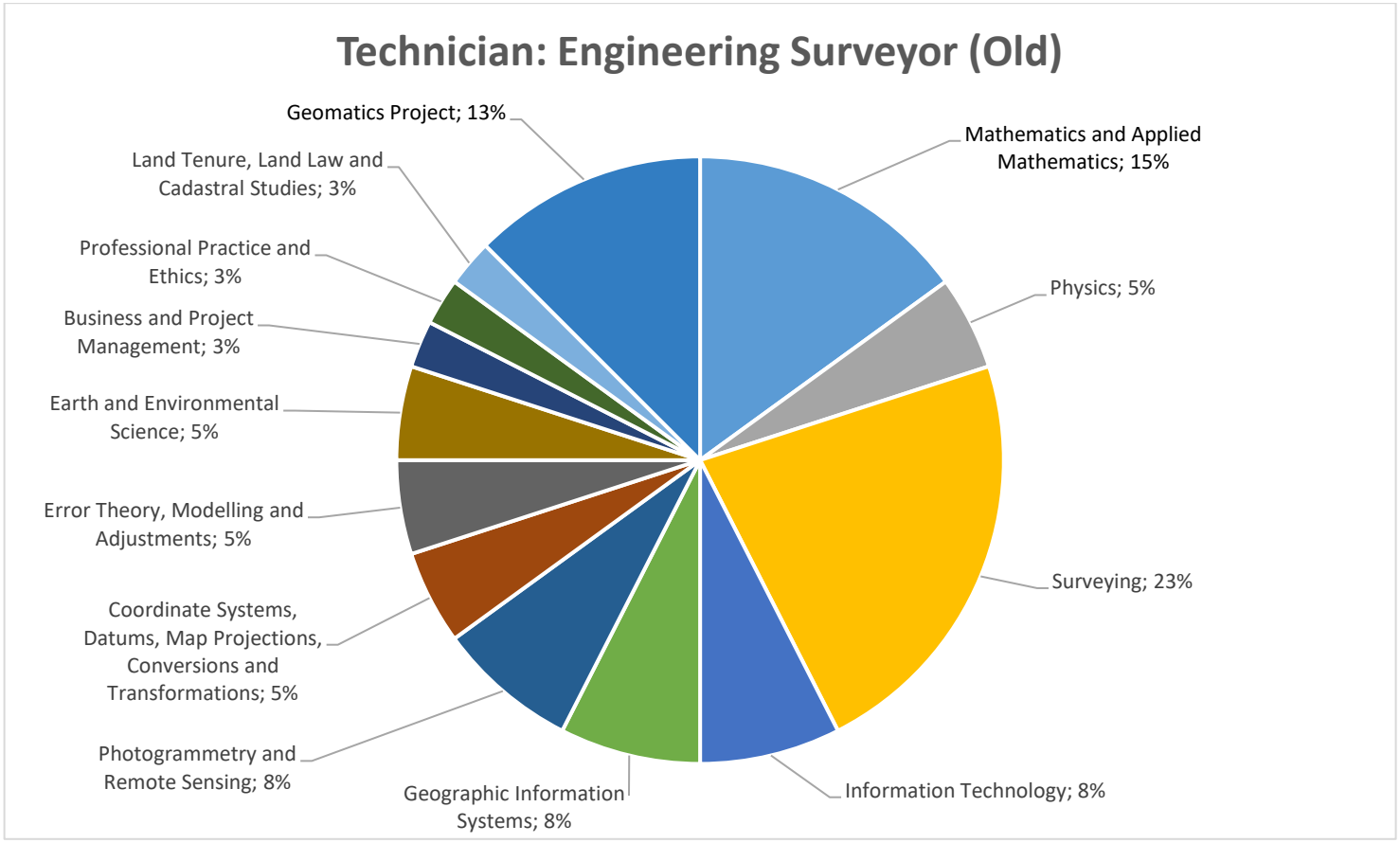
	Professional: Engineering Surveyor				Technologist: Engineering Surveyor				Technician: Engineering Surveyor			
	NQF LEVEL 8				NQF LEVEL 7				NQF LEVEL 6			
KNOWLEDGE AREA (KA)	**Old credits**	**% of 480**	**New credits**	**% of 480**	**Old credits**	**% of 360**	**New credits**	**% of 360**	**Old credits**	**% of 240**	**New credits**	**% of 240**
Mathematics and Applied Mathematics	60	13	50	10	48	13	39	11	36	15	32	13
Statistics			12	3			9	3			7	3
Physics	24	5	18	4	12	3	14	4	12	5	11	5
Surveying	60	13	60	13	60	17	47	13	54	23	38	16
Information Technology	30	6	24	5	24	7	19	5	18	8	15	6
Geographic Information Systems	24	5	28	6	18	5	22	6	18	8	18	8
Photogrammetry and Remote Sensing	36	8	30	6	24	7	23	6	18	8	19	8
Coordinate Systems, Datums, Map Projections, Conversions and Transformations	18	4	24	5	18	5	19	5	12	5	15	6
Error Theory, Modelling and Adjustments	30	8	24	5	24	7	19	5	12	5	15	6
Earth and Environmental Science	24	5	12	3	18	5	9	3	12	5	7	3
Business and Project Management	12	3	12	3	12	3	9	3	6	3	7	3
Professional Practice and Ethics	12	3	12	3	12	3	9	3	6	3	7	3
Land tenure, land law and cadastral studies	12	3	24	5	12	3	19	5	6	3	15	6
Geodesy	24	5	24	5	12	3	19	5				0
Land Management and Planning	12	3	18	4								0
Precise Engineering Surveying	48	10	54	11	24	7	42	12				0
Spatial data presentation	12	3	18	4	6	2	14	4			11	5
Professional communication			embedded in all KAs				embedded in all KAs				embedded in all KAs	
Geomatics Project	36	8	36	8	36	10	28	8	30	13	23	10
Total	**480**	**100%**	**480**	**100%**	**360**	**100%**	**360**	**100%**	**240**	**100%**	**240**	**100%**

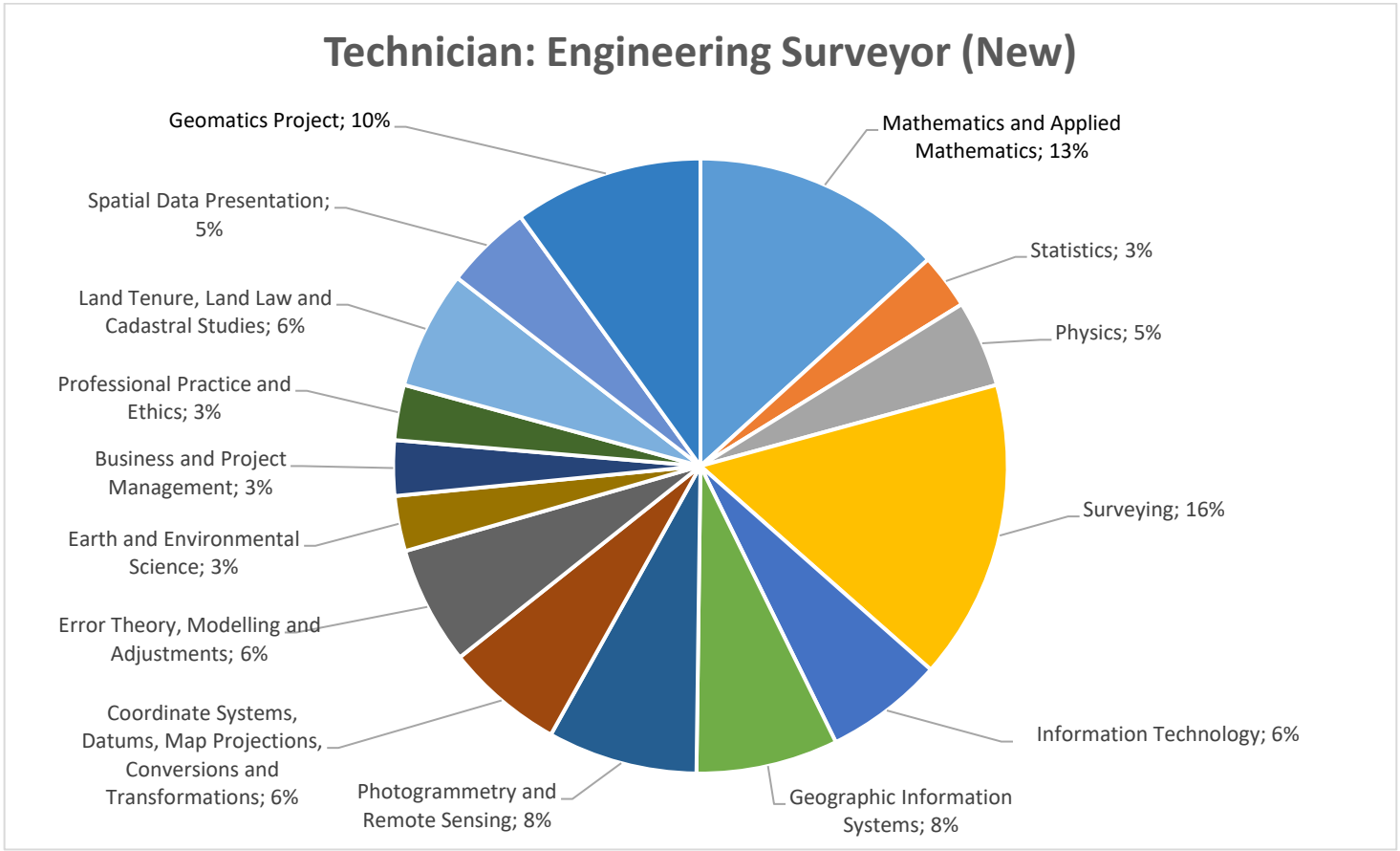

Professional Engineering Surveyor (Old)
Geomatics Project; 8%
Spatial Data Presentation; 3%
Precise Engineering Surveying; 10%
Land Management and Planning ; 3%
Geodesy; 5%
Land Tenure, Land Law and Cadastral Studies; 3%
Professional Practice and Ethics; 3%
Business and Project Management; 3%
Earth and Environmental Science; 5%
Error Theory, Modelling and Adjustments; 8%
Coordinate Systems, Datums, Map Projections, Conversions and Transformations; 4%
Photogrammetry and Remote Sensing; 8%
Geographic Information Systems; 5%
Information Technology; 6%
Surveying; 13%
Physics; 5%
Mathematics and Applied Mathematics; 13%


Professional Engineering Surveyor (New)
Geomatics Project; 8%
Spatial Data Presentation; 4%
Precise Engineering Surveying; 11%
Land Management and Planning ; 4%
Geodesy; 5%
Land Tenure, Land Law and Cadastral Studies; 5%
Professional Practice and Ethics; 3%
Business and Project Management; 3%
Earth and Environmental Science; 3%
Error Theory, Modelling and Adjustments; 5%
Coordinate Systems, Datums, Map Projections, Conversions and Transformations; 5%
Photogrammetry and Remote Sensing; 6%
Geographic Information Systems; 6%
Information Technology; 5%
Surveying; 13%
Physics; 4%
Statistics; 3%
Mathematics and Applied Mathematics; 10%


Technologist: Engineering Surveyor (Old)
Geomatics Project; 10%
Mathematics and Applied Mathematics; 13%
Spatial Data Presentation; 2%
Precise Engineering Surveying; 7%
Physics; 3%
Geodesy; 3%
Surveying; 17%
Land Tenure, Land Law and Cadastral Studies; 3%
Professional Practice and Ethics; 3%
Business and Project Management; 3%
Information Technology; 7%
Earth and Environmental Science; 5%
Error Theory, Modelling and Adjustments; 7%
Geographic Information Systems; 5%
Coordinate Systems, Datums, Map Projections, Conversions and Transformations; 5%
Photogrammetry and Remote Sensing; 7%


Technologist: Engineering Surveyor (New)
Geomatics Project; 8%
Mathematics and Applied Mathematics; 11%
Spatial Data Presentation; 4%
Statistics; 3%
Physics; 4%
Precise Engineering Surveying; 12%
Surveying; 13%
Geodesy; 5%
Land Tenure, Land Law and Cadastral Studies; 5%
Information Technology; 5%
Professional Practice and Ethics; 3%
Business and Project Management; 3%
Geographic Information Systems; 6%
Earth and Environmental Science; 3%
Photogrammetry and Remote Sensing; 6%
Error Theory, Modelling and Adjustments; 5%
Coordinate Systems, Datums, Map Projections, Conversions and Transformations; 5%


Technician: Engineering Surveyor (Old)
Geomatics Project; 13%
Mathematics and Applied Mathematics; 15%
Land Tenure, Land Law and Cadastral Studies; 3%
Professional Practice and Ethics; 3%
Physics; 5%
Business and Project Management; 3%
Earth and Environmental Science; 5%
Error Theory, Modelling and Adjustments; 5%
Surveying; 23%
Coordinate Systems, Datums, Map Projections, Conversions and Transformations; 5%
Photogrammetry and Remote Sensing; 8%
Geographic Information Systems; 8%
Information Technology; 8%


Technician: Engineering Surveyor (New)
Geomatics Project; 10%
Mathematics and Applied Mathematics; 13%
Spatial Data Presentation; 5%
Statistics; 3%
Land Tenure, Land Law and Cadastral Studies; 6%
Physics; 5%
Professional Practice and Ethics; 3%
Business and Project Management; 3%
Surveying; 16%
Earth and Environmental Science; 3%
Error Theory, Modelling and Adjustments; 6%
Coordinate Systems, Datums, Map Projections, Conversions and Transformations; 6%
Information Technology; 6%
Photogrammetry and Remote Sensing; 8%
Geographic Information Systems; 8%

Revised Academic Framework (Detailed) for ENGINEERING SURVEYING:

South African Geomatics Council (SAGC)

GUIDELINES FOR MINIMUM QUALIFICATION REQUIREMENTS FOR ENGINEERING 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: Engineering Surveyor		Technologist: Engineering Surveyor		Technician: Engineering Surveyor	
Knowledge area (KA)	**Outcomes**	**Themes and key words**	**Credits**	**Themes and key words**	**Credits**	**Themes and key words**	**Credits**
Mathematics and Applied Mathematics	Understanding and applying mathematics in solving geomatics related problems	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, trigonometric functions, spherical trigonometry, hyperbolic functions, conic sections, complex numbers, vector geometry, matrix algebra, eigen vectors and values, linear transformations, space curves and surfaces, differential geometry. Series and polynomials. Areas, volumes, and arc length. Dot product, cross product. Intersections of 3D lines and planes, distances from points to 3D line and planes. Series and polynomials.	50	Trigonometry; co-ordinate geometry; analytical geometry; Matrix algebra, vectors; Calculus: differentiation; partial differentiation; first order differential equations; integration. Solving systems of linear and non-linear equations, conic sections, vector geometry, matrix algebra, co-ordinate systems. Intersection of lines/planes, distance from points to lines/planes. Spherical geometry.	39	Trigonometry; co-ordinate geometry; analytical geometry; Matrix algebra, vectors; Calculus: differentiation; partial differentiation; first order differential equations; integration.	32

Knowledge area (KA)	Outcomes	Professional: Engineering Surveyor Themes and key words	Credits	Technologist: Engineering Surveyor Themes and key words	Credits	Technician: Engineering Surveyor Themes and key words	Credits
Statistics	Understanding and applying statistics in processing and analysing geomatics related data sets	Distributions and probability density functions, distribution functions, normal distribution, means, norms, probability, reliability, confidence intervals, distributions, and probability density functions, precision of an observation, precision of the mean or best estimate, correlation, sampling, and statistical testing. Confidence limits, rejection criteria, T-Test, Fishers F-Test, Chi Square Test. Sets, probability, permutations, and combinations.	12	Regression, distribution and probability density functions, error theory, sampling. Normal distribution, confidence limits, rejection criteria, T-Test, Fishers F-Test, Chi Square Test.	9	Regression, distribution, correlation, sampling. Normal distribution, tolerance.	7
Physics	Understanding and applying the principles of physics in relation to spatial data measurement and processing.	Kinematics, Newton's laws of motion, work, energy, power, rotational dynamics, torque, angular momentum, gravity, periodic motion, simple harmonic motion, 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. Acoustic positioning concepts, underwater acoustics.	18	Newton's laws of motion, work, energy, power, rotational dynamics, torque, angular momentum, gravitation, periodic motion, diffraction, refraction and reflection, Doppler effect, magnetism, electromagnetic spectrum, Optics	14	Newton's laws of motion, work, energy, power, rotational dynamics, torque, angular momentum, gravitation, periodic motion, diffraction, refraction and reflection, Doppler effect, magnetism, electromagnetic spectrum, Optics	11

Knowledge area (KA)	Outcomes	Professional: Engineering Surveyor Themes and key words	Credits	Technologist: Engineering Surveyor Themes and key words	Credits	Technician: Engineering Surveyor Themes and key words	Credits
Surveying	Understanding and applying surveying principles to spatial positioning	Measurement science, distance measurement principles (optical, mechanical, electro-optical, interferometry, accelerometery). Angular and azimuth measurement principles (including orientation, gyroscopy). GNSS theory (space, control and user systems; signals; processing). Surveying equipment (theodolite, EDM, total station, level, GNSS, terrestrial laser scanner, gyrocompass, gyrotheodolite, subsurface detection technologies). Sources and management of instrument errors, instrument calibration. Modelling and reduction of environmental systematic sources of error (e.g. refraction in air and water). Position determination using observed angles/directions, distances, GNSS, or combinations of these (joins, polars, traversing, intersection, resection, trilateration, triangulation, networks, topographical surveying, GNSS processing). Heighting (levelling, trigonometrical heighting, precise levelling, GNSS heighting). Control surveys (for horizontal, vertical, 3D, local, national and international control systems). Setting out of pre-calculated positions and heights, calculation of areas and volumes, interpretation of maps/plans, design and setting out of horizontal and vertical curves, cross and longitudinal sections, cut and fill calculations, mass-haul diagram. Mobile navigation, positioning, inertial navigation systems. Interpreting specifications and technical reporting. The history of surveying in SA and internationally. Field reconnaissance; planning a survey. Risk assessment and risk management.	60	Measurement science, distance measurement principles (optical, mechanical, electro-optical, interferometry). Angular and azimuth measurement principles (including orientation). GNSS theory (space, control and user systems; signals; processing). Surveying equipment (theodolite, EDM, total station, level, GNSS, terrestrial laser scanner). Sources and management of instrument errors, instrument calibration. Position determination using observed angles/directions, distances, GNSS, or combinations of these (joins, polars, traversing, intersection, resection, trilateration, triangulation, networks, topographical surveying, GNSS processing). Heighting (levelling, trigonometrical heighting, precise levelling, GNSS heighting). Control surveys (for horizontal, vertical, 3D, local, national control systems). Setting out of pre-calculated positions and heights, calculation of areas and volumes, interpretation of maps/plans, design and setting out of horizontal and vertical curves, cross and longitudinal sections, cut and fill calculations, mass-haul diagram. Interpreting specifications and technical reporting. The history of surveying in SA and internationally. Field reconnaissance; planning a survey. Risk assessment and risk management.	47	Measurement science, distance measurement principles (optical, mechanical, electro-optical). Angular and azimuth measurement principles (including orientation). Introduction to GNSS theory (space, control and user systems; signals; processing). Surveying equipment (theodolite, EDM, total station, level, GNSS, terrestrial laser scanner). Sources and management of instrument errors, instrument calibration. Position determination using observed angles/directions, distances, GNSS, or combinations of these (joins, polars, traversing, intersection, resection, trilateration, triangulation, topographical surveying, GNSS processing). Heighting (levelling, trigonometrical heighting, precise levelling, GNSS heighting). Control surveys (for horizontal, vertical). Setting out of pre-calculated positions and heights, calculation of areas and volumes, interpretation of maps/plans, design and setting out of horizontal and vertical curves, cross and longitudinal sections, cut and fill calculations, mass-haul diagram. Interpreting specifications and technical reporting. Field reconnaissance; planning a survey. Risk assessment and risk management.	38

Knowledge area (KA)	Outcomes	Professional: Engineering Surveyor Themes and key words	Credits	Technologist: Engineering Surveyor Themes and key words	Credits	Technician: Engineering Surveyor Themes and key words	Credits
Information Technology	Understanding the information technology environment and applying this in customization, processing and managing spatial data for surveying	Introduction to computer hardware, operating systems and software (proprietary and open source), and IT infrastructure (e.g. networks, data centres and servers, connectivity, limitations, backups and data security, HaaS); computer literacy (e.g. word processing, spread sheets, email, folders and file management); web services (e.g. open data portals, meetings and document sharing, data processing services); introduction to systems development (planning, analysis, design, implementation, maintenance); databases and database management systems; data formats and data transfer (e.g. Rinex, NMEA, GPRS, RTCM-104, FTP), introduction to programming and algorithms, programming for Geomatics and geo-spatial science applications, use of geomatics software. Principles of machine learning.	24	Introduction to computer hardware, operating systems and software (proprietary and open source), and IT infrastructure (e.g. networks, data centres and servers, connectivity, limitations, backups and data security, HaaS); computer literacy (e.g. word processing, spread sheets, email, folders and file management); web services (e.g. open data portals, meetings and document sharing, data processing services); databases and database management systems; data formats and data transfer (e.g. Rinex, NMEA, GPRS, RTCM-104, FTP), introduction to programming and algorithms, programming for Geomatics and geo-spatial science applications, use of geomatics software.	19	Introduction to computer hardware, operating systems and software (proprietary and open source), and IT infrastructure (e.g. networks, data centres and servers, connectivity, limitations, backups and data security, HaaS); computer literacy (e.g. word processing, spread sheets, email, \folders and file management); web services (e.g. open data portals, meetings and document sharing, data processing services); databases and database management systems; data formats and data transfer (e.g. Rinex, NMEA, GPRS, RTCM-104, FTP), introduction to programming, introduction to programming, use of geomatics software.	15

Knowledge area (KA)	Outcomes	Professional: Engineering Surveyor Themes and key words	Credits	Technologist: Engineering Surveyor Themes and key words	Credits	Technician: Engineering Surveyor Themes and key words	Credits
Geographic Information Systems	Understanding and applying GIS principles in processing, management, analysis, presentation, and dissemination of spatial data	Introduction to GIS, components of a GIS (people, hardware, software, spatial data, procedures), applications of GIS, geographic reality (continuous geographic fields, discrete geographic fields, geographic objects), spatial data models (vector and raster), spatial data structures, topology and spatial relationships, representation of third dimension in GIS, representation of time in GIS, spatial referencing in GIS, GIS data acquisition, spatial data structuring (corrective editing, post editing), spatial data quality and measures of data quality, spatial data sharing, spatial data management (spatial databases, database management systems), data retrieval, data security, database development, spatial data analysis and spatial modelling (data analysis operations, spatial analytic functions, spatial selections, classification, overlays, neighbourhood, connectivity, surfaces data analysis), presentation and dissemination of GIS output data (including static and animated maps, histograms, textual output, 3D-scenes, multimedia, web service), GIS customization and user interface programming, new trends in GIS (including Location-Based Services, big data, geospatial cyber-infrastructure), spatial data infrastructure legislation (SDI Act 2003), land information system development overview and land information system maintenance.	28	Introduction to GIS, components of a GIS (people, hardware, software, spatial data, procedures), applications of GIS, geographic reality (continuous geographic fields, discrete geographic fields, geographic objects), spatial data models (vector and raster), spatial data structures, topology and spatial relationships, representation of third dimension in GIS, representation of time in GIS, spatial referencing in GIS, GIS data acquisition, spatial data structuring (corrective editing, post editing), spatial data quality and measures of data quality, spatial data sharing, spatial data management (spatial databases, database management systems), data retrieval, data security, database development, spatial data analysis and spatial modelling (data analysis operations, spatial analytic functions, spatial selections, classification, overlays, neighbourhood, connectivity, surfaces data analysis), presentation and dissemination of GIS output data (including static and animated maps, histograms, textual output, 3D-scenes, multimedia, web service), GIS customization and user interface programming, new trends in GIS (including Location-Based Services, big data, geospatial cyber-infrastructure).	22	Introduction to GIS, components of a GIS (people, hardware, software, spatial data, procedures), applications of GIS; geographic reality (continuous geographic fields, discrete geographic objects), spatial data models (vector and raster), topology and spatial relationships, representation of third dimension in GIS, spatial referencing in GIS, GIS data acquisition, spatial data quality, spatial data sharing, introduction to spatial data management, spatial data analysis and spatial modelling, presentation and dissemination of GIS output data, new trends in GIS.	18

Knowledge area (KA)	Outcomes	Professional: Engineering Surveyor Themes and key words	Credits	Technologist: Engineering Surveyor Themes and key words	Credits	Technician: Engineering Surveyor Themes and key words	Credits
Photogram-metry and Remote Sensing	Understanding the principles of photogrammetry and remote sensing for spatial positioning	Earth radiation model and electro-magnetic spectrum, satellite orbits and orbital parameters, geometry of sensors and sensor systems (airborne, space borne and terrestrial), camera calibration, acquisition of images (including flight planning), image media and formats incl. image compression, principles of analogue and digital photography, photogrammetric measurement and data processing including geometry of images, interior and exterior (relative and absolute) orientation, 3D resection, 3D intersection, bundle adjustment and aerial triangulation, ortho-rectification, mosaicking and georeferencing, digital elevation models, Structure-from-Motion (SfM). Establishment of photo-control. Determination of 3-D coordinates in close- range photogrammetry. Accuracy and reliability assessment of photogrammetrically derived data, image (photo) interpretation, image processing (including image enhancement, image feature extraction, classification, PC analysis). UAV photogrammetry and related applications. Planning and design of photogrammetry and remote sensing projects. Theory and application of aerial laser scanning. Applications of machine learning.	30	Earth radiation model and electro-magnetic spectrum, satellite orbits and orbital parameters, geometry of sensors and sensor systems (airborne, space borne and terrestrial), camera calibration , acquisition of images (including flight planning), image media and formats incl. image compression, principles of analogue and digital photography, photogrammetric measurement and data processing including geometry of images, interior and exterior (relative and absolute) orientation, 3D resection, 3D intersection, bundle adjustment and aerial triangulation, ortho-rectification, mosaicking and georeferencing, digital elevation models, Structure-from-Motion (SfM). Establishment of photo-control. Determination of 3-D coordinates in close-range photogrammetry. Accuracy and reliability assessment of photogrammetrically derived data, image (photo) interpretation, image processing (including image enhancement, image feature extraction, classification, PC analysis). UAV photogrammetry and related applications. Planning of photogrammetry and remote sensing projects. Theory and application of aerial laser scanning.	23	Electro-magnetic spectrum, satellite orbits and orbital parameters, sensor systems (airborne, space borne and terrestrial), the need for camera calibration, acquisition of images (including flight planning), principles of analogue and digital photography, interior and exterior (relative and absolute) orientation, introduction to aerial triangulation, ortho-rectification, mosaicking and georeferencing, digital elevation models. Establishment of photo-control. Introduction to close-range photogrammetry. Accuracy and reliability assessment of photogrammetrically derived data. Introduction to image interpretation and processing. Introduction to UAV photogrammetry. Introduction to aerial laser scanning. Application of photogrammetry and remote sensing in practice.	19

Knowledge area (KA)	Outcomes	Professional: Engineering Surveyor Themes and key words	Credits	Technologist: Engineering Surveyor Themes and key words	Credits	Technician: Engineering Surveyor Themes and key words	Credits
Coordinate Systems, Datums, Map Projections, Conversions and Transforma-tions	Understanding the principles of coordinate systems, transformations and map projections and applying these to spatial data	Unit conversions (linear, areal, volumetric and coordinate values). Shape of the Earth, geoid, mathematical representations of the Earth (reference ellipsoids), spherical trigonometry. Coordinate systems theory (2D, 3D). Reference systems and reference frames (ITRF, WGS84, AfRef). Datums (Cape Datum, Hartebeesthoek94 Datum, Land Levelling Datum, Chart Datum), horizontal and vertical datum determination/redetermination processes. Geographical coordinates. Map projections (mathematical models and projection characteristics), reprojections, conformal mapping, Gauss conformal projection, reduction of observations to projection plane. Grid reference systems (historic: Cape Town local, Goldfields, Bosman; current: UTM, SA National Control Survey System (NCSS)). Scale and proportion. Coordinate conversions (geographical-cartesian, panel to panel, between projections). Coordinate transformations (centre of gravity reduction, affine, conformal, determination and assessment of coefficients). Higher order transformations, georeferencing and rubber sheeting. Converting between vertical datums (local, LLD, Chart Datum, GNSS heights, geoid models – uses and limitations), reductions of height data on land and at sea.	24	Unit conversions (linear, areal, volumetric, coordinate values). Shape of the Earth, geoid, reference ellipsoids. Coordinate systems theory (2D, 3D). Reference systems and reference frames (ITRF, WGS84, AfRef), Datums (Cape Datum, Hartebeesthoek94 Datum, Land Levelling Datum). Geographical coordinates. Map projections and reprojections (mathematical models and projection characteristics), conformal mapping, Gauss conformal projection, reduction of observations to projection plane, Grid reference systems (UTM, SA National Control Survey System). Scale and proportion. Coordinate conversions (geographical-cartesian, panel-to-panel, between projections). Coordinate transformations (centre of gravity reduction, affine, conformal, determination and assessment of coefficients). Converting between vertical datums (local, LLD, GNSS heights, geoid models – uses and limitations), reduction of height data on land.	19	Unit conversions (linear, areal, volumetric, coordinate values). Shape of the Earth, geoid, reference ellipsoids. Coordinate systems theory (2D, 3D). Introduction to reference systems and reference frames (ITRF, WGS84), Datums (Cape Datum, Hartebeesthoek94 Datum, Land Levelling Datum). Geographical coordinates. Introduction to map projections and reprojections (mathematical models and projection characteristics). Grid reference systems (UTM, SA National Control Survey System). Scale and proportion. Coordinate conversions (geographical-cartesian, panel-to-panel). Introduction to converting between vertical datums (local, LLD, GNSS heights), reduction of height data on land.	15

Knowledge area (KA)	Outcomes	Professional: Engineering Surveyor Themes and key words	Credits	Technologist: Engineering Surveyor Themes and key words	Credits	Technician: Engineering Surveyor Themes and key words	Credits
Error Theory, Modelling and Adjustments	Understanding the principles of error theory and applying these to determine the best position solution	Types of errors (blunder/gross error, systematic errors, random errors), detection of blunders (e.g. estimation, independent checks), mathematical modelling of the observation equation (dependent and independent variables) and corrections for systematic errors. Accuracy, precision. Laws of error propagation. Simple and multiple regression. Linearising observation equations. Auto- and cross-correlation. Residuals. Least squares theory and adjustments of survey observations (parametric and condition equation cases; combined adjustment) using a variety of survey methods. Pre-analysis in survey design. Network design and adjustment (including free networks, error ellipses and ellipsoids). Analysis of results and interpretation of statistical and other data. Practical applications of data analysis, survey design and processing in geomatics and geo-spatial science.	24	Types of errors (blunder/gross error, systematic errors, random errors), detection of blunders (e.g. estimation, independent checks), mathematical modelling of the observation equation (dependent and independent variables) and corrections for systematic errors. Accuracy, precision. Laws of error propagation. Simple and multiple regression. Linearising observation equations. Auto- and cross-correlation. Residuals. Least squares theory and adjustments of survey observations (parametric and condition equation cases; combined adjustment) using a variety of survey methods. Practical applications of data analysis, survey design and processing in geomatics and geo-spatial science.	19	Types of errors (blunder/gross error, systematic errors, random errors), detection of blunders (e.g. estimation, independent checks). Accuracy, precision. Introductory least squares theory and adjustments of survey observations. Practical applications.	15
Earth and Environmental Science	Understanding earth and environmental science and its application in geomatics.	Earth's natural environment and systems Earth's natural environment and systems and, human settlement and activities, against a backdrop of current international policy (e.g. the SDGs). Environmental management plans and environmental impact assessment.	12	Earth's natural environment and systems and, human settlement and activities, against a backdrop of current international policy (e.g. the SDGs). Environmental management plans and environmental impact assessment.	9	Earth's natural environment and systems and, human settlement and activities, against a backdrop of current international policy (e.g. the SDGs). Environmental management plans and environmental impact assessment.	7

Knowledge area (KA)	Outcomes	Professional: Engineering Surveyor Themes and key words	Credits	Technologist: Engineering Surveyor Themes and key words	Credits	Technician: Engineering Surveyor Themes and key words	Credits
Business and Project Management	Understanding and applying business and project management principles in the geomatics industry	Business Management: Management functions (planning, controlling, organising, staffing and directing), human resource management, financial management and management accounting, marketing management, strategic management and customer services. Introduction to entrepreneurship and small and medium enterprise development. Business plan, cash flow and risk projections (insurance included). Project Management: Project lifecycle (project initiating, planning, executing, and closing processes, monitoring, and evaluation processes). Project management (integration, scope, time, cost, quality, human resource, communications, risk, procurement, and stakeholder management). Introduction to OH&S legislation and requirements.	12	Business Management: Management functions (planning, controlling, organising, staffing and directing), human resource management, financial management and management accounting, marketing management, strategic management and customer services. Introduction to entrepreneurship and small and medium enterprise development. Business plan and cash flow projections. Project Management: Project initiating, planning, executing, and closing processes. Project management (integration, scope, time, cost, quality, human resource, communications, risk, procurement, and stakeholder management). Introduction to OH&S legislation and requirements.	9	Introduction to the principles of business and project management.	7
Professional Practice and Ethics	Understanding professionalism and ethics and how these apply in the geomatics environment	Professionalism, professional ethics, different types of professional practices, legal entities (partnerships, corporations, and trusts). Business agreements, law of contracts, labour law, taxation, stakeholder management and client relations, interactions with allied professions. Governance, compliance, and accountability. SA geomatics profession and SA Geomatics Council (including legislation and rules) and social responsibility. Intellectual property rights and copyright. Protection of personal information (including the Act). Ethical aspects of professional practice (including costing and tendering). Due diligence and fiduciary duties.	12	Professionalism, professional ethics, different types of professional practices, legal entities (partnerships, corporations, and trusts). Business agreements, law of contracts, labour law, taxation, stakeholder management and client relations. Governance, compliance, and accountability. SA geomatics profession and SA Geomatics Council (including legislation and rules) and social responsibility. Intellectual property rights and copyright. Protection of personal information (including the Act). Ethical aspects of professional practice (including costing and tendering). Due diligence and fiduciary duties.	9	Professional ethics. Law of contracts, labour law. SA geomatics profession and SA Geomatics Council (including legislation and rules). Accountability and social responsibility.	7

Knowledge area (KA)	Outcomes	Professional: Engineering Surveyor Themes and key words	Credits	Technologist: Engineering Surveyor Themes and key words	Credits	Technician: Engineering Surveyor Themes and key words	Credits
Land tenure, land law and cadastral studies	Understanding the principles of land administration systems, land tenure and land law, and applying these in cadastral practice	LAND LAW: Fundamentals of land law in South Africa. Real rights, personal rights and other forms of rights and interests in land and land-based resources (e.g. ownership; servitudes; leases; mineral and petroleum resources rights; communal rights – including sectional title, life rights, customary rights; unregistered and off-register rights – urban and rural contexts; indigenous, historic and permitted subsistence resource rights and interests, water rights). Forms of land tenure; tenure security. Registration and recording. Heights and the law: building envelopes, view and related rights; legal requirement for connection to the NCSS (in height and plan), methods of doing so; by-laws and height restrictions. CADASTRAL SURVEYING: Cadastral workflows. Survey of existing cadastral beacons and boundaries in 2D and 3D, on- and off-shore. [proviso: the PES applying this knowledge in the cadastral domain will be supervised by a PLS]	24	LAND LAW: Fundamentals of land law in South Africa. Real rights, personal rights and other forms of rights and interests in land and land-based resources (e.g. ownership; servitudes; leases; mineral and petroleum resources rights; communal rights – including sectional title, life rights, customary rights; unregistered and off-register rights – urban and rural contexts; indigenous, historic and permitted subsistence resource rights and interests, water rights). Forms of land tenure; tenure security. Registration and recording. Heights and the law: building envelopes, view and related rights; legal requirement for connection to the NCSS (in height and plan), methods of doing so; by-laws and height restrictions. CADASTRAL SURVEYING: Cadastral workflows. Survey of existing cadastral beacons and boundaries in 2D and 3D, on- and off-shore. [proviso: the technologist applying this knowledge in the cadastral domain will be supervised by a PLS]	19	LAND LAW: Fundamentals of land law; the cadastral and land administration system in South Africa. CADASTRAL SURVEYING: Cadastral workflows. Survey of existing cadastral beacons and boundaries in 2D. [proviso: the technician applying this knowledge in the cadastral domain will be supervised by a PLS]	15

Knowledge area (KA)	Outcomes	Professional: Engineering Surveyor Themes and key words	Credits	Technologist: Engineering Surveyor Themes and key words	Credits	Technician: Engineering Surveyor Themes and key words	Credits
Geodesy	Understanding geodetic principles and applying these in surveying	Motions of the Earth (annual, diurnal, precession, nutation, polar motion). Time systems (sidereal, solar, universal – UTC, UT1, atomic, GNSS); solstices, tropics. Continental plate movement. Ocean science, tidal theory (Earth tides, ocean tides, inland water tides), mean sea-level (including variations in location and time, relationship to tidal datums), ocean loading. Effects on geodetic observations (e.g. atmospheric and weather, solar flares/wind). Reference frames and reference systems. Geodetic sources of data, services and applications (e.g. GNSS, VLBI, SLR, DORIS, Global Geodetic Observing System, IAG). Gravity and gravimetry (instrumentation, observation processes and reductions, sources and management of instrument errors, calibration). Use of gravity measurements in height systems and in height network reductions. Geoids and geoid modelling. Direct and indirect geodetic problems.	24	Motions of the Earth (annual, diurnal, precession, nutation, polar motion). Time systems (siderial, solar, universal – UTC, UT1, atomic, GNSS); solstices, tropics. Continental plate movement. Introduction to ocean science and tidal theory (Earth tides, ocean tides, inland water tides), mean sea-level (including variations in location and time, relationship to tidal datums), ocean loading. Effects on geodetic observations (e.g. atmospheric and weather, solar flares/wind). Reference frames and reference systems. Geodetic sources of data, services and applications (e.g. GNSS, VLBI, SLR, DORIS, Global Geodetic Observing System, IAG). Earth Gravity Field.	19	Not included	
Land Management and Planning	Understanding planning and land management principles and processes, and applying these in a land development context	Introductory planning theory; land use management and development (Spatial Development frameworks, environmental management, land uses (types and intensity), restrictive conditions; Metropolitan and city interventions (challenges and types, activity and mobility corridors, urban edge, densification, transit nodes, design for safety); Integrated Development Planning (horizontal and vertical stakeholder participation); concepts of settlement planning and design; planning law (legislation and case law).	18	Not included		Not included	

Knowledge area (KA)	Outcomes	Professional: Engineering Surveyor Themes and key words	Credits	Technologist: Engineering Surveyor Themes and key words	Credits	Technician: Engineering Surveyor Themes and key words	Credits
Precise Engineering Surveying	Understanding and applying precise measurement and processing techniques, and use of specialised instrumentation in surveying	Specialised instrumentation (including permanent monitoring instrumentation and measuring stress/strain). Instrumentation error sources, calibration, error mitigation techniques, and expected precision. Setting out of tunnels, bridges, dams, tall buildings and industrial structures. Surveying data acquisition techniques (planar, heighting, and 3D) for precise applications (construction, industrial applications, precision alignment, monitoring of structure movements/deformation over time, shaft surveying). Design and optimisation of survey (including network design) for precise engineering surveying projects (e.g. for dams, bridges, mines and geological phenomena). Precise construction monitoring to control construction tolerances, volumes etc. Best fitting geometric shapes. Mathematical models of deformation analysis and interpretation of results. Case studies in high precision surveys.	54	Instrumentation error sources, calibration, error mitigation techniques, and expected precision. Setting out of tunnels, bridges, dams, tall buildings and industrial structures. Introduction to specialised instrumentation. Surveying data acquisition techniques (planar, heighting, and 3D) for precise applications (construction, industrial applications, precision alignment, monitoring of structure movements/deformation over time). Case studies in precise engineering surveys.	42	Not included	
Spatial data presentation	Understanding and applying cartographic and visualization techniques in geomatics	Cartographic communication, symbology (point, line, area, pictorial, 2D and 3D), generalisation, colour, cartographic design. Mapping organisations (e.g. public sector land/hydrographic, private sector), mapping standards, map types (e.g. general purpose, relief, offshore charts, thematic including statistical mapping), map production processes, map use. 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.	18	Cartographic communication, symbology (point, line, area, pictorial, 2D and 3D), generalisation, colour, cartographic design. Mapping organisations (e.g. public sector land/hydrographic, private sector), mapping standards, map types (e.g. general purpose, relief, offshore charts, thematic including statistical mapping), map production processes, map use. Digital plans and maps, and computer-aided mapping (e.g. 2D, 3D CAD). Representation from 3D data (e.g. point clouds, 3D mesh). Data and product quality, privacy and societal impact.	14	Cartographic communication, symbology (point, line, area, pictorial, 2D), generalisation, colour, cartographic design. Mapping organisations (e.g. public sector land/hydrographic, private sector), mapping standards, map types (e.g. general purpose, relief, offshore charts, thematic including statistical mapping), map production processes, map use. Digital plans and maps, and computer-aided mapping (e.g. 2D). Data and product quality, privacy and societal impact.	11

Knowledge area (KA)	Outcomes	Professional: Engineering Surveyor Themes and key words	Credits	Technologist: Engineering Surveyor Themes and key words	Credits	Technician: Engineering Surveyor Themes and key words	Credits
Professional Communication	Applying the principles of professional communication	Literacy (reading, writing and oral communication in the general context of everyday life), written communication (all mediums including professional communication via electronic communication and social media; grammar, spelling, formatting), oral communication (reporting, client liaison, presentation), information literacy (finding, accessing, understanding, collating, interpreting and referencing information), technical and professional project report writing, communicating and reporting in multidisciplinary teams, negotiation. Professional etiquette and social interaction.	Embedded in all other Kas	Literacy (e.g. reading, writing and oral communication in the general context of everyday life), written communication (all mediums including professional communication via electronic communication and social media; grammar, spelling, formatting), oral communication (reporting, client liaison, presentation), information literacy (e.g. finding, accessing, understanding, collating, interpreting and referencing information), technical and professional project report writing, communicating and reporting in multidisciplinary teams, negotiation. Etiquette and social interaction.	Embedded in all other Kas	Literacy (e.g. reading, writing and oral communication in the general context of everyday life), written communication (all mediums including professional communication via electronic communication and social media; grammar, spelling, formatting), oral communication (reporting, client liaison, presentation), information literacy (e.g. finding, accessing, understanding, collating, interpreting and referencing information), technical and professional project report writing, communicating and reporting in multidisciplinary teams, negotiation. Etiquette and social interaction.	Embedded in all other Kas
Geomatics Project	Understanding and applying principles of undertaking research, compilation of results and reporting	Engagement with a geomatics-related problem (demonstrate the ability to understand the problem), and design a solution, execute, analyse, and report on the outcome in a written format and through oral presentation, the modality of which may vary.	36	Geomatics project demonstrating integration of, and competence in applying geomatics theory using geomatics technologies appropriate to the task. Convey results in a written project report and through oral presentation, the modality of which may vary.	28	Geomatics project in the last semester of the theoretical component of the qualification (not part of WIL) demonstrating practical skills in the application of relevant competencies applied in the surveying field. This will take the form of a simulated workplace project and may include (in a holistic and integrated manner) triangulation, GNSS, levelling, traversing, control networks, setting out and topographical surveys. Convey results in a specified written report and portfolio.	23
		Total	**480**	**Total**	**360**	**Total**	**240**