



GEOPHYSICS SYLLABUS OF EXAMINATIONS 2010 Edition

For textbook information please refer to the Textbooks section on page 6 of the document entitled Information for Examination Candidates and Students.

1. PREAMBLE

There are major differences between the 2005 and 2010 editions of the APEGGA Geophysics syllabus in that the 2010 edition consists of two versions: one is identical to the 2005 syllabus and the other comprises the Geophysics Knowledge Requirements found on pages 5-7 of the document “Geoscience Knowledge and Experience (GKE) Requirements for Professional Registration in Canada” (May 2008) prepared by the Canadian Council of Professional Geoscientists (CCPG). This document can be found at the link <http://www.ccpq.ca/pgeoreq/en/Documents/4214%20CCPG%20Requirements%20Booklet%20Web.pdf> Until August 31, 2014, both versions will be in effect and the one most favourable to applicants will be used in the assessment (see the assessment forms at the end of this document). For applications received on or after September 1, 2014, only the GKE document will be used.

Minimum Required Knowledge

Examinations offered by APEGGA in connection with the above-mentioned GKE document are based on the subject descriptions in the GKE document recommending the geoscience knowledge requirements for professional registration, outlined below. The fundamental unit of knowledge in the outline below is the educational unit (EU). One educational unit in a subject is defined as formal instruction equivalent to a one-term (one semester) course in an honours B.Sc. degree program at a Canadian university. For example, one EU could consist of approximately 3 hours of lecture or equivalent per week, with or without a lab, for thirteen weeks. An EU can be considered as the equivalent of one 3-credit-hour course in a 120 credit-hour, 4-year degree program.

SECTION 1: FUNDAMENTAL SCIENCE

(9 EUs required)

1A. COMPULSORY FOUNDATION SCIENCE *(3 EUs required)*

- Chemistry - 1 EU
- Mathematics - 1 EU
- Physics - 1 EU

AND

1B. ADDITIONAL FOUNDATION SCIENCE *(6 EUs required; maximum of two in any subject area, e.g. two in biology, two in chemistry, etc.)*

- Biology
- Chemistry
- Computer Programming
- Mathematics
- Physics
- Statistics

SECTION 2: GEOSCIENCE as outlined by CCPG

(18 EUs required, in addition to Section 1 Fundamental Science)

2A. COMPULSORY FOUNDATION GEOSCIENCE (4 EUs required, with 1 EU from each subject area)

- Field techniques (field-based instruction in geophysics, not classroom lectures)
- Mineralogy & petrology
- Stratigraphy and sedimentation
- Structural geology

2B. ADDITIONAL FOUNDATION GEOSCIENCE (5 EUs required, with 1 EU from each of 5 of the 6 subject areas)

• Digital Signal Processing
• Global Geophysics / Physics of the Earth
• Seismology / Seismic Methods
• Exploration Geophysics
• Radiometrics / Gravity & Magnetics
• Electrical & Electromagnetic Methods

2C. OTHER GEOSCIENCE/SCIENCE (9 EUs required. The 9 EUs must be at the second level (not introductory) or higher acceptable for science credit toward a degree in science, applied science, or engineering, and relevant to geoscience. Extra courses not used in 2A and 2B can be used in 2C. EUs must chosen from at least 4 of the 11 subject areas listed below.

- Applied Math / Physics
- Communication (e.g., thesis, technical writing)
- Earth & Planetary Geoscience
- Field Techniques
- Fundamental Math / Physics
- Geology
- Geophysical Methods & Interpretation
- Modern Physics
- Near-surface Geoscience (e.g., environmental geophysics)
- Regional Geology
- Resource Geoscience (e.g., hydrology, petroleum geology)

2. 2010 Geophysics Syllabus (APEGGA) – SYLLABUS OF EXAMINATIONS

FUNDAMENTAL EXAMINATIONS

These examinations cover subjects normally taken in the first two years of a university course in physical sciences or engineering. They do not usually have university level pre-requisites.

10-GP-F1 Introductory Calculus

Functions and graphs, differentiation and integration of simple functions, analytical geometry.

10-GP-F2 Linear Algebra

Vector and matrix algebra, determinants, linear systems of equations, vector spaces, eigenvalues and eigenvectors. Applications.

10-GP-F3 Introductory Physics I

Fundamental concepts, definitions and physical laws. Vectors, kinematics and statics. Newton's laws, force, work and energy, conservation laws.

10-GP-F4 Introductory Physics II

Applications of Newton's laws. Particle dynamics. Rotational Mechanics, Work and energy with variable forces. Fluid mechanics, kinetic and wave theory. First law of thermodynamics.

10-GP-F5 General Chemistry I

Atomic and molecular structure, stoichiometry in chemical reactions. Chemical bonding. Structures and reactions of organic and inorganic compounds. Materials science.

10-GP-F6 General Chemistry II

Gas laws. Kinetics and chemical equilibrium, acids and bases. Oxidation-reduction processes and electrochemistry. Elementary thermodynamics.

10-GP-F7 Computing Science

Application of programming techniques using a high level language for the manipulation of large data sets and the solution of problems in mathematics and physics.

CORE SUBJECTS

With the exception of the geology courses, most core subjects require one or more fundamentals as prerequisites. They may appear after the first year of a Canadian University Course in science or engineering, but are more likely to be taken after the second year.

10-GP-C1 Differential Equations

First and second order linear differential equations with applications. Series solutions about regular points and singular points.

10-GP-C2 Intermediate Calculus

Differential and integral calculus to multiple integrals, with applications. Trigonometric, exponential and logarithmic functions and their inverses. Numerical integration, Taylor Series. Partial differentiation.

10-GP-C3 Electricity and Magnetism

Electrostatics, DC circuits, electric field, electric potential, Gauss's law, electromagnetic induction, capacitance. AC circuits. Electrical and magnetic properties of materials.

10-GP-C4 Vibrations, Waves and Optics

Harmonic damped and forced oscillators. Geometrical optics, interference, waves, diffractions. Wave - equation.

10-GP-C5 Physical Geology

Composition and internal structure of the Earth. Surface and internal processes. Continents, oceans, rocks and minerals. Global tectonics and mountain building.

10-GP-C6 Physics of the Earth

Figure of the earth, gravity, the geoid, geomagnetism, paleomagnetism, heat flow, radioactivity and geochronology. Earthquake seismology. Solar system, meteorites.

10-GP-C7 Probability and Statistics

Concepts of probability, events and populations, probability theorems, concept of a random variable, continuous and discrete random variables, probability distributions, moments, skewness, kurtosis, estimation of moments, joint distributions, probability. Distribution of functions of a random variable, sampling and statistical estimation theory, hypotheses testing, simple regression analysis, introduction to the design of experiments.

10-GP-C8 Integral Transform Methods and their Application

Fourier and Laplace transforms and their applications in the physical sciences.

10-GP-C9 Complex Variable Calculus

Analytic functions, poles, residues, contour integration and its applications, and conformal mapping.

10-GP-C10 Database Management, or Computer Graphics, or Computational Physics***Database Management***

Concepts and structures for design and implementation. Data models, data normalization, data description languages, query facilities, data integrity and reliability, concurrency. File organization, including sequential, indexed and direct access, multiple key, indexed files and hashing. File processing, including records, files and compaction. Sorting, merging and updating files. Algorithms for inverted lists, multilist, indexed sequential and hierarchical structures.

Computer Graphics

Graphics hardware, including architecture and circuits. Vector and raster graphics systems. Input and output devices. Techniques for describing images, including point, vector and raster approaches. Image transformations, including scaling, translation, rotation, clipping and windowing. Graphics software and data structures.

Computational Physics

Basic methods in computational physics including numerical algorithms applied to problems in

nonlinear mechanics (chaotic dynamics, iterative maps, etc.), wave motion, electrodynamics, statistical physics, and quantum mechanics, parallel computing methods, writing programs and running simulation algorithms.

10-GP-C11 Thermodynamics

Thermodynamic states of simple systems; the fundamental relation of thermodynamics; the first and second laws of thermodynamics; equilibrium, PVT and other thermodynamic diagrams; energy of state; compressibility charts and steam tables; calculation of property changes; enthalpy; Helmholtz and Gibbs function; the Maxwell equations; applications of thermodynamics, cycles, reversibility; thermodynamics of phase changes, the Clapeyron equation Gibbs phase rule; gas-vapor mixtures, psychrometrics.

10-GP-C12 Continuum Mechanics

Stress and strain in continuous media; elasticity. Mechanics of fluid flow in two and three dimensions. Thermodynamics and mechanics of compressible and viscous flows. Turbulence and convection.

10-GP-C13 Optics and Lasers

Review of waves and EM theory, the electromagnetic spectrum, interaction of light with matter and optical materials, Geometrical optics and aberrations, polarization, electro-optic modulators, diffraction, diffraction gratings, spot size and resolution of imaging systems, Fourier optics and image processing, laser fundamentals and examples of laser systems.

10-GP-C14 Electromagnetic Theory

Time varying electromagnetic fields up to Maxwell's Equations including topics such as induced fields. Gradient, divergence, curl. Boundary value problems in electrostatics and magnetostatics. Dielectric and magnetic properties of materials.

10-GP-C15 Historical Geology

Methods of interpretation of the history of the Earth. Structural geology and application of plate tectonics. Global change. Paleontology, origin and evolution of life. Resource geology, principles of stratigraphy. Relative and radiometric age dating.

10-GP-C16 Crystallography and Mineralogy

Morphological crystallography. Crystal systems, rotation and inversion axes, crystal classes, Miller indices, axial ratios and stereonet. Determinative and descriptive mineralogy. Optical crystallography.

10-GP-C17 Sedimentation and Stratigraphy

Sedimentary processes, environments and facies. Properties and classification of sedimentary rocks. Stratigraphic nomenclature and the stratigraphic column. Stratigraphic relationships and interpretations.

10-GP-C18 Structural Geology

Orientation, measurement, representation and geometric analysis of planar and linear geologic structures such as faults and folds; relation of faults to stress. Geologic maps and cross-sections. Descriptive geometry, stereographic and equal area projections. Mechanical principles involved in the deformation of rocks.

10-GP-C19 Introduction to Applied Geophysics

Reflection and refraction seismology, gravity and magnetics, and electrical and electromagnetic methods applied to exploration and environmental problems.

MAJOR OPTIONS

The major options define the geophysics content of the academic qualifications of a professional geophysicist. The subject matter here should be at the level of third or fourth year in science or engineering programs in most Canadian Universities. Major Options all require Fundamentals and or core subjects as prerequisites. In some cases these options may be taught as graduate courses in some Canadian Universities.

10-GP-M1 Quantitative Seismology

Theory of body and surface wave propagation, techniques in exploration seismology. Earthquake source mechanisms. Seismic attenuation.

10-GP-M2 Digital Signal Processing

Basics of geophysical data processing, convolution, correlation, z-transforms, basic spatial, time and frequency domain analysis.

10-GP-M3 Principles of Applied Seismic Methods

Introduction to refraction and reflection seismic methods applied to the exploration for resources and their use in engineering studies. Elasticity theory, seismic instrumentation, velocity surveys, near-surface corrections.

10-GP-M4 Principles of Applied Electrical and Electromagnetic Methods

Electromagnetic, resistivity, induced polarization, and self-potential methods applied to problems in the search for metallic mineral deposits. Theory and application of Maxwell's equations. Direct and indirect methods of inversion.

10-GP-M5 Principles of Applied Gravity and Magnetic Methods

The nature of the magnetic and gravity fields of the Earth. Density, porosity, magnetic susceptibility. Gravity meters and magnetometers. Potential theory. Theory and applications of gravity and magnetic methods of geophysical exploration.

10-GP-M6 Advanced Global Geophysics or Global Geology

Global Geophysics

Theory and research applications in gravitation, rotation and figure of the Earth, seismology and Earth structure, free oscillations of the Earth, seismic risk, geomagnetism and the core, paleomagnetism and continental drift. Thermal energy at plate boundaries and hot-spots. Mantle convection.

Global Geology

Global aspects of plate tectonics and regional geology through time. Application of fundamental stratigraphic and structural principles. Contributions of geophysics, geochemistry, experimental and theoretical petrology to the modern plate tectonic model. Analysis and of major structural

provinces as they relate to plate interactions.

10-GP-M7 Petroleum Geology

Origin and distribution of petroleum. Geochemistry and maturation of organic matter; microbial and thermal degradation of hydrocarbons, conventional and unconventional source and reservoir rocks. Principles of primary and secondary migration. Diagenesis of carbonate and clastic reservoir rocks, with reference to seals and traps.

10-GP-M8 Metallic Mineral deposits

Processes of ore formation and concentration in association with all the major geological processes. Stratigraphic and structural control of ore deposits. Examples of the occurrence of the economically more important types of deposits in Canada and the world. Study of ores in polished and thin section. The application of chemical principles to the understanding of ore deposits; solution chemistry, phase equilibria, isotope geochemistry. Exploration for, and evaluation of metallic mineral deposits.

10-GP-M9 Hydrogeology

The occurrence of groundwater; rock properties that affect groundwater, quality of groundwater; geology of groundwater basins; procedures for surface and subsurface investigations. Hydrology of groundwater flow, derivation of Darcy's law from fundamental concepts of fluid mechanics, and its generalization to spatially varied flows. Permeability parameters and validity of Darcy's law in terms of Reynold's number.

10-GP-M10 Physical Properties of Rocks/Engineering Geology

Physical properties of minerals and rocks. Measurement methods and their relationship to geophysical surveys and interpretation. Engineering site surveys and exploration, geological aspects of a given site with regard to the engineering design of foundations, hydraulic structures and the stability of natural or man-made slopes and open cuts.

10-GP-M11 Well log analysis

Petrophysics and modern well-logging methods. Theory and applications of measurements of physical properties of the formation near the well bore, types of well logging devices, interpretation and use of information in petroleum and natural gas engineering.

10-GP-M12 Partial Differential Equations

Orthogonal sets of functions. Numerical solution of partial differential equations. Classification of second order linear equations. Hyperbolic and parabolic equations, methods of descent.

10-GP-M13 Solid State Physics

Crystal structure. Classification of solids and their bonding. Elastic, electric and magnetic properties of solids. Lattice structure, Fermi surfaces.

10-GP-M14 Geostatistics (same as 2005-Glgy-26)

Analysis of quantitative geological data using digital computers, simple and multivariate statistical models (multiple regression, factor analysis and discriminant functions). Application of these methods to real and hypothetical geological situations.

10-GP-M15 Advanced Signal Processing

Advanced methods of data analysis in exploration and production geophysics including advanced filtering, migration, inversion and tomography.

10-GP-M16 Advanced Seismic Methods

Acquisition design of three-dimensional (3-D) seismic surveys; processing and interpretation of 3-D seismic data volumes. Multi-component seismic methods.

10-GP-M17 Advanced Seismic Interpretation

Principles of seismic stratigraphy, and seismic sequence analysis, and structural interpretation of reflection seismic data, Depth conversion Methods.

10-GP-M18 Advanced Electrical and Electromagnetic Methods and Interpretation

Advanced topics in electromagnetic, resistivity, induced polarization and self-potential methods. Advanced problems starting at Maxwell's Equations.

10-GP-M19 Advanced Gravity and Magnetic Methods

Advanced applications of gravity and magnetic methods of geophysical exploration. Filtering, upward and downward continuation techniques. Reduction to the pole. Modeling and inversion methods.

10-GP-M20 Reservoir Engineering

Rock properties, rock-fluid interactions, flow through porous media, and material balance.

10-GP-M21 Geophysical Field Methods

Field surveys and data collection techniques for seismic, gravity, magnetic, electromagnetic, electrical and radiometric methods. Surveys for elevation and position location. Field analysis of geophysical data. Instrumentation.

(There is no textbook for this course. No exam will be set by APEGGA but the candidate can qualify here with the geophysical field course included in most Canadian geophysics curricula.).

10-GP-M22 Isotope Geophysics

Theory and systematics of radioactive decay, geochronology using K-Ar, Rb-Sr, U-Pb, Pb-Pb, Fission-track, C-14, U-series disequilibrium and Sm-Nd systems.

10-GP-M23 Fluid Dynamics

Flow of viscous and non-viscous fluids, dimensional methods in turbulence.

10-GP-M24 Computer Controlled Instrumentation

Data communications, including signals, modulation and reception. Performance of optimum and sub-optimum systems. Data transmission characteristics, including half/full duplex, asynchronous/synchronous, point-to-point/multidrop and character/bit oriented. Error detecting and correcting codes. Character sets and message communications. Local area networks, including bus, ring and tree topologies, protocols and hardware.

10-GP-M25 Igneous Petrology (Same as 2005 Glgy-3)

Mineralogical and chemical classification of igneous rocks. Physics and chemistry of igneous rock formation.

10-GP-M26 Metamorphic Petrology (Same as 2005 Glg-5)

Mineralogy and textures of metamorphic rocks. Concepts of metamorphic facies and facies series, and their pressure-temperature-composition interpretation.

10-GP-M27 Advanced Sedimentology (Same as 2005- Glg-20)

Processes of sedimentation: weathering, transportation, deposition and diagenesis; classification and description of the principal types of detrital and chemical sedimentary rocks.

10-GP-M28 Advanced Structural Geology (Same as 2005-Glg-25)

Structural features of complexly folded and faulted strata. Simple statistical analysis of structural data. Analysis of strains. Computer-based procedures for determining the geometry of faults and folds. Structural analysis in plutonic and metamorphic rocks.

10-GP-M29 Fluid Flow in Porous Media

Porosity, fluid saturation, permeability, interfacial tension, wettability, capillary pressure, effective and relative permeability, steady and unsteady state fluid flow.

10-GP-M30 Geochemistry

Chemical processes taking place in geologic settings with emphasis on the abundance relationships of the elements in the Earth's crust and the laws governing the migration and distribution of elements of the Earth. Application of geochemistry in the search for mineral deposits.

10-GP-M31 Numerical Modeling Methods

Numerical modeling methods in geophysics, including finite difference and finite element techniques.

10-GP-M32 Remote Sensing

Sensor principles and capabilities. Image analysis. Interpretation of geological structure and landforms.

Revised: May 2010

2010 Geophysics Syllabus (APEGGA – identical to the 2005 syllabus)

In effect until 31 August 2014. For applications received after that, use only the GKE-based syllabus.

Checklist for Course-by-Course Assessment

Date: _____

Applicant Name: _____ Application Type: _____

Applicant Education: _____

Applicant - Other Info: _____

APEGGA course labels : F1 = 10-GP-F1, C3 = 10-GP-C3, etc.

F1-F7. All 7 required :		M1-M32: 7 required.	
F1	Introductory Calculus	A. At least 4 required :	
F2	Linear Algebra	M1	Quantitative Seismology
F3	Introductory Physics I	M2	Digital Signal Processing
F4	Introductory Physics II	M3	Principles of Applied Seismic Methods
F5	General Chemistry I	M4	Applied Electrical & Electromag Methods
F6	General Chemistry II	M5	Principles of Applied Gravity & Mag Methods
F7	Computing Science	M6	Advanced Global Geophysics or Geology
		M7	Petroleum Geology
		M8	Metallic Mineral Deposits
		M9	Hydrogeology
C1	Differential Equations	M10	Physical Properties of Rocks / Eng'g Geol
C2	Intermediate Calculus	M11	Well Log Analysis
C3	Electricity & Magnetism	M12	Partial Differential Equations
C4	Vibrations, Waves, Optics	M13	Solid State Physics
C5	Physical Geology		
C6	Physics of the Earth		
		B. At least 2 required :	
		M14	Geostatistics
		M15	Advanced Signal Processing
		M16	Advanced Seismic Methods
		M17	Advanced Seismic Interpretation
		M18	Advanced Electrical & Electromag Methods
		M19	Advanced Gravity & Magnetic Methods
		M20	Reservoir Engineering
C11	Thermodynamics	M21	Geophysical Field Methods
C12	Continuum Mechanics	M22	Isotope Geophysics
C13	Optics and Lasers	M23	Fluid Dynamics
C14	Electromagnetic Theory	M24	Computer Controlled Instrumentation
C15	Historical Geology	M25	Igneous Petrology
C16	Crystallography & Mineralogy	M26	Metamorphic Petrology
C17	Sedimentation & Stratigraphy	M27	Advanced Sedimentology
C18	Structural Geology	M28	Advanced Structural Geology
C19	Intro to Applied Geoph	M29	Fluid Flow in Porous Media
		M30	Geochemistry
		M31	Numerical Modeling Methods
		M32	Remote Sensing

2010 Geophysics Syllabus (GKE). In effect June 2009.

Checklist for Course-by-Course Assessment

Date: _____

Applicant Name: _____ Application Type: _____

Applicant Education: _____

Applicant - Other Info: _____

*For detailed descriptions of the subject areas listed below, refer to the GKE document, at
<http://www.ccpq.ca/pgeoreg/en/Documents/4214%20CCPG%20Requirements%20Booklet%20Web.pdf>*

1A. All 3 required :		2B. 5 required, with 1 from each of 5 of the 6 subject areas :	
1. Chemistry			
2. Mathematics		1. Digital Signal Processing	
3. Physics		2. Global Geophysics / Physics of the Earth	
		3. Seismology / Seismic Methods	
1B. 6 required. No more than 2 from any one subject area :		4. Exploration Geophysics	
		5. Radiometrics / Gravity & Magnetics	
		6. Electrical & Electromagnetic Methods	
1. Biology			
2. Chemistry		2C.* 9 required from at least 4 of the 11 subject areas. Extra courses not used in 2A and 2B may be used in 2C :	
3. Computer Programming			
4. Mathematics			
5. Physics			
6. Statistics		1. Applied Math / Physics	
		2. Communication	
2A. All 4 required :		3. Earth & Planetary Geoscience	
		4. Field Techniques	
1. Field Techniques (Geophysics)		5. Fundamental Math / Physics	
2. Mineralogy & Petrology		6. Geology	
3. Sedimentation & Stratigraphy		7. Geophysical Methods & Interpretation	
4. Structural Geology		8. Modern Physics	
		9. Near Surface Geoscience	
		10. Regional Geology	
		11. Resource Geoscience	

** Courses for 2C must be at a second level (not introductory) or higher acceptable for science credit towards a degree in science, applied science, or engineering, and relevant to geoscience.*