EAS100

Planet Earth

3 Credits

Instructor: Dr. Robert Cuny
780 871 5766

Original Developer: Dr. Robert Cuny

Current Developer: Dr. Robert Cuny

Reviewer: Mark Cryderman

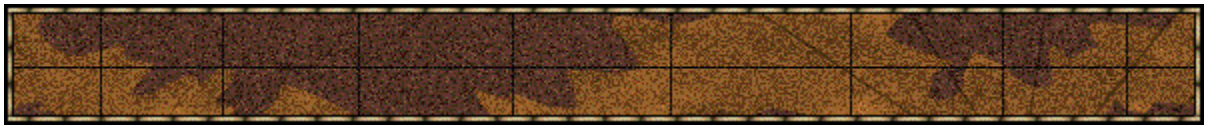
Created: 12/10/2005

Revised: 01/06/2017

Approval: 07/06/2017

The Implementation Date for this Outline is 01/09/2017

EAS100 Version: 7



Planet Earth

Calendar Description

Introduction to the origin and evolution of the Earth and the solar system. Introduction to plate tectonics and the rock cycle. Simple energy balances and interactions between radiation and the atmosphere, land, oceans, ice masses, and the global hydrological cycle. Evolution of life, biogeography, and global climate in the context of geologic time. The carbon cycle. Human interaction with the Earth. Mineral and energy resources.

Rationale

EAS 100 provides an overview over Planet Earth as a dynamic closed system that continuously changes due to interactions within and between its geoshere, hydrosphere, atmosphere, and biosphere. Major topics are Planet Earth in the universe and solar system, laws of Kepler, Newton, and Einstein, paralax, red shift, solar energy and luminosity, thermodynamics, matter and the chemical periodic table, chemical bonds and mineral properties, rock cycle, plate tectonic cycle, hydrologic cycle, and biogeochemical cycles, volcanism, Bowen's reaction series and magma differentiation, weathering and sedimentary rocks, principles of geology, geological time scale, radiometric dating, metamorphic grade and metamorphic facies, earthquakes and the Earth interior, rivers, groundwater, glaciers, ocean circulation, tides, atmosphere, climate change, wind and weather, classification and evolution of life, biomes and ecosystems, food webs, soils, niche and competitive exclusion, biogeographic realms and biodiversity, energy resources and mineral resources, human overpopulation and pollution.

EAS 100 is thus a starting point for studies in all branches of earth science, and it provides insight into human influences on our planet. This introductory course forms a foundation for first year university transfer students who plan to specialize in any science, arts, civil or petroleum engineering, agriculture, forestry, education, and medical fields.

Prerequisites

English 30

Co-Requisites

None

Course Learning Outcomes

Upon successful completion of this course, students will be able to (cognitive skills)

1. distinguish components of the integrated Earth system -- geosphere, hydrosphere, atmosphere, and biosphere; troposphere, stratosphere, mesosphere, thermosphere, ionosphere; crust, lithosphere, asthenosphere, upper and lower mantle, inner and outer core or metallosphere.
2. explain plate tectonics -- shallow and deep mantle convection, mantle diapirs and hotspots; divergent, transform, and convergent plate motion; sea-floor spreading, subduction, and plate boundaries -- relationship to earthquakes and volcanoes.
3. discuss geological time -- planetary accretion and the origin of the Earth, relative and absolute geological time, radiometric dating, and stratigraphic principles (original horizontality, superposition, faunal and floral succession, unconformities, crosscutting relations, and others).
4. identify components of the solid Earth -- elements and the chemical periodic table -- elemental particles, ions, atoms, isotopes, chemical bonds; minerals; mineral groups and their physical and chemical properties (silicates, carbonates, sulfides) -- rocks are composed of minerals.
5. describe the rock cycle -- origins of igneous, sedimentary, and metamorphic rocks -- intrusive and volcanic igneous rocks, and Bowen's reaction series -- weathering, clastic and precipitated sedimentary rocks, soils, and landslides -- metamorphic deformation of rocks during mountain-building and near intrusions.
6. epitomize the groundwater, oceanic, and atmospheric water system -- chemical and physical properties of water; uniqueness, distribution, geological and geochemical functions -- the hydrological cycle: evaporation, precipitation, tides, and latent heat; the cryosphere: snow, glaciers, glaciation, ice ages and sea ice.
7. list the composition of the atmosphere -- thermal structure of the atmosphere, compositional structure of the atmosphere, relative humidity -- greenhouse gases, ozone, absorption of solar radiation, auroras, aerosols.
8. outline the dynamics of the atmosphere, adiabatic processes, jet streams and Rossby waves -- solar radiation and the coupled ocean-atmosphere circulations, air cells and Coriolis deflection -- weather and climate, proxy records.
9. define the role of the biosphere in Earth science -- the emergence of life and its role in atmospheric composition; oxygenation involvement in the carbon cycle and ocean acidity; banded iron formation -- metazoan radiation and phanerozoic evolution of major lineages of plant and animals; origin and distribution of biogenic sedimentary rocks.
10. quote the organization of life in space and time -- ecological theories: trophic webs, niches and the competitive exclusion principle -- speciation and diversity; mass extinctions -- life's role in biogeochemical cycles: Gaia.
11. relate the Earth and humans -- Earth mineral resources: distribution of economic ores, mining strategies -- energy resources; renewable and non-renewable; dependency on fossil fuels -- anthropogenic effects on the Earth system: human controls over elemental cycles (C, N, P and S); geochemistry of pollution -- human interference with global energy balance: global heating (greenhouse gasses); ozone depletion (UV penetration); human effects on geomorphic processes and biodiversity.

Upon successful completion of this course, students will be able to (applied skills)

12. read contours on topographic maps, use metric and imperial scales, operate in three coorditate grid systems (Longitude/Latitude, Universal Transverse Mercator, Dominion Land Survey) in the Canadian National Topographic System.
13. determine the bearing of a travel direction, and appreciate the power of the Global Positioning System.
14. construct topographic profiles on any map baseline, and calculate any vertical exaggeration.
15. work safely in the field as a team, use personal protective equipment and outdoors gear, work with maps, clinometer compass, measuring tape, sounding line, binoculars, geology hammer, and collecting jars.
16. explain the concepts of geological formation, type locality, depositional sequence, unconformity and other principles of geology required for the reconstruction of the geological history and sequence of events.
17. interpret river drainage basins, erosion and deposition banks, active and former terrasses, as well as rotational landslides.
18. employ aerial photographs and satellite images to determine the rate of tectonic motion and uplift.
19. analyze geological maps and assemble cross-sections to derive the sequence of events in an area.
20. calculate the radioactive decay time based on radioisotopes and their stable daughter isotopes for of absolute age determination.
21. identify some common minerals based on their physical, chemical and geometric properties.
22. distinguish some common igneous, sedimentary and metamorphic rocks based on their texture and mineral composition.
23. locate the epicentre of an earthquake, correlate magnetic anomalies with the rate of ocean floor spreading, measure continental drift of South America away from Africa, and calculate velocity of Pacific Plate motion over the Hawaiian hotspot.
24. read hydrologic maps, determine the hydraulic gradient based on water well data, calculate groundwater flow and artesian rates, assess ocean circulation and climatic heat exchange, quantify river erosion at Niagara Falls.
25. correlate oxygen isotope ratios with glacier growth and sea level changes, recognize glacial landforms (moraines, drumlins), calculate glacial volumes, discharge and sediment loads.
26. assess weather reports and forecasts, read meteorological maps and instruments, correlate adiabatic air processes with precipitation, angle of incidence with solar energy absortion, predict geostrophic wind direction.
27. recognize, label and sketch some Proterozoic and Phanerozoic fossils, and correlate them with eons, eras and periods.
28. infer molecular oxygen concentrations in Proterozoic oceans based on volumes and grades of Banded Iron Formation, and deduce cabon dioxide concentrations in air of the Eocene Epoch based on the stomatal index in *Metasequoia*.
29. scrutinize economic metal resources, calculate profitability, market value, and contribution to the gross domestic product of reef dolomite-hosted zinc-lead ore at the

Pine Point Mine, NWT, and correlate the occurrence of porphyry-hosted copper ore with plate tectonics.

30. quantify the economic benefits and royalty revenues of the Athabasca tarsands at Fort McMurray, and predict the human footprint in the form of rising atmospheric carbon dioxide levels.

Resource Materials

***Required Text(s)*:**

Skinner, B. J. & Murck, B. (2011). *The blue planet*. (3rd edition). Hoboken, New Jersey: John Wiley & Sons, 656 pp.

Waldron, J. W. F. (Editor). (2017/2018). *Earth and atmospheric science 100. Planet Earth. Laboratory manual*. Edmonton, AB: Department of Earth and Atmospheric Sciences, University of Alberta.

Cuny, R. (2017). *EAS 100, Planet Earth. Course notes*. Lloydminster, AB: Lakeland College.

Reference Text(s):

Godfrey, J. (Editor) (1992). *Edmonton beneath our feet*. Edmonton, AB: Edmonton Geological Society.

Mottana, A., Crespi, R., Liborio, G. (1977). *Simon & Schuster's guide to rocks and minerals*. Milano, Italy; New York, NY: Arnoldo Mondadori; Simon & Schuster Inc.

Chesterman, C.W., Lowe, K.E. (1979). *The National Audubon Society field guide to North American rocks and minerals*. New York, NY: Knopf, 850 pp.

Conduct of Course

This is a 3 credit course with 3 hours of lecture and 3 hours of lab per week. (3-0-3).

Lectures - 3 hours per week:

The lectures are supported by Power Point data projection, whiteboard, and occasionally by a movie. The printed course notes, and electronic files placed on Desire-2-Learn must be supplemented by notes taken by the students. The library can be used to access the earth science literature and on-line databases. Students are expected to do the assigned reading in the textbook and lab manual on a weekly basis.

Laboratory work - 3 hours a week:
The laboratory is conducted weekly, starting in the second week of classes. Students must pass a safety quiz in Lab 2 based on the safety orientation and instructions given in Lab 1, before continuing with the labs. Safety procedures must be followed; however, the wearing of lab coats or goggles is not required, except when working with acid, UV light or a geology hammer. The ten lab worksheet sets with attachments are graded within one week. Lab worksheet sets with attachments shall be submitted at the beginning of the following lab session. Attendance and completion of the labs, and a passing grade on this component of the course are mandatory to obtain a passing grade in EAS 100.

The WHIMS Workplace Hazardous Materials Information System requires the safe handling and storage of chemicals as specified in the MSDS Materials Safety Data Sheets. The EAS 100 labs are held in a biology lab, and hence some biology safety rules apply; for example no food, beverage or medicine intake is permitted while in the lab. Mineral crystals, thin sections, sedimentary structures, and fossils are generally not replaceable and must be used with care. Maps fall under the Canadian Copyright Law and authors' rights and conditions of use are honoured. While Geomatics and National Resources Canada have recently set up the GeoGratis website for unlimited use, and dropped the copy permit requirement for educational not-for-profit use of their topographic maps, other publishers, including the Geological Surveys of Alberta and Canada, the Canadian Society of Petroleum Geologists, or American Association of Petroleum Geologists, must be asked for permission before copying. Excavation and planned fossil collecting requires a permit in Alberta. Mineral and rock specimens are not regulated when obtained from loose surface rock. All laboratory equipment is operated as specified in the Operation Manual.

Evaluation Procedures

The student's performance is evaluated in terms of percentage points that reflect the number of correct answers out of the total number of questions asked on exams and lab worksheets. The practical work in the laboratory is part of the evaluation, to encourage active learning and safety awareness. The final mark is the aggregate of the evaluations; however, students must achieve a mark of 50% or higher in the laboratory component, which includes the safety quiz, the lab worksheets, the lab final exam, and the practical work evaluations combined, to pass the course.

The weighting of the course components is as follows:

Laboratory Component:

Lab and Field Safety Quiz (You must pass.)	5%	
Worksheets and Attachments (10) graded	15%	
Laboratory Final Exam	15%	
Practical Work	5%	
Laboratory Subtotal		**40%**

Lecture Component:

Quiz	5%	
Mid-term Exam	20%	
Final Exam	35%	
Lecture Subtotal		**60%**
	Total	**100%**

The lecture exams are composed of a 2 : 1 mixture of multiple choice questions and short answer questions. **No supplemental assignments or exam re-writes are allowed in the University Studies Department**. Signed compliance forms and the lab and field safety quiz ensure that students know how to be safe. The lab worksheets help students make sure that all tasks have been completed. Work on maps, graphs, tables, calculations, descriptions, drawings shall be appended. There are no lecture assignments. Late submission of lab assignments will suffer a 5% deduction on the mark per day late, except under documented extraordinary circumstances.

Cheating, falsifying of laboratory data, plagiarism, and non-compliance with safety or copyright regulations or the code of conduct, are academic and professional offenses. Depending on the severity of the offence, a student may be reminded, sent out of the classroom, reported to the department chair, may have marks deducted, assigned a failing grade in the course, or may be expelled from the college.

Grade Equivalents and Course Pass Requirements

A minimum grade of D (50%) (1.00) is required to pass this course.

Letter	F	D	D+	C-	C	C+	B-	B	B+	A-	A	A+
Percent Range	0-49	50-52	53-56	57-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-100
Points	0.00	1.00	1.30	1.70	2.00	2.30	2.70	3.00	3.30	3.70	4.00	4.00

Students must maintain a cumulative grade of C (GPA - Grade Point Average of 2.00) in order to qualify to graduate.

Attendance

Regular attendance is essential for success in any course. Absence for any reason does not relieve a student of the responsibility of completing course work and assignments to the satisfaction of the instructor. Poor attendance may result in the termination of a student from a course.

If you do not meet the established attendance requirements, your instructor will recommend that the Registrar withdraw you from the course. A failing grade of RW (Required to Withdraw) will appear on your transcripts.

Instructors have the authority to require attendance at classes.

1. All labs are mandatory. If more than 2 labs are missed, excused or unexcused, the student will either be required to withdraw (RW) or will be assigned a failing grade (F) for the entire course.
2. Students are only allowed to submit completed lab worksheets for labs they have attended. If the student's absence is excusable, the missing lab worksheets will not be counted. If the absence is inexcusable, the lab worksheets will be assigned a mark of 0.
3. Make-up labs are difficult or impossible to set up. Only students with an excused absence may arrange for a make-up lab.

Course Units/Topics

Week	Type	Title
		1. The Earth System
1	Lec -	LABOUR DAY/REGISTRATION/ORIENTATION DAY
	Lab 0	Earth Science laboratory and field work safety orientation.
	Lec 1	Introductions, Overview over the course; Earth is an integrated, closed system; scientific method; geo-, hydro-, atmo-, and biospheres.
	Lec 2	Matter: rock -, plate tectonic -, hydrologic -, biogeochemical cycles; energy flux: thermodynamics, feed-back regulation; uniformitarism - catastrophism.
		2. Plate Tectonics
2	Lec 3	Mantle convection, geothermal gradient, Earth magnetic field and paleomagnetism, ages of magnetic lineations on the ocean floor.
	Lab 1	Topographic maps, scales, coordinate grids, and topographic profiles.
	Lec 4	Tectonic plate boundaries: divergent at rifts of spreading centres, convergent at trenches of subduction zones, transform faults at fracture zones; suture zones, hotspots and mantle plumes.
	Lec 5	Plate tectonic (Tuzo Wilson) cycles: oceans open and close, isostasy and mountains, fusion of rifts between triple junctions, aulacogens.
		3. Earth in the Solar System and the Universe
3	Lec 6	Geo- or heliocentric universe, solar nebula and system, terrestrial and gaseous planets, epicycles, zodiac, paralax, types of telescopes.
	Lab 2	LAB/FIELD SAFETY QUIZ; identification and physical properties of 10 minerals, and texture and mineral composition of 7 igneous rocks.
	Lec 7	Black body radiators, luminosity, emission/absorption spectra, nuclear fusion/ fission, periodic table of elements, red shift, expansion of the universe.

	Lec 8	Sun interior, core/shell fusion, Hertzsprung -Russell diagram, main sequence stars, blue/red supergiants, supernovae, white/black dwarfs, comets, galaxies and black holes.
		4. Geological Time
4	Lec 9	Relative time, stratigraphic principles (superposition, unconformities, fossils, crosscutting relations, inclusions, original horizontality, contact metamorphism, . . .).
	Lab 3	Field work: geomorphology and geology of the Vermilion River Valley at Lea Park, Alberta.
	Lec 10	Absolute time, parent/daughter isotopes, radiometric dating, half-life, ions, atoms, geological time scale; major events and fossil groups.
		5. Seismic Waves and the Earth Interior
	Lec 11	Earthquakes, epicenter, elastic rebound, seismographs, surface/body waves, P/S shadow zones, discontinuities, Richter/Mercalli scales, seismic refraction/reflection, seismic gaps.
		6. Geosphere: Minerals and the Rock Cycle
5	Lec 12	LECTURE QUIZ 1; Minerals: definition, properties (lustre, hardness, cleavage, streak, crystal system, color density,...), chemical mineral classes (elements, silicate polymers, carbonate, oxides, sulfides, sulfates, ...).
	Lab 4	Geological maps, sections, 5 sedimentary rocks, radiometric dates, and regional geological history.
	Lec 13	Igneous rocks: crystallization, types of volcanoes, lavas, pyroclastic ejecta, magma chamber, caldera, diatreme, viscous and phreatic eruption hazards.
	Lec 14	N.L.Bowen reaction series, magma differentiation, intrusive bodies, mafic/ felsic color density, phaneritic/aphanitic textures.
6	Lec -	THANKSGIVING DAY
	Lab 5	Tectonic plate motion over Hawaiian hotspot, former continental positions of South America and Africa, locating earthquakes based on seismograms, 5 metamorphic rocks.
	Lec 15	Sedimentary rocks: mechanical/chemical weathering, joints, regoliths, soils, erosion, transport, sorting, clastic, chemical/precipitated, and biogenic sediments, lithification, landslides.
	Lec 16	Metamorphic rocks: deformation/recrystallization, metamorphic grade/facies, index minerals, kinds of metamorphism, foliated/nonfoliated textures.
7	Lec 17	Rock and tectonic cycle interaction: continental center=craton (Laurentian Craton) surrounded by orogenic mountain belts: former supercontinents Pangea and Rodinia.

		7. Hydrosphere: Rivers, Groundwater, Glaciers, Oceans
	Lab 6	River drainage patterns and erosion; ground water hydraulic potential, artesian flow; ocean basins and ocean currents.
	Lec 18	Hydrologic cycle, 3 phases, reservoirs, river drainage basins and patterns, river channels, discharge, capacity, gradient, competence, sediment loads, depositional/ erosional landforms.
	Lec 19	Climate moderation, lakes, wetlands, floods, ground water table, aquifers, springs, karst and caverns.
8	Lec 20	Cryosphere: snow to ice, temperate/polar glaciers, calving, sea ice, glacial flow/mass balance, permafrost, annual firn line, crevasses, moraines, erosional cirques, horns, ice ages.
	Lab 7	Glaciers, ice flow, mass balance, equilibrium line; glaciation, ice sheets, moraines, drumlin swarms.
	Lec 21	MIDTERM LECTURE EXAM
	Lec 22	Ocean basins, depth, salinity, pycnocline, plankton, pelagic/benthic, heat capacity, ocean currents, Coriolis deflection, deep water upwelling, thermohaline circulation, terrigenous/ pelagic sediments.
9	Lec 23	Sea waves, wave refraction, tsunamis, coasts, surf, tides, beach, estuaries, deltas, coral reef islands, sea level changes.
		8. Atmosphere: Structure, Composition, Dynamics
	Lab 8	Solar radiation, albedo, angle of incidence, climate and weather, geostrophic winds, ocean circulation and salinity.
	Lec 24	Thermal structure and composition of the atmosphere past and present; aerosols, carbon dioxide, greenhouse gases, oxygen, ozone, solar energy absortion, blue skylight scatter, rainbows, auroras.
	Lec 25	Barometric air pressure, partial pressure, relative humidity, adiabatic lapse rate, air mass lift forces, dew point, coalescence: rain, Bergeron process: snow, cloud types, friction.
10	Lec 26	Wind speed, chill, pressure gradient, geostrophic winds, Coriolis deflection, cyclone: convergence, anticyclone: divergence, air cells, intertropical convergence zone, jet streams, Rossby waves.
	Lab 9	Life, taxonomy, Banded Iron Formation, anoxic conditions, stomatal index (*Metasequoia*) and CO_2 , labeled sketches with scale of vertebrate, invertebrate, plant, ice-age, and trace fossils.
	Lec 27	Regional climate, extreme weather: monsoon, ENSO El Nino, desert, drought, desertification, cyclones: typhoons, hurricanes, thunderstorms, hail, tornadoes, inversions, sea breeze, dust/sand storms.

	Lec 28	Climate proxies, climate change, Koppen's climate classes, pollen, $^{18}O/^{16}O$ ratio, loess, Earth orbit, Milankovitch cycles, Fourier analysis, Dansgaard-Oeschger events, Heinrich layers.
11	Lec -	REMEMBRANCE DAY
		9. Biosphere: history of Life, Evolution, Ecology
	Lab 10	Ore mineral resources, fracture-hosted zinc-lead ore, porphyry-hosted copper ore; fossil fuel energy resources, coal maturation ranks, petroleum window, traps and host rocks; the human CO_2 footprint.
	Lec 29	Life, phototrophs, atmospheric oxygen, carbon cycle, autotrophs/heterotrophs, DNA/RNA, size and taxonomic hierarchy, phylogenetic trees, species, origin and history of life, stromatolites, arcitarchs.
	Lec 30	Evolution by natural selection, mutations, prokaryotes/eukaryotes, important fossil beds: Conception Bay, Ediacara, Burgess Shale; evolution of fishes to mammals, allopatric/sympatric speciation, extinction of dinosaurs.
12	Lec 31	Energy flow through ecosystems, biomass, trophic pyramids, food webs, primary/secondary production, bioconcentration of toxins, nutrients, biogeochemical cyles, Gaia hypothesis, soils and horizons.
	Lab 11	LABORATORY FINAL EXAM
	Lec 32	Competitive exclusion, niches, diversity, terrestrial zonobiomes, marine zones, pelagic/benthic, plankton, freshwater: lentic/lotic, biomes, communities, keystone species.
	Lec 33	Exponential and logistic population growth, carrying capacity, biogeographic realms, islands.
		10. Earth Resources and Human Footprint
13	Lec 34	Mineral resources/reserves, profitable ores, gems, host/source/cap rocks, types of mines, mine decommissioning, metals; building materials: clay, sand, concrete, gypsum, glass; salt, potash.
	Lab -	
	Lec 35	Energy resources; renewable/not renewable; need for fossil fuels: coal maturation, petroleum window, petroleum traps, distillated fractions of crude, hydrocarbon cracking; alternative energy: nuclear fission of uranium ^{235}U, nuclear waste; renewable energy: wind, hydroelectric, tidal, geothermal, biomass, passive solar heating, photovoltaic cells.
	Lec 36	Disruption of biogeochemical cycles, pollution, greenhouse gasses, deforestation, vegetation burning, aquaculture and disease, soil erosion, groundwater depleation, oil spills, pipelines, nuclear power plant meltdown, mine effluents, invasive species.

14	Lec 37	Global warming. overpopulation, deforestation, desertification, acid rain, ozone hole, smog, eutrophication, raw sewage, fisheries collapse, coral bleaching, plastic garbage.
	Lab -	LECTURE FINAL EXAM WEEKS
	Lec -	
	Lec -	
15	Lec -	
	Lab -	
	Lec -	
	Lec -	

2602 - 59 Avenue, Lloydminster, Alberta, Canada T9V 3N7. Ph: 780 871 5700
5707 College Drive, Vermilion, Alberta, Canada T9X 1K5. Ph: 780 853 8400
Toll-free in Canada: 1 800 661 6490 E-mail: admissions@lakelandcollege.ca