

## NOVA COLLEGE-WIDE COURSE CONTENT SUMMARY GOL 105 – PHYSICAL GEOLOGY (4 CR.)

### **Course Description**

Introduces the science of physical geology through a comprehensive systems-based examination of Earth's structure, composition, rocks and minerals, landforms, geomorphology, and agents responsible for shaping and modifying its environments. Explores the origin and evolution of Earth's topographic and bathymetric features, geologic phenomena, and geologic hazards, resulting from plate tectonics. Lecture 3 hours. Laboratory 3 hours. Total 6 hours per week.

### **General Course Purpose**

GOL105 provides students with an understanding of Earth's structure, composition, geologic features and geomorphology. This course offers a comprehensive examination of the physical and natural world. Students will enhance their observational and critical thinking skills through the analysis and interpretation of physical and graphical data. This course introduces geologic concepts to broaden students' general knowledge and exposes students to future opportunities in this area of study.

### **Course Prerequisites/Corequisites**

None

### **Course Objectives**

Upon completing the course, the student will be able to:

#### Quantitative Literacy

- Interpret numerical data to identify topographic and bathymetric features, grain size, degree of sorting, and angle of repose
- Interpret numerical data to construct a topographic profile, calculate gradient and local relief, and to classify rocks and minerals

#### Scientific Literacy

- Explain the importance of science in developing an understanding of the natural world and making informed and objective decisions concerning the environment
- Describe the scientific method and its application in the natural sciences

#### Civic Engagement

- Identify and describe geologic hazards, land use planning, water and soil conservation, coastal processes and management, and environmental issues

#### Critical Thinking

- Analyze topographic data, geologic features, soil characteristics, rock type, tectonic setting, and climate conditions to identify areas susceptible to geologic hazards, such as earthquakes, landslides, flash floods, and volcanic eruptions

#### Scientific Method

- List and describe the steps of the scientific method
- Explain the difference between a hypothesis and scientific theory.
- Analyze the elements of the scientific method and explain how these principles apply to the study of the Earth

## Earth Systems

- Identify and describe the Earth's principle systems – the lithosphere, hydrosphere, biosphere, atmosphere, mantle, and core
- Explain the interactions and feedback loops between the principle systems
- Define and explain the Earth's internal and external heat engines.
- Describe the hydrologic cycle and its impact on the lithosphere, streams, glaciers, and groundwater
- Describe the rock cycle

## Plate Tectonics

- Explain the theory of plate tectonics and why it is the unifying theory for geology
- Describe the formation of continental crust and the creation and destruction of oceanic crust
- Explain the driving force and mechanism responsible for plate tectonics
- Identify and describe the tectonic processes responsible for shaping Earth's surface and environments
- Identify and describe the different plate boundaries and their associated features, such as volcanoes, earthquakes, and mountains
- Describe the relationship between the lithosphere and asthenosphere, and their role in plate tectonics

## Minerals and Rocks

- Identify and describe the criteria used to define a mineral
- Explain the different types of chemical bonds and their influence on mineral structure and physical characteristics
- Identify the most abundant elements of the Earth's crust and the influence of their abundance on mineral and rock composition
- Describe silicate minerals and their atomic structures
- Explain how crystalline rocks are classified according to their mineralogy
- Identify the different rock groups and explain their origin
- Explain the role of rocks in the creation of sediment, soils, and energy production
- Discuss the role of sedimentary rocks in the release and sequestration of atmospheric gases, such as carbon dioxide
- Discuss the economic uses of rocks and minerals

## Volcanism and Volcanoes

- Discuss how volcanism is related to plate tectonics
- Explain the origin of magma, lava, and pyroclastic material
- Identify and describe shallow intrusive structures and lava flows
- Describe the geologic hazards resulting from volcanic eruptions
- Explain how volcanic eruptions can impact global climate.
- Identify and describe the different types of volcanoes and their explosive potential
- Explain the significance of Bowen's Reaction Series
- Describe the different types of magma and how they are classified
- Explain the origin of volcanic hotspots, and their role in the creation of islands and supervolcanoes
- Discuss volcano monitoring and eruption forecasting

## Weathering, Erosion, sediment, and Soil

- Explain the origin of soil
- Describe the soil profile and its different horizons
- Explain what properties of soil make it productive
- Explain why rocks weather at different rates
- Discuss how soils are classified
- Describe methods of soil conservation
- Identify the different types of weathering and their products
- Identify and describe the natural agents of erosion, transport, and deposition
- Explain how sediment becomes a sedimentary rock
- Identify and describe sedimentary structures
- Explain the economic value of sedimentary rocks and their use in energy production

### Depositional Environments

- Identify and describe the continental, transitional, and marine depositional environments
- Identify and describe the features associated with the most common depositional environments
- Explain the dominant processes or agents responsible for shaping and modifying a particular depositional environment
- Use topographic maps to identify depositional landforms

### Crustal Deformation and Mountain Building

- Identify and explain the origin of structural features, such as folds, faults, and the tectonic stresses involved
- Describe how structural features are mapped using strike and dip
- Explain the origin of mountains
- Explain the principle of Isostasy and isostatic rebound

### Earthquakes and Seismic Waves

- Explain the origin of earthquakes or the elastic rebound theory
- Describe how earthquake location, intensity, and magnitude is calculated
- Identify and describe the different types of seismic waves created by earthquakes, and how they are used to study the Earth's interior
- Discuss the geologic hazards associated with earthquakes and practices to mitigate their destructive potential
- Describe the characteristics of a tsunami and how they are created.
- Discuss how earthquakes can be predicted

### Earth's Interior

- Describe the formation of Earth's internal structure through differentiation, the origin of the Earth's magnetic field, and the heat source driving plate tectonics
- Identify and describe each compositional layer of Earth's interior and its role in plate tectonics
- Describe the lithosphere and asthenosphere and their role in plate tectonics
- Explain how seismic waves are used to study the Earth's interior

### Streams and Rivers

- Explain how streams are classified
- Identify and describe the erosional and depositional features associated with streams
- Calculate stream gradient and discuss its impact of stream characteristics
- Explain the origin of floods, how they are classified, and practices used to control their effects
- Discuss the erosion, transport, and deposition of sediment by streams
- Explain how urbanization increases discharge, and its impact of flood intensity

### Groundwater

- Describe the role of permeability and porosity in groundwater characteristics
- Explain the factors controlling groundwater movement
- Identify and describe the different types of aquifers and their environmental implications
- Discuss how anthropogenic activities modify the groundwater system
- Identify and describe the origin of karst features
- Identify and describe the elements of the groundwater system, such as the unsaturated and saturated zones, and the water table
- Identify and explain the origin of hydrothermal features, such as hot springs and geysers

### Glaciers

- Explain the origin of glaciers and their impact on global sea level
- Identify and describe the erosional and depositional features associated with alpine and continental glaciers
- Discuss how glaciers eroded and transport material
- Identify and describe landform features shaped and modified by glaciers
- Explain the glacial budget and how it affects the movement of glaciers

- Discuss the impact of global warming on the distribution and extent of glaciers
- Explain what causes ice ages

#### Deserts

- Describe the erosion, transport, and deposition of sediment by wind
- Identify the erosional and depositional features created by wind
- Explain the characteristics of a desert and what controls their origin and distribution
- Identify and describe the different types of sand dunes
- Explain the process of desertification
- Use topographic maps to identify desert landforms and erosional features

#### Mass Wasting

- Identify the different types of mass wasting events
- Identify the most common triggers for mass wasting
- Explain the environmental factors controlling the susceptibility of an area to mass wasting
- Describe the hazards associated with mass wasting and practices to mitigate these hazards
- Identify landscape features resulting from mass wasting

#### Oceans, Coasts, and shoreline Processes

- Explain seawater and oceanic circulation and its impact on global climate
- Identify and describe shoreline processes responsible for erosion, transport, and deposition of sediment along the coast
- Explain how coasts are classified relative to sea level or the dominant process responsible for shaping its shoreline and coastal features
- Identify and describe features of erosional and depositional coasts
- Identify and describe features of submergent and emergent coasts
- Describe the hazards of living near the shore
- Identify poor coastal management practices
- Identify and describe the artificial structures built to protect or modify the shoreline
- Explain how ocean waves are classified
- Explain the effects of tides, waves, and nearshore currents on shoreline morphology
- Identify and describe seafloor features and deposits

#### Climate Change

- Explain how the rock cycle is connected to climate change
- Discuss the implications of burning fossil fuels
- Explain the Greenhouse Effect and the impact of anthropogenic activities
- Explain the role of the ocean in sequestration of atmospheric gases, such as carbon dioxide
- Describe how glacial ice cores and rock record can be used to investigate climate change in the past and future

### **Laboratory Skills**

#### General Skills

- Use and identify Earth Materials such as Minerals, rocks, and sediments in Geological Studies
- Utilize Topographic maps and Google Earth for analysis and interpretation
- Conduct on-site or on-line virtual Field Study to determine natural and human environmental issues
- Utilize GPS, GIS, sediment auger, anemometer, compass,
- Utilize field methods and equipment for water sampling, elevation mapping, climatic conditions, and sample collection
- Write formal field and lab reports
- Connect topics discussed in lecture and laboratory observations

## Minerals

- Test the physical and chemical properties to identify the most common rock forming minerals
- Identify economic uses for the most common rock forming minerals

## Igneous Rocks

- Identify those most common igneous rocks
- Determine the cooling rate and magma composition of igneous rocks
- Identify and describe shallow intrusive structures and volcano types
- Explain the origin and differences of extrusive and intrusive igneous rocks
- Identify the different types of lava and their viscosity

## Sedimentary Rocks

- Identify those most common sedimentary rocks
- Explain how detrital and chemical sedimentary rocks are formed
- Determine grain size, rounding, and sorting for detrital sedimentary rocks
- Determine depositional environment for sedimentary rocks and sedimentary structures
- Identify sedimentary structures and describe their origin

## Metamorphic Rocks

- Identify those most common metamorphic rocks
- Explain the different types of metamorphism
- Identify index minerals to determine the degree or grade of metamorphism
- Identify foliated metamorphic rocks and describe their origin

## Topographic Maps

- Utilize topographic maps and GIS computer applications to identify and interpret geologic phenomena, structures, and landforms
- Calculate distances using fractional, verbal, and graphic map scales
- Calculate relief and gradient
- Identify and utilize map elements such as contour interval, symbols, and magnetic declination
- Locate features and areas of interest using Latitude and Longitude
- Construct topographic profile using contour lines and calculate vertical exaggeration

## Streams

- Identify and classify streams based on their relationship to base level
- Identify and describe the erosional and depositional features associated with streams
- Identify stream channel patterns
- Identify and explain stream drainage patterns
- Calculate stream gradient

## Deserts

- Identify the depositional and erosional features created by running water and wind in arid climates
- Identify and describe the landscape features of the Colorado Plateau and Basin and Range geologic provinces
- Explain of origin of the Basin and Range and Colorado Plateau provinces
- Identify and describe the different types of sand dunes

## Shorelines

- Explain the origin and effect of the longshore current on shoreline morphology
- Classify coastlines according to dominant process modifying its morphology or in reference to changing sea levels
- Identify and describe coastal features associated with submergent and emergent coasts
- Identify and describe depositional and erosional coastal features
- Identify artificial structures and describe their effect on the shoreline
- Utilize bathymetric lines to interpret seafloor characteristics

### Karst Topography

- Identify and describe karst features using topographic maps and GIS
- Determine location of natural springs
- Describe the process of solution weathering
- Identify geologic hazards in karst landscapes

### Glaciers

- Identify the different types of glaciers
- Identify and describe glacial erosion and depositional features
- Describe the characteristics of alpine and continental glaciers
- Determine the direction of glacial advance for active and past glaciers

### **Major Topics to be Included**

Scientific Method

Earth Systems

Plate Tectonics

Minerals and Rocks

Volcanism and Volcanoes

Weathering, Erosion, sediment, and Soil

Depositional Environments

Crustal Deformation and Mountain Building

Earthquakes and Seismic Waves

Earth's Interior

Streams and Rivers

Groundwater

Glaciers

Deserts

Mass Wasting

Oceans, Coasts, and shoreline Processes

Climate Change

### **Laboratory Skills**

General Skills

Minerals

Igneous Rocks

Sedimentary Rocks

Metamorphic Rocks

Topographic Maps

Streams

Deserts

Shorelines

Karst Topography

Glaciers