Department of Geology

Cotton University, Guwahati

B.Sc. FOURTH SEMESTER SYLLABUS

PAPER: GLY24C401	**Mineralogy**	**L+T+P=3+0+1= 4 credits**
PAPER: GLY24C402	**Optical Mineralogy**	**L+T+P=3+0+1= 4 credits**
PAPER: GLY24C403	**Geochemistry & Geological Field Work – I**	**L+T+P=3+0+1= 4 credits**
PAPER: GLY24M401	**Mineralogy**	**L+T+P=3+0+1= 4 credits**

DETAILED SYLLABUS (CORE/MAJOR)

PAPER: GLY24C401 **Mineralogy** **L+T+P=3+0+1= 4 credits**

Total Number of Theory Classes (*Lectures*): 45 (45 hours)
Total Number of Practical Classes (*Practical*): 15 (30 hours)

(i) Course learning outcome
After studying this course student will be able to understand:
CO1 The physical and optical properties of minerals.
CO2 Identification of minerals based on their physical properties.
CO3 Transformation processes of minerals.
CO4 Basic concept of X-ray diffractometry
(ii) Broad contents of the course
The course has been designed to give students a clear understanding of the important concepts of mineralogy and the different mineral groups. It includes the major groups of minerals as well as their distinguishing properties. Also, it contains mineral transformation processes and basic concept of X-ray diffractometry.
(iii) Skills to be learned
From this course, students will be able to identify different rock–forming minerals in hand specimen based on their distinguishing physical properties. Another skill to be learned is mineral identification by X-ray diffractometry.

Detail contents of this course:

THEORY

Study of physical and optical properties, atomic structure and chemistry of the following groups of mineral – Olivine, Garnet, Pyroxene, Amphibole, Mica, Clay minerals, Silica, Feldspar and Feldspathoid. (20)

Rules governing solid solution; Transformation processes of minerals: exsolution, transient- and structural- phase transformations; Examples from natural rocks: exsolution in pyroxenes and feldspars. (10)

Nature of X-rays; Interaction of X-rays and atoms; Interference of X-rays; Diffraction of X-rays; Cell parameters; d-values; Principles of X-ray crystallography; Single crystal and powder methods; Mineral identification by X-ray diffractometry. (15)

PRACTICAL

Study of the distinguishing characters and physical properties of the important silicate minerals and carbonate minerals (Calcite & Dolomite) in hand specimen. Numerical related to X-ray crystallography. (15)

Recommended Books:

1. Mineral Science – Cornelis Klein, *John Wiley and Sons*.
2. Mineralogy – Dexter Perkins, *Pearson*.
3. Manual of Mineralogy – C. Klein and C. S. Hurlbut, *Wiley*.
4. Introduction to Mineralogy – William D. Nesse, Oxford Univ. Pr.

PAPER: GLY24C402 Optical Mineralogy L+T+P=3+0+1= 4 credits

Total Number of Theory Classes (*Lectures*): 45 (45 hours)
Total Number of Practical Classes (*Practical*): 15 (30 hours)

(i) Course learning outcome

After studying this course, the student will be able to:

CO1 The Optical mineralogy course will enable students to gain knowledge on the optical properties of the minerals constituting different rock types.

CO2 Identify the minerals based on their optical properties. 28

(ii) Broad contents of the course

The Optical Mineralogy course is designed to give the students the knowledge about the optical properties of minerals, particularly rock forming minerals and how petrological microscopes can be used to identify minerals constituting the rocks.

(iii) Skills to be learned

The students will have idea about the optical properties of rock forming minerals and also learn the skills to identify minerals under the petrological microscope based on minerals' optical properties.

Detail contents of this course

THEORY

Reflection and refraction of rays; Refractive index; Dispersion of light; Polarization of light (*plane or linear polarization, circular polarization & elliptical polarization*); Polarizer; Linear or plane polarization by doubly refracting crystals (*Nicol prism*), by differential absorption (*Polaroid*) and by reflection (*Brewster's Law*); Isotropic and anisotropic media. (5)

Isotropic and Anisotropic (Uniaxial positive & negative and Biaxial positive & negative) minerals; Optic axis; Optical Indicatrix : Isotropic, Uniaxial & Biaxial indicatrices, their configuration and different sections within these indicatrices.

Opaque and non-opaque minerals; Petrological (refraction or transmitted-light) and Ore (reflection-light) microscope and their configuration; Orthoscopic and conoscopic arrangement of Petrological microscope; Accessory plates (*Mica Plate*, *Gypsum Plate* & *Quartz Wedge*) & their uses. (10)

Properties of minerals in thin section : Colour; Pleochroism; Determination of pleochroic scheme; Relief; Shape or Form; Cleavage; Fracture; Double refraction; Birefringence; interference colour. (10)

Determination of refractive index of minerals [*Liquid immersion method*, *Central illumination method* (*Becke Test*) & *Oblique illumination method*]; Extinction positions; Extinction angle (*straight* or *parallel*, *oblique* & *symmetrical extinction*); Interference colour & its determination; Determination of vibration direction. (10)

Different types of Uniaxial and Biaxial Interference figures; Determination of optic sign; Measurement of optic axial angle. (6)

Distinguishing Optical Characters of Some Important Non-opaque minerals: Garnet group (*Garnet*); Olivine group (*Olivine*); Aluminosilicate group (*Sillimanite*, *Kyanite*, *Andalusite*); *Serpentine*; *Staurolite*; Pyroxene group (*Enstatite*, *Hypersthene*, *Augite*, *Diopside*); Amphibole group (*Actinolite*, *Hornblende*); Mica group (*Biotite*, *Muscovite*); Feldspar group [*Orthoclase*, *Microcline*, *Plagioclase*(*Albite* to *Anorthite*)]; Feldspathoid group (*Nephelene*, *Leucite*) and Silica group (*Quartz*); Carbonate minerals (*Calcite*, *Dolomite*). (4)

PRACTICAL

Study & Identification of the following minerals in thin section under Petrological Microscope :

Minerals with high to moderate relief: Garnet group (***Garnet***); Olivine group (***Olivine***); Alumino-silicate group (***Sillimanite***, ***Kyanite***, ***Andalusite***); ***Serpentine***; ***Staurolite***; Pyroxene group (***Enstatite***, ***Hypersthene***, ***Augite***, ***Diopside***); Amphibole group (***Actinolite***, ***Hornblende***); Mica group (***Biotite***, ***Muscovite***). (4)

Minerals with low relief: Feldspar group (***Orthoclase***, ***Microcline***, ***Plagioclase***); Feldspathoid group (***Nephelene***, ***Leucite***) and Silica group (***Quartz***). (2)

Minerals with variable relief : Carbonate minerals (***Calcite***, ***Dolomite***). (1)

Comparison of the refractive index of mineral in thin section with the help of central illumination method (Becke Test). (1)

Determination of the composition of plagioclase by Michael-Levy method. (2)

Study under Petrological Microscope of uniaxial and biaxial interference figures and their recognition. Determination of optic sign from cantered & off-cantered uniaxial interference figures and cantered acute bisectrix & cantered optic axis biaxial interference figures by the use of accessory plates. (5)

Recommended Books:

1. Optical Mineralogy: Principles and Practice – Colin D. Gribble and Allan J. Hall, *George Allen and Unwin, 1985*.
2. Optical Mineralogy – P.F.Kerr; *McGraw-Hill Book Company, INC*.
3. Fundamentals of Optical, Spectroscopic and X-ray Mineralogy – S.Mitra; *New Age International Publishers*.
4. Optical Mineralogy: The Nonopaque Minerals – W.R.Phillips and D.T.Griffen; *CBS Publishers and Distributors*.
5. Optical Crystallography – E.E.Wahlstrom; *John Wiley and Sons, Inc.*
6. An Introduction to the Rock-Forming Minerals – W.A.Deer, R.A.Howie and J.Zussman; *ELBS Publishers with Longman*.

PAPER: GLY24C403 Geochemistry L+T+P=3+0+1= 4 credits

Total Number of Theory Classes (*Lectures*): 45 (45 hours)
Total Number of Practical Classes (*Practical*): 7 (14 hours)

(i) Course learning outcome
On completion of the course the students will have gained an understanding about the chemical processes that operate within and upon the Earth, both present and in the past.
(ii) Broad contents of the course
The course is designed to give them a preliminary idea about the natural earth materials and how their chemistry can be used to understand the chemical processes of the Earth.
(iii) Skills to be learned
The students will have a preliminary idea on major, trace, rare earth elements, radiogenic and non-radiogenic isotopes and their applications in earth sciences.

Detail contents of this course:

THEORY
Cosmic abundance of elements; Formation of Earth and Solar System; Chemical differentiation of the Earth; Composition of crust, mantle and core of the Earth; Composition of the bulk silicate Earth; Geochemical classification of elements; Geochemical cycle; Biogeochemical cycle; Sedimentation as a geochemical process; Composition and evolution of seawater; Composition and evolution of atmosphere; Composition of meteorites and lunar rocks; Element partitioning and concept of partition coefficient, camouflage, capture and admittance; Utility of major, trace and rare earth elements in petrogenesis of rocks; Chemical analysis of rocks and minerals. (25)

Stability and abundance of radionuclides; Decay mechanisms of radionuclides; Radioactive decay and growth rate of radiogenic decay; Principle and methodology of isotope dating; Isotopic tracers; Stable isotope geochemistry and its applications in earth sciences; Introduction to cosmogenic isotope geochemistry. (20)

PRACTICAL
Mineral formula calculation (2)
Preparation of geochemical variation diagrams and their interpretation (4)

Geological Field Work – I

(a) Duration of the Fieldwork is to be of minimum 5 days.
(b) An area with good rock exposures is to be selected for this field trip.
(c) Students are to be trained how to take readings like strike direction, amount & direction of dip; plunge & bearing; front bearing & back bearing with the help of Clinometer and Brunton Compass.
(d) A Field report is to be submitted before the Fourth Semester Examination and Viva-voce to be conducted.

Recommended Books:

1. Principles of Geochemistry (1986) - Mason, B. 3rd Edition, Wiley New York.
2. Using geochemical data – evaluation, presentation and interpretation (2007) - Rollinson, H. 2nd Edition. Publisher Longman Scientific & Technical.
3. Essentials of Geochemistry (2009) - Walther, J. V., Jones & Bartlett Publishers.
4. Geochemistry: an introduction (2003) - Albarède, F., Cambridge University Press.
5. Isotopes: Principles and Applications (2004) - Faure, Gunter and Teresa M. Mensing, Wiley India Pvt. Ltd.

DETAILED SYLLABUS (MINOR)

PAPER: GLY24M401 Mineralogy L+T+P=3+0+1= 4 credits

Total Number of Theory Classes (*Lectures*): 45 (45 hours)
Total Number of Practical Classes (*Practical*): 15 (30 hours)

(i) Course learning outcome
After studying this course student will be able to understand:
CO1 The physical and optical properties of minerals.
CO2 Classification of minerals.
CO3 Identification of minerals based on their physical and optical properties.
(ii) Broad contents of the course
The course has been designed to give students a clear understanding of the important concepts of mineralogy and the different mineral groups. It includes the major groups of minerals and their distinguishing physical and optical properties.
(iii) Skills to be learned
From this course, students will be able to identify different rock-forming minerals in hand specimen based on their distinguishing physical properties. Students will also be able to handle petrological microscope and identify minerals with the help of their optical properties.

Detail contents of this course:

THEORY

Definition of mineral; Physical properties of mineral; Relationship of physical properties with atomic structure; Mineral Classification; Structure of silicate minerals. (10)

Study of physical and optical properties, atomic structure and chemistry of the following groups of minerals – Olivine, Garnet, Pyroxene, Amphibole, Mica, Clay minerals, Silica, Feldspar and Feldspathoid. (15)

Optical Mineralogy: Scope of optical mineralogy; Nature of light; Wave front and wave surface; Isotropism/Anisotropism; Pleochroism; Refractive index – its determination; Polarization of light; Double refraction; Uniaxial & biaxial minerals; Extinction in minerals; Interference colour; Relief; Nicol prism. (10)

Isotropic and Anisotropic (Uniaxial positive & negative and Biaxial positive & negative) minerals; Optic axis; Opaque and non-opaque minerals; Petrological microscope orthoscopic and conoscopic arrangement of petrological microscope; Optical properties of minerals in conoscopic light. (10)

PRACTICAL

Study of the distinguishing physical properties of the following groups of minerals in hand specimen- – Olivine, Garnet, Pyroxene, Amphibole, Mica, Clay minerals, Silica, Feldspar and Feldspathoid. (7)

Study of the following groups of minerals under petrological microscope- Olivine, Garnet, Pyroxene, Amphibole, Mica, Silica, Feldspar and Feldspathoid. (8)

Recommended Books:

1. Mineral Science – Cornelis Klein, *John Wiley and Sons*.
2. Mineralogy – Dexter Perkins, *Pearson*.
3. Manual of Mineralogy – C. Klein and C. S. Hurlbut, *Wiley*.
4. Introduction to Mineralogy – William D. Nesse, Oxford Univ. Pr.
5. Optical Mineralogy: Principles and Practice – Colin D. Gribble and Allan J. Hall, *George Allen and Unwin, 1985*.
6. Optical Mineralogy – P.F. Kerr; *McGraw-Hill Book Company, INC*.