Course Type	Course Code	Name of Course	L	T	P	Credit
DC	NGLC508	**X-Ray Crystallography and Mineral Optics**	3	1	0	4

Course Objective
The student will learn the basics of crystallography and X-ray application in crystallography; X-Ray diffractometry will also enable the students to understand the fundamental concepts of crystal structure, morphology and its application to mineral sciences. Mineral optics part will help the student to understand microscopic techniques applicable to mineralogical and petrographic studies.
Learning Outcomes
Upon successful completion of this course, students will be able to: • Understand the fundamental of crystallography and mineralogy. • Appreciate the techniques in recognition and identification of mineral under thin section. • Learn XRD technique in mineral identification and use stereographic projection for plotting and understanding crystal data.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	Fundamentals of Crystallography: Elementary ideas about crystal structure – faces, edges, solid angles, interfacial angles, Steno's rule, zones; External symmetry (symmetry operations in two and three dimensions)	7L + 2T	This unit will help the student in understanding the basic concepts of external symmetry and its elements in crystal structure.
2	Miller indices, crystal forms, Crystallographic axes, axial ratio, 32 crystal classes and classification in seven systems, Bravais Lattice	7L + 2T	This unit will help the student in learning the mathematical expressions of crystal faces, forms, zones and characteristic properties of 32 crystal classes in 7 crystal systems
3	Spherical and stereographic projections; Crystal growth, twinning and defects; Bragg's Law, X-Ray Diffraction and its applications to crystallography	7L + 2T	This unit will help the student in learning the concept and procedure of representing crystallographic data in stereo-net. Also, the student will understand the fundamentals of crystal growth, twinning, defects and R-ray diffraction.
4	Mineralogy: Properties of Light, Petrographic microscope; Uniaxial and biaxial indicatrix and minerals;	7L + 2T	This unit will help the student in understanding the fundamental properties of light that are related to optical properties in minerals
5	Double refraction, Extinction angles, pleochroism, birefringence of minerals and their relation with mineral composition; Uniaxial and biaxial figures and optic sign determination, Optical properties of common rock forming silicate minerals. Dispersion.	7L + 2T	This unit will help the student in understanding the variation in optical properties in minerals, its reason and application in identifying different rock-forming minerals
6	Crystal Field theory, Molecular orbital theory, Molecular band theory and Field theory; Pauling's Rules, Chemical Bonding, Coordination; Bowen's reaction series, Silicate structures; Common rock forming minerals	7L + 2T	This unit will help the student to understand the theoretical background of crystal colour, which has application in the gem industry. Also, the students will learn solid-chemistry basics of crystal structure

	Total	42L +14T 56	

Text Books:

1. C. Klein & B. Dutrow. Manual of Mineral Science. CBS Publishers & Distributers Pvt. Ltd., New Delhi, 2012.
2. W. D. Nesse. Introduction to Optical Mineralogy. Oxford University Press, 2004

Reference Books:

1. W. H. Blackburn and W. H. Dennen. Principles of Mineralogy. Universal Book Stall, New Delhi, 1990.
2. Bob B. He. Two-Dimensional X-Ray Diffraction. John Wiley & Sons, New Jersey, 2009.
3. Dexter Perkins. Mineralogy. PHI Learning Private Ltd., New Delhi, 2012.
4. Ernest G. Ehlers. Optical Mineralogy, Vol. 1: Theory and Technique. Blackwell, 1987.
5. Ernest G. Ehlers. Optical Mineralogy, Vol. 2: Mineral Descriptions. Blackwell, 1987.
6. Christopher Hammond. The Basics of Crystallography and Diffraction. Oxford University Press Inc., New York, 2009.
7. Ernest Ehlers. Optical Mineralogy: Theory and Technique. Vol. 1 & 2, Blackwell Scientific Publications, 1987.