Name of Programme: M. Sc. Applied Geology
Course Code: GEO-512
Title of the Course: Metamorphic Petrology
No of Credits: 03
Effective from AY: 2022-23

Prerequisites for the course:	Degree of Bachelor of Science in Geology from any UGC recognized University or an equivalent examination.	
Objective:	To provide a conceptual understanding of metamorphism, and metamorphic rocks encompassing the chemical and physical transformations that take place in response to changing pressure, temperature, and chemical environments, including different petrogenetic processes involving mineral reactions and equilibrium thermodynamics.	
Content:	**Module 1:** Introduction, Types, Facies and Textures of metamorphic rocks: Definitions, factors and conditions of metamorphism; pressure and temperature limits of metamorphism; Types of metamorphism - orogenic metamorphism, ocean-floor metamorphism, regional metamorphism, contact metamorphism, cataclastic metamorphism, hydrothermal metamorphism, other types of small-scale metamorphism. Facies and facies series; Zones of Metamorphism; Concept and origin of isograds; General characteristics of contact and regional metamorphic rocks; Classification and types of textures; Interpretation of porphyroblast–inclusion relations.	15 hours
	Module 2: Introduction to Elementary Thermodynamics Related to Mineral Science: Concept of equilibrium in metamorphic systems; Gibbs phase rule and Mineralogical Phase Rule and their application in simple and complex systems. First law of thermodynamics, second law of thermodynamics- definition of entropy, third law of thermodynamics, thermodynamic equations, free energy of formation of minerals at any temperature and pressure, free energy surface in G–T–P–X space, free energy of ideal and non-ideal solutions, the regular solution model, equilibrium constant of a reaction and its relation with Gibbs free energy; Introduction to geothermobarometry.	15 hours
	Module 3: Metamorphic Reactions, Chemographic Projections and Progressive metamorphism in pelitic, carbonate and mafic rocks: Different types of metamorphic reactions, reactions among solid-phase components, reactions involving volatiles as reacting species, controls of pressure, temperature and chemical compositions on the metamorphic reactions, time scale of metamorphism; ACF, AKF and AFM diagrams; Progressive metamorphism in pelitic, carbonate and mafic rocks;	15 hours

	Metamorphism in the context of plate tectonics	
Pedagogy	Lectures/ tutorials/ assignments/ self-study	
References/ Readings	1. Winter, J. D. (2010). *An Introduction to Igneous and Metamorphic Petrology* (2nd Edition), Pearson Education, Inc. 2. Philpotts, A., and Ague, J. (2009). *Principles of Igneous and Metamorphic Petrology* (2nd ed.). Cambridge: Cambridge University Press. doi:10.1017/CBO9780511813429. 3. Bucher, K., and Grapes, R. (2011). *Petrogenesis of Metamorphic Rocks* (8th Edition), Springer. 4. Best, M. (2002). *Igneous and metamorphic petrology* (2nd Edition). Blackwell Science Ltd. 5. Frost, R., and Frost, C., (2014). *Essentials of Igneous and Metamorphic Petrology.* Cambridge University Press, New York. 6. Vernon, R., (2018). *A Practical guide to Rock Microstructure* (2nd Ed.), Cambridge University Press, https://doi.org/10.1017/9781108654609. 7. Winkler, H.G.F., (1979). *Metamorphic petrogenesis* (5th Ed.). Springer-Verlag, New York. 8. Spear, F., (1993). *Metamorphic Phase Equilibria and Pressure-Temperature-Time paths*. Mineralogical Society of America, Washington, D.C.	
Course outcomes	1. Students will acquire a comprehensive understanding of metamorphism and types of metamorphic rocks 2. Students will learn thermodynamic principles related to metamorphic petrology, applicable to a number of orogenic events in time and space 3. Students will be able to estimate Pressure-Temperature conditions of metamorphic rocks especially those formed during orogenesis.	