Name of Programme: M. Sc. Applied Geology
Course Code: GEO-606
Title of the Course: Trace Element Geochemistry
No of Credits: 03
Effective from AY: 2023-24

Prerequisites for the course	Students should have undergone M.Sc. Semester I and II.	
Objective	To provide knowledge of the concepts of trace element geochemistry, isotope geochemistry, hydro geochemistry, geological and geodynamic processes.	
Content	**Module I** Geochemistry: Historical perspective of geochemistry; Atomic properties of elements, the periodic table and geochemical classification of elements with examples; abundance of elements in the universe, bulk earth, crust, hydrosphere, atmosphere and biosphere; introduction to mineral structures and compositions; distribution and behaviour of major, minor, trace elements and REE in geological systems. Thermodynamic consideration of TE solid solutions. Nomenclature for trace element classification. Determination of partition coefficients. Fractional crystallization and melting, complex melting models. **Module II** Isotope geochemistry: Elements of nuclear systematics, introduction to isotopes and their properties. Fundamentals of radiogenic isotope geochronometers, isotope geology of Sr, Nd and Pb and their applications. Thermochronology. Introduction to stable isotopes, studies of O, H, S, and C isotopes and their applications, cosmogenic nuclides and their applications, extinct radionuclides, analytical techniques for TE measurements. **Module III** Hydro geochemistry: Chemical properties and principles. Chemical equilibria, association and dissociation of dissolved species, mineral dissolution and solubility. Evolution of natural groundwater hydrochemical sequences and facies, graphical methods of representation of chemical data, groundwater in crystalline and sedimentary rocks, Groundwater contamination and hydrogeochemical behaviour of contaminants, measurements of parameters, sources of contamination. Rock-water interaction studies chemical interaction of rock and water at low temperatures, thermal springs chemistry, origin, interpretation of chemical data, hydrochemical exploration of mineral deposits.	15 hours 15 hours 15 hours

Pedagogy	Lectures/ tutorials/assignments/field study/discussion
References/ Readings	1. Albarede, F. (1995) *Introduction to Geochemical Modeling.* New York, NY: Cambridge University Press 2. Faure, G. and Mensing, T. M., (2005) *Isotopes: Principles and Applications*, 3rd Edn. John Wiley & Sons 3. Freeze, R.A. and Cherry, J.A. (1979) *Groundwater*. Prentice Hall 4. Gasper, E. and Onescu, M. (1972) *Radioactive tracers in hydrology*. Elsevier 5. Hiscock, K. M., & Bense, V. F. (2021). *Hydrogeology: principles and practice*. John Wiley & Sons. 6. McSween, H. Y., Jr., S. M. Richardson, and M. E. Uhle (2003). *Geochemistry: Pathways and Processes*. New York, NY: Columbia University Press. 7. Wood, B. J., and D. G. Fraser (1977). *Elementary Thermodynamics for Geologists*. New York, NY: Oxford University Press. 8. Rollinson, H. R. (1993). *Using Geochemical Data: Evaluation, Presentation, Interpretation*. Harlow, Essex, England: Longman Group 9. Sharp Zachary (2006). *Principle of Stable Isotope Geochemistry*. Prentice Hall 10. Shaw, D. M. (2006) *Trace Elements in Magmas*. New York, Cambridge University Press. 11. Stumm, W. and Morgan, J.J. (1981) *Aquatic chemistry*. John Wiley & Sons 12. White, M. W. (2014). *Isotope Geochemistry*. Wiley – Blackwell
Course outcomes	1. Students will able to learn about the geochemical distribution of elements in space and time. 2. The students will be able to discuss the geochemical attributes and fingerprint different magmatic and tectonic processes involved in the origin and evolution of trace elements. 3. Techniques to use isotopic study as a tool for tracking source composition and in rock water interaction systems. 4. students will acquire indepth knowledge about hydrogeochemistry