Igneous and Metamorphic Petrology

1.1. Course Number: GE 311

1.2. Contact Hours : 3-0-2 Credits: 11

1.3. Semester Offered: 3rd Year- Odd

1.4. Prerequisite: Basic knowledge of Geology, Physics, and Chemistry

1.5. Syllabus Committee Members: Dr. Alok Kumar Singh & Dr. Hemant Kumar Singh

2. **Objective:** To impart knowledge of various processes associated to magma genesis and magmatic activity and portraying magmatic processes in Phase diagrams. A comprehensive understanding of the processes of metamorphism, characteristics of metamorphic rocks, metamorphic phase rules and its relationship with tectonics.

3. **Course Content:** Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-topics	Lectures
1	Introduction to Igneous Petrology	Petrology and its scope, Major structural units of the Earth, Pressure distribution within the Earth, Temperature gradients and heat flow in the lithosphere, Heat sources in the Earth, Magma generation in the crust and upper mantle, Physical properties of magma, Intrusion of magma, Forms of igneous bodies, Modes of emplacement of igneous rocks.	7
2	Classification, Composition of Igneous Rocks and Phase Diagram	Classification based on visual examination (size of crystal) and chemical composition, The IUGS Classification for various Igneous rock such as Aphanitic rocks, Pyroclastic rocks, and Mafic and Ultramafic rocks, TAS diagram for volcanic rocks; Composition and important igneous rocks: granitoids, pegmatite, syenite, gabbro, anthrothosite, dolerite, pyroxenites, peridotite, lamprophyres, carbonatite, rhyolite, basalt, komatiite. Phase rule and its application to eutectic, peritectic and solid solution system. Phase equilibria in the following binary and ternary systems, and their petrogenetic significance: diopside – anorthite, forsterite – silica, albite – anorthite, albite – orthoclase, diopside – albite – anorthite, forsterite – diopside – silica.	10
3	Texture and Structures of Igneous Rocks	Textures: phaneritic, aphanitic, holohyaline, porphyritic, phenocrysts, idiomorphic granular, hypidiomorphic granular, allotriomorphic granular, Myrmekitic, Ophitic, Subophitic, Poikilitic, Intergranular, Trachytic, Perthitic, Rapakivi, Spherulitic, graphic, Cumulate, Volcanic etc.	6

		Structures: Pillow Structures, Lava flow structures, Spherulitic structures, Vesicular structures, Columnar structures, Microlithic, Amygdaloidal, color banding, Ropy lava, Comb, orbicular, Corono, pahoehoe, Lava Domes, Maars, Tephra Cones, Stratovolcanoes, Shield Volcanoes etc.	
4	Introduction to Metamorphic Petrology	Definition, agent of metamorphism, types of metamorphism, Metamorphic volatiles, Metamorphic grade, Metamorphic facies, Petrogenetic grids, Ultrahigh-pressure, and ultrahigh-temperature metamorphism, Metasomatism.	6
5	Structure, texture, and Rock Nomenclature	Processes involved during metamorphic texture formation, Texture formed during different types of metamorphism, Classification of metamorphic rocks depending on texture and composition.	5
6	Metamorphic Phase Rule and Relation with Tectonics	different types of P-T-t path, derivation of P-T-t information using textural relation and geothermobarometric, close system and open system, application of phase rule in such systems. Chemographic projections: ACF, AFM, AKFM, CMS diagram. Relationship with tectonics	6
		Total	**40**

List of experiments:

Igneous Petrology:

- Hand specimen identification of various Igneous rocks
- Study of well-known igneous rocks in thin sections: Granite, granodiorite, diorite, syenite, nepheline syenite, gabbro.
- Plotting of modal data in IUGS classification diagram for plutonic rocks (Streckeisen diagram).

Metamorphic Rocks

- Hand specimen identification of various Metamorphic Rocks
- Textural and mineralogical study of metamorphic rocks in thin sections: varieties of schists, amphibolite, charnockite, khondalite, mafic granulite.
- Graphical plots of metamorphic mineral assemblages using chemographic diagram

4. Readings:

4.1. Textbook:

- J.D. Winter (2010) Principles of Igneous and Metamorphic Petrology, Pearson Prentice Hall.
- Philpotts and J. Ague (2009) Principles of Igneous and Metamorphic Petrology, Cambridge University Press.

- Gautam Sen (2014) Petrology: Principles and Practice, Springer-Verlag publisher.
- K.G. Cox, J.D. Bell and R.J. Pankhurst (1979). The Interpretation of Igneous Rocks Chapman and Hall publishing
- M. Wilson (1989) Igneous Petrogenesis: A Global Tectonic Approach. Chapman and Hall publishing.

4.2. Reference Books:

- Myron G. Best. (2013): Igneous and Metamorphic Petrology, Willey Blackwell.
- Robin Gill. (2011): Igneous Rocks and Processes: A Practical Guide, Willey Blackwell.
- Turner F.J & Verhoogen J. (1951): Igneous and Metamorphic Rocks, McGraw Hill.
- Gupta, Alok (1998) Igneous Rocks, Allied Publishers Limited.

5. Outcome of the course:

After the successful completion of the course the students will have following knowledge:

- Various processes associated to magma genesis and magmatic activity.
- Portraying magmatic processes in Phase diagrams
- Internal dynamics of the earth and its evolution through time
- the processes of metamorphism and characteristics of metamorphic rocks and Relation of metamorphism with plate tectonics