

AC 7-4-2014  
Item No. 4.2

# **UNIVERSITY OF MUMBAI**



## **Syllabus for the Bridge Course in Geology (leading to M. Sc. in Geology)**

(Credit Based Semester and Grading System with  
effect from the academic year 2014–2015)

**Syllabus - Bridge Modules in GEOLOGY**  
**To be implemented from the Academic year 2014-2015**

**Preamble**

The University of Mumbai has Geology as a full Six units course i.e. a graduate student from the Mumbai university does 4 geology courses in FY, 6 geology courses in SY and 8 geology courses in TY. As students from other universities may not have the requisite exposure to the subject, they find it difficult to obtain admission and cope with the Post Graduate course work in geology. Bridge courses are designed keeping the basic minimum requirements of the subject of Geology in mind, as expected from a Graduate student. These courses will be opted by students who have less than the required courses in geology during their undergraduate studies.

**The Rational:**

A graduate student seeking admission to the Masters degree in geology, is expected to have the minimum exposure to subjects like Structural geology and Petrology. It has been observed that some universities do not have the required minimum content of the subject at the undergraduate level. The below framed syllabus will ensure that students from other universities, after completing the three courses will be on par with the requirements of prequalification for admission to the M.Sc in Geology.

Bridge Courses in Geology:

<b>Course</b>	<b>Title</b>	<b>Credits</b>	<b>L / Week</b>
<b>PSBRGE01</b>	Structural geology	4	4
<b>PSBRGE02</b>	Advanced Igneous Petrology	4	4
<b>PSBRGE03</b>	Advanced Sedimentary and Metamorphic Petrology	4	4

Detailed Syllabus for Bridge Courses in Geology  
**To be implemented from the Academic year 2014-2015**

**Theory**

Course	UNIT		Credits	L / Week
<b>PSBRGE01</b>		<b>Structural geology</b>		
<b>PSBRGE01</b>	<b>I</b>	<p><b>Introduction, Types of Structures, Stress, Strain, Measurements of Stress and Strain, Mechanical Behaviour of Rocks</b></p> <p>Introduction and Review  Structures and Structural Geology  Fundamental Concepts  Plate Tectonics  Nontectonic Structures  Primary Sedimentary Structures  Sedimentary Facies  Dewatering Structures  Unconformities  Stress  Definitions  Stress on a Plane  Stress at a Point  Mohr Construction  Mohr's Hypothesis  Stress Ellipsoid  Strain  Definitions  Kinds of Strain  Strain Ellipsoid  Mohr Circles for Strain  Simple and Pure Shear  Measurement of Strain in Rocks  Kinds of Strain  Strain Markers  Flinn Diagram</p>	<b>4</b>	<b>1</b>

		<p>Mechanical Behavior of Rock Materials</p> <p>Elastic (Hooken) Behavior</p> <p>Permanent Deformation – Ductility</p> <p>Controlling Factors</p>	
	<b>II</b>	<p><b>Study of Structures I: Joints and Faults</b></p> <p>Joints and Shear Fractures</p> <p>Formation of a Fracture Griffith Theory</p> <p>Joints and Fracture Mechanics</p> <p>Joints in Plutons</p> <p>Fault Classification and Terminology</p> <p>Anatomy of Faults</p> <p>Andersonian Classification</p> <p>Criteria for Faulting</p> <p>Fault Mechanics</p> <p>Anderson’s Fault Types</p> <p>Brittle versus Ductile Faults</p> <p>Shear Zones</p> <p>Shear – Sense Indicators</p> <p>Thrust Faults</p> <p>Nature of Thrust Faults</p> <p>Detachment within a Sedimentary Sequence</p> <p>Small – Scale Features of Thrust Sheets</p> <p>Strike – Slip Faults</p> <p>Properties and Geometry</p> <p>Environments of Strike – Slip Faulting</p> <p>Fault Geometry and Other Fault Types</p> <p>Termination of Strike – Slip Faults</p> <p>Transforms</p> <p>Normal Faults</p> <p style="text-align: center;">Properties and Geometry</p>	<b>1</b>

	<b>III</b>	<p><b>Study of Structures II: Folds</b>          Fold Geometry and Classifications          Descriptive Anatomy of Simple Folds          Map – Scale Parallel Folds and Similar Folds          Recognition of Folds          Fold Classifications              Based on interlimb angle              Chapman classification              Hudleston classification              Ramsay standard classification              Donath and Parker classification              Noncylindrical and Sheath Folds              Fundamentals of Parallel Folds and Similar Folds          Complex Folds          Occurrence and Recognition          Fold Interference Patterns          Recognition of Multiple Fold Phases</p>		<b>1</b>
	<b>IV</b>	<p><b>Study of Structures II: Folds-II</b>          Fold Mechanics          Fold Mechanisms and Accompanying Phenomena          Deformation Mechanisms and Strain          Theory of progressive evolution of fold shapes in single competent layers.          Layer parallel shortening              Dependence of fold shape on viscosity contrast in a single layer buckles          High competence contrast, Low Competence contrast              Zone of contact strain and its interrelationship with buckle</p>		<b>1</b>

		<p>folds</p> <p>Change of fold shape with packing distance of competent layers</p> <p>Fold styles in multilayers</p>		
<b>Course</b>	<b>UNIT</b>		<b>Credits</b>	<b>L / Week</b>
<b>PSBRGE02</b>	<b>Advanced Igneous Petrology</b>			
	<b>I</b>	<p><b>The Interior of the Earth:</b></p> <p>Evidence of the Earth's Composition and Mineralogy: Seismic data, The Geothermal Gradient, Meteorites, Xenoliths.</p> <p>Mantle Petrology; Low Velocity Zone, Pressure and Temperature variations with Depth.</p> <p><b>Classification and Description of Igneous Rocks:</b></p> <p>The IUGS Classification System, Other aspects of classification; Chemical Classification;</p> <p><b>Textures of Igneous rocks,</b></p> <p>Crystallinity, Granularity, Shape of Crystals and Mutual Relations.</p> <p>Equigranular, Inequigranular, Directive and Intergrowth Textures.</p> <p>Terms related to some specific Textures and Microstructures : Perlitic Cracks, Spherulites, Orbicular Structure, Rapakivi Structure, Zoned Crystals, Xenocrysts, Quench Texture, Crystal Pseudomorph, and Cumulus Crystals.</p>	<b>4</b>	<b>1</b>

		<p>Characters of the Common Igneous Rocks: Plutonic and Volcanic types; Examples of Common Igneous Rock Types and their Indian Occurrences.</p>	
	<b>II</b>	<p><b>The Phase Rule and One and Two- Component Systems:</b></p> <p>Melting Behavior of Natural Magmas, Phase Equilibrium and The Phase Rule, One Component Systems, Two Component (Binary Systems) and Its Petrogenetic Significance.</p> <p>Binary Systems with Complete Solid Solution, Binary Eutectic Systems, Binary Peritectic Systems, the Alkali Feldspar System,</p> <p>Ternary Systems:- Ternary Eutectic Systems, Ternary Systems with Solid Solution</p> <p>Reaction Series, The Effect of Pressure on Melting Behavior, The effect of Fluid on Melting Behavior. The effects of Pressure on the Melting and Crystallization of Magma; Time and Crystallization; Rock Types and Mode of Occurrence.</p>	<b>1</b>
	<b>III</b>	<p><b>The Evolution of Magmas:</b></p> <p>Differentiation: Fractional Crystallization; Other Differentiation Mechanisms.</p> <p>Magmatic Mixing and</p>	<b>1</b>

		<p>Assimilation.</p> <p>Mantle Melting and Generation of Basaltic Magma, Petrology of Mantle, , High-Pressure Experimentation,</p> <p>Melting of the Mantle, Partial Melting, Magma Generation and Differentiation. Generation of Basalts from a Chemically Uniform Mantle.</p>		
	<b>IV</b>	<p>Subduction –Related Activity : Island Arcs, Island Arc Volcanism, Island Arc Volcanic Rocks and Magma Series, The Ophiolite Suite; Calcalkaline and Tholeiite Groups; Petrogenesis of Island Arc Magmas, Plutonic Rocks – Batholiths related to subduction zones.</p> <p>Gabbroic Layered Intrusions; Anorthosites; Alkali Basalts and Nephelinites; Carbonatites, Kimberlites and related Rocks.</p>		<b>1</b>
<b>PSBRGE03</b>	<b>Advanced Sedimentary and Metamorphic Petrology</b>			
	<b>I</b>	<p><b>Clastic Sedimentary Rocks.</b></p> <p><b>The Occurrence of Sedimentary Rocks:</b></p> <p>Origin, transportation and deposition of sediments. Basin, environment and</p> <p>facies concepts. Provenance. Brief concept about Plate tectonics and sedimentation</p>	<b>4</b>	<b>1</b>



		<p><b>Sedimentary Texture:</b></p> <p>Laboratory Techniques, Grain Size, Udden-Wentworth Size Scale, Phi Scale, Grain Size Measurement, Roundness and Shape, Grain to Grain relationship, permeability and porosity.</p> <p>Classification of Sedimentary rocks. Diagenesis.</p> <p><b>Sandstones and Conglomerates:</b></p> <p>Field Observations: Textures, Colour, Distance from source, Structures, Mineral composition.</p> <p>Laboratory Studies: Textures, Mineral composition; Recycling of Grains.</p> <p>Classification of Sandstones and conglomerates.</p> <p><b>Mudrocks:</b></p> <p>Field Observations: Textures, Structures, Colour, Nomenclature</p> <p>Laboratory Studies: Mineral composition; Bentonites; Mudrocks and Source areas.</p>		
	<p><b>II</b></p>	<p><b>Non-clastic Sedimentary Rocks</b></p> <p><b>Limestones and Dolomites:</b></p> <p>Field Observations of Limestones: Textures; Noncarbonate Mineralogy; Classification; Structures; Reefs and Palaeoclimate; Diagenesis.</p> <p>Laboratory Studies: Allochemical</p>		<p><b>1</b></p>

		<p>and Orthochemical Particles.</p> <p>Sites of Calcium Carbonate Deposition; Modern Reef Environments.</p> <p>Dolomites: Laboratory Studies; Modern Dolomite. Dolomitization.</p> <p><b>Other Types of Sedimentary Rocks:</b></p> <p><b>Evaporites,</b> Origin of Giant Evaporite Deposits; Evaporites and Climate.</p> <p><b>Bedded Cherts:</b> Phanerozoic Marine Cherts; Phanerozoic Nonmarine Cherts; Precambrian Cherts.</p> <p><b>Bedded Phosphate Rocks:</b> Origin of Phosphorites.</p> <p><b>Bedded Iron Deposits:</b> Oolitic Iron Formations; Bedded Iron Formations.</p>		
	<p><b>III</b></p>	<p><b>Introduction to Metamorphic Petrology</b></p> <p><b>The Occurrence of Metamorphic Rocks:</b></p> <p>Recognition of Metamorphic Rocks; Common Metamorphic Rocks.</p> <p>Definition of metamorphism. Factors of metamorphism. P-T limits of metamorphism. Agents of</p>		<p><b>1</b></p>

		<p>metamorphism – Pressure, Temperature, Fluid</p> <p>phase and time. Classification of metamorphic rocks.</p> <p><b>Facies and Graphic Representation:</b></p> <p>The Facies Concept; Equilibrium; The Phase Rule; Graphic Representation.</p> <p>Metamorphic zone concept and index</p> <p>minerals, grade concept, Isograds.</p> <p><b>Controls and Processes of Metamorphism:</b></p> <p>The Controls: Pressure, Temperature and Composition.</p> <p>Metamorphic Processes: Initiation of metamorphism, Contact Metamorphism, Metamorphism of Igneous Rocks, Submarine Metamorphism; Porphyroblasts; Preferred Orientation;</p> <p>The Upper Limit of Metamorphism.</p>		
	IV	<p><b>Facies Concept in Metamorphism and its Applications</b></p> <p><b>Mineral Changes During Metamorphism:</b></p>		1

		<p>Mineral Variation and Metamorphic Facies: Zeolite and Prehnite-Pumpellyite-Metagraywacke Facies, Greenschist Facies, Epidote-Amphibolite Facies, Amphibolite Facies, Granulite Facies, Blueschist Facies, Eclogite Facies, Hornfels and Sanidinite Facies.</p> <p>Mineral Variation Related to Initial Rock Composition: Carbonate rocks, Mudrocks, Mafic Igneous Rocks and Tuffs, Ultrabasic Rocks.</p> <p><b>Time, Temperature and Deformational Relationships:</b></p> <p>Porphyroblasts and Tectonism: Pre-tectonic, Syntectonic and Post-tectonic Porphyroblasts; More complex situations.</p> <p>Polymetamorphism.</p> <p><b>Metamorphic Rocks and Global Tectonics:</b></p> <p>Metamorphism at Transform Faults and Divergent Junctions; Metamorphism at Convergent Junctions, Time of Formation of Paired Belts.</p> <p>A brief study of the petrography of the following metamorphic rocks : Slate,</p> <p>Phyllite, Quartzite, Schist, Gneiss, Granulite, Khondalite, Leptynite,</p> <p>Charnockite, Eclogite, Amphibolite, Migmatite,</p>		
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		Blueschist, Breccia, Mylonite, Hornfels.		
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### **List Of Recommended Reference Books**

1. Hatcher Jr. R.D. (1990), Structural Geology, Merrill Publishing Company.
  2. Ghosh S.K. (1993), Structural Geology, Pergamon Press.
  3. Raj Pradeep (1997), Geological Maps, Concepts of Interpretation Practical Record with Key, Creative Educators.
  4. Hobbs D.W., Means W.D. And Williams P.F. (1976), An Outline of Structural Geology, John Wiley.
  5. Billings M.P. (1972), Structural Geology, 3<sup>rd</sup> ed., Prentice- Hall, Inc., Englewood cliffs, New Jersey.
  6. De Sitter L.U. (1956), Structural Geology, McGraw-Hill Book Company, INC.
  7. Ragan D.M. (1968), Structural Geology- An Introduction to Geometrical Techniques, 2<sup>nd</sup> ed., John Wiley and Sons.
  8. Badgley P.C. (1959), Structural Methods for the Exploration Geologist, Oxford Book Company.
  9. Ramsay J.G. and Huber M.I. (2002), The Techniques of modern structural geology, 2<sup>nd</sup> ed., Vol. 2, Elsevier Science Ltd.
  10. Bose M.K. (1997), Igneous Petrology. The World Press Pvt. Ltd. 568 p.
  11. Bowen N.L. (1928), The evolution of Igneous Rocks. Princeton Univ. Press. N.J 332 p.
  12. Hall A. (1987), Igneous Petrology. Longman. 573p.
  13. Hatch F.H., Wells A.K and Wells M.K. (1984), Petrology of the igneous rocks. CBS Publishers, 551 p.
  14. Philpotts A.R. (1994), Principles of igneous and metamorphic Petrology, Prentice Hall of India. 498p.
  15. Turner F.J & Verhoogen J. (1951), Igneous and Metamorphic Rocks, McGraw Hill.
  16. Williams H, Turner F.J & Gilbert C.M. (1955), Petrography. San Francisco: W.H. Freeman and company. 406p
  17. Winter J. D. (2001), an Introduction to Igneous and Metamorphic Petrology, Prentice Hall, 697p.
  18. Ehlers, E.G. and H. Blatt (1982), Petrology, Igneous, Sedimentary and Metamorphic, W.H Freeman, San Francisco.
  19. Philpotts A. R. (2009), Petrography of Igneous and Metamorphic Rocks, Cambridge University Press, 686p.
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20. Sengupta S.M. (2007), Introduction to Sedimentology (2<sup>nd</sup> Edition), CBS Publishers and Distributors, New Delhi.
  21. Blatt H, Middleton G. & Murray R. (1972), Origin of sedimentary rocks, Prentice-Hall, Englewood Cliff, N.J., 634p.

22. Pettijohn F.J. (1984), Sedimentary Rocks (3<sup>rd</sup> Edition), CBS Publishers and Distributors, New Delhi.
23. Tucker E.M. (2001), Sedimentary Petrology (3<sup>rd</sup> Edition), Blackwell Science Ltd.
24. Greensmith J. (1989), Petrology of the Sedimentary rocks (7<sup>th</sup> Edition), C.B.C. Publishers, New Delhi.
25. Blatt H., Tracy R.J. and Owens B.E. (2006), Petrology – Igneous, sedimentary and Metamorphic (3<sup>rd</sup> Edition), W.H. Freeman and Company, New York.
26. Sukhtanker R.K. (2004), Applied Sedimentology, CBS Publishers and Distributors, New Delhi.
27. Lindholm R.C. (1987), A practical approach to Sedimentology, Allen and Unwin, London.
28. Collinson J.D and Thompson D.B (1989), Sedimentary Structures (2<sup>nd</sup> Edition), Unwin Hyman Ltd, Sydney.
29. Yardley Bruce W.D. (1989), An Introduction to Metamorphic Petrology, Longman Singapore Publishers (Pvt.) Ltd.
30. Harker Alfred (1974), Metamorphism, Chapman and Hall, London.
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32. Bayley B. (1996), Introduction to Petrology, Prentice Hall, New York.
33. Miyashiro A. (1998), Metamorphism and Metamorphic Belts, George Allen & Unwin, New York.
34. Mason Roger (1984), Petrology of the Metamorphic Rocks, CBS Publishers and Distributors, New Delhi.
35. Winkler Helmut G.F. 1987), Petrogenesis of Metamorphic Rocks (Fifth Edition), Narosa Publishing House, New Delhi.