

A.C. 10/2/2012  
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# **UNIVERSITY OF MUMBAI**



**Syllabus for the M.Sc. Semester I and II**  
**Program: M.Sc.**  
**Course : GEOLOGY**

(Credit Based Semester and Grading System with  
effect from the academic year 2012–2013)

**M.Sc. Semester I and Semester II GEOLOGY Syllabus**  
**Credit Based and Grading System**  
**To be implemented from the Academic year 2012-2013**

**SEMESTER I**

<b>Course Code</b>	<b>UNIT</b>	<b>MINERALOGY Study of Rock forming Minerals:</b>	<b>Credits</b>	<b>2L / Week</b>
<b>PSGE101</b>	I	Fe-Mg Group and Mica Group	<b>4</b>	
	II	Feldspar Group and Feldspathoids		
	III	Other Minerals 1		
	IV	Other Minerals 2		

<b>Course Code</b>	<b>UNIT</b>	<b>GEOCHEMISTRY I</b>	<b>Credits</b>	<b>2L / Week</b>
<b>PSGE102</b>	I	Elements	<b>4</b>	
	II	Geochemical Cycle		
	III	Radiogenic Isotopes		
	IV	Stable Isotopes		

<b>Course Code</b>	<b>UNIT</b>	<b>STRUCTURAL GEOLOGY</b>	<b>Credits</b>	<b>L / Week</b>
<b>PSGE103</b>	I	Introduction	<b>4</b>	
	II	Time Relationship and Behaviour		
	III	Mechanics and Measurement of Deformation		
	IV	Diapirs and Salt Domes		

<b>Course Code</b>	<b>UNIT</b>	<b>IGNEOUS PETROLOGY</b>	<b>Credits</b>	<b>2L / Week</b>
<b>PSGE104</b>	I	MAGMAS 1	<b>4</b>	
	II	MAGMAS 2		
	III	PETROGRAPHIC PROVINCES IN RELATION TO PLATE TECTONIC SETTING 1		
	IV	PETROGRAPHIC PROVINCES IN RELATION TO PLATE TECTONIC SETTING 2		

<b>PSGEP101</b>	<b>MINERALOGY</b>	<b>2</b>	
<b>PSGEP102</b>	<b>GEOCHEMISTRY I</b>	<b>2</b>	
<b>PSGEP103</b>	<b>STRUCTURAL GEOLOGY</b>	<b>2</b>	
<b>PSGEP104</b>	<b>IGNEOUS PETROLOGY</b>	<b>2</b>	

## SEMESTER II

Course Code	UNIT	CRYSTAL OPTICS	Credits	L / Week
<b>PSGE201</b>	I	Crystal Optics Principles	<b>4</b>	
	II	Refractometry:		
	III	Reflected Light Optics		
	IV	Optics		

Course Code	UNITS	GEOCHEMISTRY II	Credits	L / Week
<b>PSGE202</b>	I	Thermodynamics 1	<b>4</b>	
	II	Thermodynamics 2		
	III	Applications		
	IV	Trace Elements		

Course Code	UNITS	METAMORPHIC PETROLOGY	Credits	L / Week
<b>PSGE203</b>	I	Metamorphic Structures	<b>4</b>	
	II	Metamorphic Facies		
	III	Metamorphism 1		
	IV	Metamorphism 2		

Course Code	UNITS	SEDIMENTARY PETROLOGY	Credits	L / Week
<b>PSGE204</b>	I	Origin and Classification of Sediments	<b>4</b>	
	II	Sedimentary Environments		
	III	: Sediment Analysis		
	IV	: Sediment Characteristics		

<b>PSGEP201</b>	CRYSTAL OPTICS	<b>2</b>	
<b>PSGEP202</b>	GEOCHEMISTRY II	<b>2</b>	
<b>PSGEP203</b>	METAMORPHIC PETROLOGY	<b>2</b>	
<b>PSGEP204</b>	SEDIMENTARY PETROLOGY	<b>2</b>	

### Semester I Detailed Syllabus

Course Code	Title	Credits
PSGE101	<b>MINERALOGY</b>	4
	Study of the following groups of rock forming minerals with particular reference to their <b>crystal structure, chemistry, solid solutions, stability conditions, classification, physical and optical properties, alteration products and paragenesis: (UNITS I to IV)</b>	
	<b>Unit I: Fe-Mg Group and Mica Group</b> Pyroxenes, Amphiboles, Olivines and Mica	
	<b>Unit II: Feldspar Group and Feldspathoids</b> Potassic Feldspar, Plagioclase Feldspar; Feldspathoids	
	<b>Unit III: Other Minerals 1</b> Calcite, Dolomite and Apatite; Clay minerals, Zeolite, Aluminosilicates (Sillimanite, Andalusite & Kyanite)	
<b>Unit IV: Other Minerals 2</b> Staurolite, Epidote, Cordierite, Scapolite, Spinel		

Course Code	Title	Credits
PSGE102	<b>GEOCHEMISTRY I</b>	4
	<b>Unit I: Elements:</b> Atomic Structure, Formation, Abundances, Distribution in Earth, Geochemical classification of elements.	
	<b>Unit II: Geochemical Cycle</b> Geochemical cycle. Basic principles of various analytical techniques in geochemistry	
	<b>Unit : III Radiogenic Isotopes:</b> Radioactivity, Range of Isotopic Systems (Rb/Sr, Sm/Nd, Lu/Hf, UTh-Pb, K/Ar-40 Ar/39Ar, (U-Th) /He and Fission Tracks) Applications to Geology (to trace source and reconstruct evolution)	
	<b>Unit : IV Stable Isotopes:</b> Fractionation, Range of Isotopic Systems (O, H, C), Applications to Geology Goldschmidt's stability series.	

Course Code	Title	Credits
PSGE103	<b>STRUCTURAL GEOLOGY</b>	4
<b>Unit I : Introduction</b> Principles of geological mapping and map reading, projection diagrams. Stress-strain relationships of elastic, plastic and viscous materials.		
<b>Unit II : Time Relationship and Behaviour</b> <b>Time-relationship</b> between crystallization and deformation; Structural behaviour of igneous rocks		
<b>Unit III : Mechanics and Measurement of Deformation</b> Mechanics of Deformation: of folding and faulting, Unconformities and basement-cover relations; Measurement of strain in deformed rocks		
<b>Unit IV : Diapirs and Salt Domes</b> Behaviour of minerals and rocks under deformation conditions; Diapirs and salt domes		

Course Code	Title	Credits
PSGE104	<b>IGNEOUS PETROLOGY</b>	4
<b>Unit I: MAGMAS 1</b> Nature and types of Magmas; Cooling Behaviour of magmas		
<b>Unit II: MAGMAS 2</b> Properties of magmas, Evolution and Sources of Magmas		
<b>Unit III : PETROGRAPHIC PROVINCES IN RELATION TO PLATE TECTONIC SETTING 1</b> Oceanic basaltic; Continental tholeitic; Continental deep source		
<b>Unit IV : PETROGRAPHIC PROVINCES IN RELATION TO PLATE TECTONIC SETTING 2</b> Continental marginal and Island Arc andesitic; Continental plutonic, granitic and anorthositic Orogenic belt ultramafic		

## Semester II Detail Syllabus

Course Code	Title	Credits
PSGE201	<b>CRYSTAL OPTICS</b>	4
<b>Unit I: Crystal Optics Principles:</b> Introduction to Optical Mineralogy : Theoretical aspects of optical properties of mineral, Fedarov stage-construction and adjustments.		
<b>Unit II : Refractometry:</b> Determination of: Birefringence Refractive indices of uniaxial and biaxial minerals		
<b>Unit III : Reflected Light Optics</b> Twinkling Pleochroism Interference / Polarization colours		
<b>Unit IV : Optics</b> Optics of isotropic minerals, Optics of anisotropic minerals. Optical Indicatrix, Uniaxial and biaxial interference figures Optic sign determination Sign of elongation Optic orientation		

Course Code	Title	Credits
PSGE202	<b>GEOCHEMISTRY II</b>	4
<b>Unit I: Thermodynamics 1 :</b> Basic Principles Mineral Stability Diagrams		
<b>Unit II : Thermodynamics 2:</b> Oxidation and Reduction Reactions Kinetics.		
<b>Unit III : Applications:</b> Sedimentary Rocks (Weathering, Diagenesis) Igneous Rocks (Partial Melting, Fractional Crystallization) Metamorphic Rocks (Metamorphic Reactions, P-T-t path)		
<b>Unit IV : Trace Elements:</b> Definition and Types Distribution of trace elements in Igneous rocks Sedimentary rocks Metamorphic rocks		



Course Code	Title	Credits
PSGE203	<b>METAMORPHIC PETROLOGY</b>	4
Unit I: <b>Metamorphic Structures</b> Metamorphic Structures Equilibrium in Metamorphism		
Unit II: <b>Metamorphic facies</b> Experimental Work in Metamorphic equilibria Metamorphic Facies Facies Series of Tectonic and Non Tectonic Domain		
Unit III : <b>Metamorphism 1</b> Facies of Contact and Regional Metamorphism Retrograde Metamorphism Metasomatism		
Unit IV: <b>Metamorphism 2</b> Metamorphic Differentiation and Diffusion Granitization		

Course Code	Title	Credits
PSGE204	<b>SEDIMENTARY PETROLOGY</b>	4
<b>Unit I: Origin and Classification of Sediments</b>  Character and classification of sedimentary rocks. Origin of sediments, classification of sediments		
<b>Unit II: Sedimentary Environments</b>  Sedimentary differentiation. Environments of deposition.		
<b>Unit III : Sediment Analysis</b>  Mineral stability in sedimentary rocks. Lithification and diagenesis. Mechanical analysis of sediments: Presentation and processing of sedimentary analytical data.		
<b>Unit IV : Sediment Characteristics</b>  Textural structural and mineralogical characters of sedimentary rocks. Provenance and palaeogeography.		

## SEMESTER I PRACTICAL

### **PSGEP1 Mineralogy:**

Megascope and microscopic identification of minerals. :  
Olivine, Pyroxene, Amphibole, Mica, Feldspar, Feldspathoid, Garnets

### **PSGEP2 Geochemistry I: Petrographic Calculations**

1. CIPW Norm Calculations
2. Niggli Values Calculation

### **PSGEP3 Structural Geology**

1. Interpretation of Geological Survey Maps
2. Structural Problems

### **PSGEP4 Igneous Petrology :**

1. Megascope Examination of Igneous Rocks
2. Microscopic examination of Igneous Rocks
3. Variation diagrams of Igneous rocks
4. Interpretation of differentiation trends by AFM diagrams

## SEMESTER II PRACTICAL

### **PSGEP5 Crystal Optics : Crystallography:**

1. Symmetry diagrams
2. Axial Ratios
3. Stereographic and Gnomonic Projections

### **PSGEP6 Geochemistry II: Mineral calculations:**

- a. Olivine
- b. Pyroxene
- c. Amphibole
- d. Mica
- e. Feldspar
- f. Feldspathoid
- g. Garnets

### **PSGEP7 Metamorphic Petrology: Plotting and Interpretation**

Plotting and Interpretations of AFM/ACF Diagrams of metamorphic rocks

### **PSGEP8 Sedimentary Petrology**

- a. Megascope & Microscopic Examination of Sedimentary rocks
- b. Sedimentary Mechanical Analysis Interpretations
- c. Determination of Roundness of Grains, grain size and Pipette analysis.

## **M.Sc.: SEMESTER I**

### **MINERALOGY**

1. Berry, Mason & Dietrich, (1985) Mineralogy. CBS Publishers, New Delhi.
2. Deer, Howie & Zussman, (1985) An Introduction to the Rock-Forming Minerals. ELBS/Longman.
3. Deer, Howie & Zussman, Rock Forming Minerals, Vol. I – IV.
4. Ford, William E. (1992) A Textbook of Mineralogy. Wiley Eastern Ltd., New Delhi.
5. Frye, K., Modern Mineralogy.
6. Klein, Cornelis and Hulburt, Cornelius S., Jr. (1985) Manual of Mineralogy. John Wiley and Sons, Singapore.
7. Mason, Brian & Berry, L. G. (1968) Elements of Mineralogy. W.H. Freeman and Co., San Francisco
8. Perkins, Dexter (2002) Mineralogy, 2<sup>nd</sup> edition, Prentice Hall of India Pvt. Ltd., New Delhi.
9. Putnis, Andrew (1992) Introduction to Mineral Sciences. Cambridge University Press, U.K.

### **GEOCHEMISTRY I**

1. Faure, Gunter (1998) Principals and Applications in Geochemistry. Prentice Hall International (U.K.) Ltd., London
2. Jones, P. Meurig (1987) Applied Mineralogy a quantitative approach. Graham and Trotman, U.K.
3. Mason, Brian & Moore, Carleton B. (1982) Principals of Geochemistry. John Wiley and Sons, Singapore.
4. Werk, Hans-Rudolf and Bulakh, Andrei (2004) Minerals their constitution and Origin. Cambridge University Press, U.K.
5. Willard, Merritt & Dean, Instrumental Methods of Analysis.
6. Rollinson, H., (1994) Using Geochemical Data. Longman.

### **STRUCTURAL GEOLOGY**

1. Structural Geology by R.D.Hatcher
2. Foundations of Structural Geology by R.G. Park
3. Structural Geology by P.C.Badgley
4. Structural Geology by E.S.Hills

### **IGNEOUS PETROLOGY**

1. Igneous and Metamorphic Petrology by M.Best
2. Igneous and Metamorphic Petrology by Carmaichael , Turner & Verhoogen
3. Igneous Petrology by A. Hall
4. Petrology of Igneous and Metamorphic Petrology by D.W.Hyndman
5. Petrology of Igneous rocks by Hatch and Wells
6. Petrology for students by Nockalds, Knox & Chinner
7. Metamorphic Rocks by Y. R. Mason
8. Petrology of Metamorphic Rocks by H. Winkler
9. Metamorphism and Metamorphic belts by A. Miyashiro
10. Petrography by William, Turner & Verhoogen

## **M.Sc. : SEMESTER II**

### **CRYSTAL OPTICS**

1. Gay, P., Crystal Optics.
2. Hartshorne & Stuart, Practical Optical Crystallography
3. Kerr, Paul F. (1977) Optical Mineralogy, 4<sup>th</sup> edition, McGraw-Hill Inc., U.S.A.
4. Nesse, William D. (2004) Introduction to optical mineralogy, 3<sup>rd</sup> Edition, Oxford University Press, New York.
5. Shelley, David (1985) Optical Mineralogy, 2<sup>nd</sup> edition, Elsevier Science Publishing Co., New York.
6. Whalstrom, Ernest E. (1969) Optical Crystallography, 4<sup>th</sup> edition, John Wiley and Sons, Inc. London.
7. Willard, Merritt & Dean, Instrumental Methods of Analysis.
8. Winchell, Elements of Optical Mineralogy
9. Zussman, J., Physical Methods in Determinative Mineralogy.

### **GEOCHEMISTRY II**

1. Faure, Gunter (1998) Principals and Applications in Geochemistry. Prentice Hall International (U.K.) Ltd., London
2. Jones, P. Meurig (1987) Applied Mineralogy a quantitative approach. Graham and Trotman, U.K.
3. Mason, Brian & Moore, Carleton B. (1982) Principals of Geochemistry. John Wiley and Sons, Singapore.
4. Werk, Hans-Rudolf and Bulakh, Andrei (2004) Minerals their constitution and Origin. Cambridge University Press, U.K.
5. Willard, Merritt & Dean, Instrumental Methods of Analysis.
6. Rollinson, H., (1994) Using Geochemical Data. Longman.

### **SEDIMENTARY PETROLOGY**

1. Blatt, Harvey, Middleton, Gerard & Murray, Raymond (1972) Origin of Sedimentary Rocks. Prentice-Hall, Inc., N.J., U.S.A.
2. Muller, German (1967) Methods in Sedimentary Petrology. Hafner Publishing Co. New York.
3. New York.
4. Pettijohn, F. J. (1984) Sedimentary Rocks, 3<sup>rd</sup> edition, CBS Publishers and Distributors, New Delhi.
5. Prothero Donald R. & Schwab Fred (1996) An introduction to Sedimentary Rocks and Stratigraphy. W. H. Freeman and Co. New York.
6. Sengupta, Supriya (1994) Introduction to Sedimentology. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
7. Stow, Dorrik A. V. (2005) Sedimentary rocks in the field. Mason Publishing Ltd., U.K.
8. Tucker, Maurice E. (2001) Introduction to Sedimentology. Blackwell Publishing, U.S.A.

### **METAMORPHIC PETROLOGY**

1. Igneous and Metamorphic Petrology by M. Best
2. Igneous and Metamorphic Petrology by Carmaichael, Turner & Verhoogen
3. Igneous Petrology by A. Hall
4. Petrology of Igneous and Metamorphic Petrology by D.W. Hyndman

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