

**Centre for Geography and Geology**  
Central University of Punjab

**Syllabus**  
  
**for**  
  
**M.Sc. Geology**  
  
**2016 – 2017**

**Centre for Geography and Geology**  
**Central University of Punjab, Bathinda**

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**ANNEXURE-I**

<b>Syllabus for M.Sc. Earth and Geological Sciences</b>											
Course Code	Course Title	Credit Hours				% Weightage				E	CBSC
		L	T	P	Cr	A	B	C	D		
<b>Semester-I</b>											
<b>Core courses</b>											
EGS.501	Mineralogy and Crystallography	4	1	-	4	25	25	25	25	100	C
EGS.502	Principles of Stratigraphy and Palaeontology	4	1	-	4	25	25	25	25	100	C
EGS.503	Sedimentology	4	1	-	4	25	25	25	25	100	C
EGS.504	Geomorphology & Geotectonic	4	1	-	4	25	25	25	25	100	C
EGS.505	Lab- I (EGS.501)	-	-	4	2	-	25	-	25	100	C
EGS.506	Lab- II (EGS.502 and EGS.503)	-	-	4	2	-	25	-	25	100	C
EGS.507	Computer applications*	2		-	2	-	-	-	-	50	F
<b>Elective courses: Select any one of the interdisciplinary courses listed below</b>											
IC.	Interdisciplinary course from other discipline A/B/C/D.....N	2	-	-	2	-	-	-	-	50	E
	<b>Total</b>	<b>20</b>	<b>4</b>	<b>8</b>	<b>24</b>	-	-	-	-	<b>700</b>	
<b>Semester-II</b>											
<b>Core courses</b>											
EGS.511	Geochemistry and Isotope Geology	4	1	-	4	25	25	25	25	100	C
EGS.512	Igneous and Metamorphic Petrology	4	1	-	4	25	25	25	25	100	C
EGS.513	Structural Geology	4	1	-	4	25	25	25	25	100	C
EGS.514	Lab- III (EGS 512)	-	-	4	2	-	25	-	25	100	C
EGS.515	Lab- IV (EGS 513)	-	-	4	2	-	25	-	25	100	C
EGS.516	Academic activities/Assignment based Seminar- I	2	-	-	1	-	-	-	-	50	F
EGS.517	Field training - I (~10days), report writing and presentation†	2	-	-	2	-	-	-	-	50	F
EGS.518	Basic Statistics	2	-	-	2	-	-	-	-	50	F
<b>Elective Course: Select any one</b>											
EGS.521	Natural Resource Management	2	-	-	2	-	-	-	-	50	E
EGS.522	Oceanography	2	-	-	2	-	-	-	-	50	E
EGS.523	Watershed Management	2	-	-	2	-	-	-	-	50	E
EGS.524	Environmental Geology and Natural Hazards	2	-	-	2	-	-	-	-	50	E
	<b>Total</b>	<b>20</b>	<b>3</b>	<b>8</b>	<b>23</b>	-	-	-	-	<b>700</b>	

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<b>Semester-III</b>											
<b>Core courses</b>											
EGS.601	Geophysics	4	1	-	4	25	25	25	25	100	C
EGS.602	Ore Geology	4	1	-	4	25	25	25	25	100	C
EGS.603	Remote Sensing and GIS in Geology	4	1	-	4	25	25	25	25	100	C
EGS.604	Hydrogeology	4	1	-	4	25	25	25	25	100	C
EGS.605	Lab- IV(EGS.601, 602)	-	-	4	2	-	25	-	25	100	C
EGS.606	Lab- V(EGS.603, 604)	-	-	4	2	-	25	-	25	100	C
EGS.607	Academic activities/Assignment based Seminar-II	2	-	-	1	-	-	-	-	50	F
<b>Elective courses: Select any one from the followings:</b>											
EGS.621	Petroleum Geology	2	-	-	2	-	-	-	-	50	E
EGS.622	Climatology	2	-	-	2	-	-	-	-	50	E
EGS.623	Mineral Exploration and Mineral Economics	2	-	-	2	-	-	-	-	50	E
EGS.624	Palaeobotany	2	-	-	2	-	-	-	-	50	E
<b>Total</b>		<b>20</b>	<b>4</b>	<b>8</b>	<b>23</b>	-	-	-	-	<b>700</b>	
<b>Semester-IV</b>											
<b>Core courses</b>											
EGS.611	Indian Stratigraphy	4	1	-	4	25	25	25	25	100	C
EGS.612	Engineering Geology and Environmental Geology	4	1	-	4	25	25	25	25	100	C
EGS.613	Lab-VI (EGS. 611, EGS. 612)	-	-	4	2	-	-	-	-	100	C
EGS.614	Field training - II (~10days), report writing and presentation ††	-	-	4	2	-	-	-	-	50	F
EGS.699	Dissertation/Project work/Academic activities and Viva voce	-	-	12	12	-	-	-	-	300	C
<b>Total</b>		<b>8</b>	<b>2</b>	<b>20</b>	<b>24</b>	-	-	-	-	<b>650</b>	
<b>Grand total</b>		<b>68</b>	<b>13</b>	<b>44</b>	<b>94</b>	-	-	-	-	<b>2750</b>	

<p><b>A:</b> Continuous Assessment: Based on Objective Type Tests</p> <p><b>B:</b> Mid-Term Test-1: Based on Objective Type and Subjective Type Test</p>	<p><b>C:</b> Mid-Term Test-2: Based on Objective Type and Subjective Type Test</p> <p><b>D:</b> End-Term Exam (Final): Based on Objective Type Tests</p> <p><b>E:</b> Total Marks</p>
<b>L: Lectures T: Tutorial P: Practical Cr: Credits</b>	

\* Offered by Centre for Computer Sciences and Technology

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† Field work will be conducted during 2<sup>nd</sup> semester. This field work will be focused on the sedimentological and paleontological aspect. Evaluation of this course will be based on the field activity, daily field report, final report submission and presentation.

†† Field work will be conducted in the beginning of 4<sup>th</sup> semester. This field work will be focused on the lithological and structural mapping, ore geology. Evaluation of this course will be based on the field activity, daily field report, final report submission and presentation during the 4<sup>th</sup> semester.

**SEMESTER I**

**Course Title: Mineralogy and Crystallography**

<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>	<b>Marks</b>
4	1	-	4	<b>100</b>

**Course Code: EGS. 501**

**Unit I**

**Mineralogy**

- a) Introduction to mineralogy, broad classification, properties of minerals & environments of formation
- b) Crystal chemistry: chemistry of elements, bonding and packing in mineral, coordination number, chemical analysis of minerals, general and structural mineral formulae
- c) Polymorphs/structural states, rules of substitution, introduction to phase diagram and solid solution series, (12 Lectures)

**Unit II:**

**Crystallography**

- a) Crystal systems, introduction to symmetry, derivation of 32 classes of symmetry. 2D and 3D lattice, 14 Bravais lattice, introduction to space group,
- b) International system of crystallographic notation and study of stereograms. Different types of crystal projections – spherical and stereographic and their uses.
- c) Crystal defects, twinning and twin laws: common types of twins and their examples in minerals. Liquid crystals.
- d) Introduction to X-ray crystallography, and Bragg's equation. Powder method in X-ray crystallography. (12 Lectures)

**Unit III:**

**Optical Mineralogy**

Introduction to optics, Isotropic and anisotropic minerals, optical crystallography of uniaxial and biaxial crystals, indicatrix, pleochroism, interference figures, crystal orientation, 2V and 2E.

(12 Lectures)

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**Unit IV:**

**Systematic Mineralogy:**

A detailed study of the important silicates (listed below) and non-silicate mineral with reference to general and structural formulae, classification, atomic structure, polymorphs/structural states, solid solution and experimental work on pressure-temperature stability of the minerals, modes of occurrence and alterations.

- (a) Nesosilicates/Orthosilicates: olivine group, garnet group, aluminosilicate group (kyanite, andalusite, sillimanite), humite group, zircon.
- (b) Sorosilicates: melilite, axinite and epidote group.
- (c) Cyclosilicates: beryl, tourmaline, cordierite, eudialyte
- (d) Inosilicates: pyroxene group, amphibole group and wollastonite
- (e) Phyllosilicates: mica group, kaolinite-serpentine group, talc-pyrophyllite, chlorite, smectite.
- (f) Tectosilicates: silica group, feldspar group, zeolite and feldspathoid

(20 Lectures)

**Suggested readings:**

1. Mineralogy and Optical Mineralogy by Dyar M. D., Gunter ME, Tasa D., 2008, Mineralogical Society of America, ISBN 978-0-939950-81-2.
2. Mineralogy by Perkins Dexter, 3<sup>rd</sup> edition, 2012, Pearson Education, ISBN-13: 978-8120345089.
3. Dana's Textbook of Mineralogy (With Extended Treatise on Crystallography and Physical Mineralogy), by William E. Ford, 4<sup>th</sup> edition, 2006, CBS Publishers & Distributors Pvt. Ltd., ISBN 10: 8123908091.

**Further readings:**

4. Optical Crystallography by Bloss, 1999, Mineralogical Society of America.
5. Crystallography and Crystal Chemistry by Bloss, 1994, Mineralogical Society of America.
6. Introduction to Mineralogy by William Nesse, 2<sup>nd</sup> edition, 2011, Oxford University Press, ISBN: 9780199827381.
7. Introduction to Optical Mineralogy by William Nesse, 4<sup>th</sup> edition, 2012, Oxford University Press, ISBN: 9780199846276.
8. Minerals and Rocks-Exercises in Crystallography, Mineralogy and Hand Specimen Petrology by Cornelius Klein, 3<sup>rd</sup> edition, 2007, Wiley.
9. Mineralogy by Berry, L.G., Mason, B. and Dietrich, R.V., 2004, CBS Publishers, ISBN 10: 8123911483, ISBN 13: 9788123911489.
10. Introduction to the Rock-Forming Minerals by Deer W.A., Howie R.A. and Zussman J., 3<sup>rd</sup> edition, 2013, Mineralogical Society of America.
11. Rutley's Elements of Mineralogy, by Gribble, 27<sup>th</sup> edition, 2005, CBS Publishers, ISBN-10: 8123909160.

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### Course Title: Principles of Stratigraphy and Palaeontology

Course Code: EGS. 502

L	T	P	Cr	Marks
4	1	-	4	100

#### Unit I

##### Principles of Stratigraphy

History and development of stratigraphy; stratigraphic procedures (surface and subsurface), concept of lithofacies and biofacies; stratigraphic correlation (litho, bio- and chronostratigraphic correlation).

Study of standard stratigraphic code (lithostratigraphic, biostratigraphic and chronostratigraphic); Concepts of magnetostratigraphy, chemostratigraphy, event stratigraphy, and sequence stratigraphy.

(14 Lectures)

#### Unit II:

##### Palaeontology

Scope of palaeontology; evolution of life through age; techniques in palaeontology for mega fossils, microfossils, nannofossils and ichnofossils – collection, identification and illustration; binomial nomenclature; species and species concept.

Invertebrate palaeontology – a brief study of morphology, classification, evolutionary trends and distribution of brachiopods, bivalves and gastropods, cephalopoda, echinoids and corals.

(14 Lectures)

#### Unit III:

Vertebrate Palaeontology: brief study of vertebrate life through ages. Evolution of reptiles and mammals including horse, elephant and man. Vertebrate fossil records of Siwaliks. A brief study on the Mesozoic reptiles of India.

Introduction to micropalaeontology, types of microfossils; palynology; foraminifera, ostracods, Radiolaria.

(14 Lectures)

#### Unit IV:

Use of palaeontological data in stratigraphy, palaeoecology, evolution, palaeoclimate and sea level changes; Principle of palaeobiogeography. Principles and applications of SEM, EDX and cathodeluminescence in palaeontological study.

Use of microfossils in interpretation of sea floor tectonism. Application of micropalaeontology in hydrocarbon exploration; oxygen and carbon stable isotopes studies of microfossils and their use in palaeoclimate interpretation.

(14 Lectures)

#### Suggested readings:

1. Principles of sedimentology & stratigraphy by Sam Boggs Jr, 5<sup>th</sup> edition, 2011, Prentice Hall, ISBN-13: 978-0321643186.
2. Fundamentals of historical geology and stratigraphy of India by Ravindra Kumar, 1998, New Age publisher, ISBN-13: 978-0852267455.
3. Invertebrate Palaeontology & Evolution 4th Edition by Euan Clarkson, N.K. Clarkson Euan, 4<sup>th</sup>

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edition, 1998, Wiley-Blackwell; ISBN-13: 978-0632052387.

4. Vertebrate Palaeontology, by Michael Benton, 3<sup>rd</sup> edition, 2004, Wiley-Blackwell, ISBN: 9780632056378.
5. Microfossils, by Howard A. Armstrong, Martin D. Brasier, 2<sup>nd</sup> edition, Blackwell Publishing Ltd., ISBN: 9780632052790.

**Further readings:**

6. Sedimentology and stratigraphy by Gary Nichols, 2<sup>nd</sup> edition, 2009, Wiley-Blackwell, ISBN: 978-1-4051-3592-4
7. Geology of India by Ramakrishnan M. and Vaidyanathan R., 2008, Geological Society of India, Bangalore, Vol. 1 & 2, ISBN No: 978-81-85867-98-4.
8. Principles of Sequence Stratigraphy by O. Catuneanu 1<sup>st</sup> edition, 2006, Elsevier Science, ISBN :9780444515681
9. Geology of India and Burma by M. S. Krishnan, 6<sup>th</sup> edition, 2009, CBS Publisher; ISBN-13: 978-8123900124
10. Principles of Paleontology by Michael Foote, Arnold I. Miller, W. H. Freeman; 3<sup>rd</sup> edition, 2006, ISBN-13: 978-0716706137
11. Bringing Fossils to Life: An Introduction to Paleobiology, by Donald R. Prothero, 2<sup>nd</sup> edition, 2003, McGraw-Hill Higher Education; ISBN-10: 0073661708
12. Principles of Invertebrate Paleontology by N. Shrock, 2<sup>nd</sup> edition, 2005, CBS Publisher; ISBN-13: 978-8123912189
13. Paleontology Invertebrate by Henry Wood, 8<sup>th</sup> edition, 2004, CBS Publication ISBN: 9788123-910802.

**Course Title: Sedimentology**

L	T	P	Cr	Marks
4	1	-	4	100

**Course Code: EGS. 504**

**Unit I**

Origin of terrigenous clastic and non-clastic grains; weathering and its products; chemical weathering of granite and basalt, submarine weathering. Major carbonate minerals; carbonate grains of biological origin. Simple fluid flow concepts and sediment transport; sediment gravity flows and their deposits.

(14 Lectures)

**Unit II**

Important bed forms and sedimentary structures – their genesis and stratigraphic significance. Application of sedimentary structures in palaeocurrent analysis; evolution and classification of sedimentary basins: tectonic and sedimentation; major sedimentary basins of India.

(14 Lectures)

**Unit III:**

Grain size, textural parameters and their significance. Textural and compositional maturity. Petrography and origin of sandstones, limestones and mudrocks. Sedimentary facies, methods of their analysis and

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interpretation of depositional environments. Processes and characteristics of aeolian, fluvial, barrier-beach, tidal-flats and deep sea environments. (14 Lectures)

**Unit IV:**

Diagenesis of clastic and non-clastic rocks; Stages and processes of diagenesis, compaction and cementation by silica, carbonate and iron-oxide, dolomitization. Heavy minerals and their importance in determination of provenance. (14 Lectures)

**Suggested readings:**

1. Principles of sedimentology & stratigraphy by Sam Boggs Jr, 5<sup>th</sup> edition, 2011, Prentice Hall, ISBN-13: 978-0321643186.
2. Sedimentary Geology, by Donald R. Prothero, Fred Schwab, W. H. Freeman; 3<sup>rd</sup> edition, 2013, ISBN-13: 978-1429231558.
3. Carbonate Sedimentology by M. E. Tucker and V.P. Wright, 1991, Wiley Publisher, ISBN 0632014725, 9780632014729.

**Further readings:**

4. Sedimentology and stratigraphy by Gary Nichols, 2<sup>nd</sup> edition, 2009, Wiley-Blackwell, ISBN: 978-1-4051-3592-4.
5. Sedimentary Environments: Processes, Facies and Stratigraphy by H.G. Reading, 3<sup>rd</sup> edition, 1996, Wiley-Blackwell.
6. Atlas of Sedimentary Rocks Under the Microscope by A. E. Adams, W. S. MacKenzie, C. Guilford, 1<sup>st</sup> edition, 1984, Prentice Hall, ISBN-13: 978-0582301184.
7. Sedimentary Rocks in the Field: A Practical Guide (Geological Field Guide), by Maurice E. Tucker, 4<sup>th</sup> edition, 2011, Wiley-Blackwell; ISBN-13: 978-0470689165.
8. Principles of Sedimentary Basin Analysis by Miall, A.D., 2000, Springer-Verlag.
9. Sedimentary Basins by Einsele, G., 1992. Springer Verlag.
10. Depositional Sedimentary Environments by Reineck, H.E. and Singh, I.B., 1980, Springer-Verlag.
11. Introduction to Sedimentology by Sengupta, S., 1997, Oxford-IBH

**Course Title: Geomorphology and Geotectonic**  
**Course Code: EGS. 511**

L	T	P	Cr	Marks
4	1	-	4	100

**Unit I**

Development in geomorphology, Historical and process geomorphology, The geomorphic systems, Geomorphic materials and process: weathering, sediment production, pedogenesis, mass movement, erosion, transportation and deposition, landforms in relation to climate, rock type, structure and tectonics. (10 Lectures)



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**Unit II:**

Geomorphic processes and landforms – fluvial, glacial, aeolian, coastal and karst. River forms and processes – stream flow, stage-discharge relationship; hydrographs and flood frequency analysis, Submarine relief, Environmental change– causes, effects on processes and landforms. Extra-terrestrial geomorphology. (16 Lectures)

**Unit III:**

Physiography, drainage, climate, soils and natural resources of the Himalaya, Ganga Brahmaputra plains, and peninsular India, climate zones of India. Geomorphology and topographic analysis including DEM, topographical maps, map reading, geomorphic mapping, slope analysis and drainage basin analysis, applications of geomorphology in mineral prospecting, civil engineering, hydrology and environmental studies. (14 Lectures)

**Unit IV:**

Planetary evolution of the earth and its internal structure. Heterogeneity of the earth's crust. Major tectonic features of the oceanic and continental crust. Seafloor spreading and plate tectonics. Island arcs, Oceanic islands and volcanic arcs. Continental drift — geological and geophysical evidence, mechanics, objections, present status. Gravity and magnetic anomalies at mid-oceanic ridges, deep sea trenches, continental shield areas and mountain chains. Isostasy, orogeny and epiorogeny. Seismic belts of the earth. Seismicity and plate movements. Geodynamics of the Indian plate. (16 Lectures)

**Suggested readings:**

1. Principles of Geomorphology by W.D. Thornbury, 2<sup>nd</sup> edition, 2004, CBS publisher, ISBN-13: 978-8123908113
2. Global Tectonics by Philip Kearey, Keith A. Klepeis, Frederick J. Vine, 3<sup>rd</sup> edition, 2009, Wiley-Blackwell, ISBN-10: 1405107774
3. Fundamental of Geomorphology by Richard John Huggett, 2<sup>nd</sup> edition, 2007, Taylor & Francis, ISBN 978-0-415-39084-2

**Further readings:**

4. Geological Field Techniques by Angela L. Coe (edt), 2010, Wiley-Blackwell, ISBN-13: 978-1444330618
5. Basic Geological Mapping (Geological Field Guide), by Richard J. Lisle, Peter Brabham, John W. Barnes, Wiley-Blackwell; 5<sup>th</sup> edition, 2011, ISBN-13: 978-0470686348
6. Geomorphology and Global Tectonics, Michael A. Summerfield (Editor), 2000, Wiley, ISBN: 978-0-471-97193-1,
7. Principles of Physical Geology by Holmes, and edited by P. McL. D. Duff. 4<sup>th</sup> edition, 1993, Chapman and Hall, London.
8. Applied Geomorphology: Theory and Practice, by R. J. Allison, 1<sup>st</sup> edition, 2002, Wiley.
9. Tectonic Geomorphology by Douglas W. Burbank, Robert S. Anderson, Wiley-Blackwell; 2<sup>nd</sup> edition, 2011, ISBN-13: 978-1444338867

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10. Geomorphology: The Mechanics and Chemistry of Landscapes by Robert S. Anderson, Suzanne P. Anderson, Cambridge University Press; 1<sup>st</sup> edition, 2010, ISBN-13: 978 0521519786
11. Key Concepts in Geomorphology, by Paul R. Bierman, David R. Montgomery, W. H. Freeman, 2013, ISBN-13: 978-1429238601
12. Indian Geomorphology by H.S. Sharma, 1991, Concept Publishing Co. New Delhi., ISBN: 817022344X
13. Textbook of Physical Geology by G.B. Mahapatra, CBS; 1<sup>st</sup> edition, 2008, ISBN-13: 978-8123901107
14. Plate Tectonics and Crustal Evolution by Condie, Kent. C., 4<sup>th</sup> edition, 1997, Butterworth-Heinemann, ISBN-10: 0750633867

**Course Title: Lab- I**  
**(Mineralogy and Crystallography)**

**Course Code: EGS. 505**

L	T	P	Cr	Marks
-	-	4	2	<b>50</b>

### Unit I

#### Mineralogy and crystallography

Identification of rock-forming minerals in hand specimens. Introduction to crystal models, Goniometer and its use in measuring interfacial angle of crystals and calculation of axial ratio. Representation of symmetry elements of crystals belonging to 32 classes of symmetry and study of their stereograms. Analysis of XRD spectrum.

### Unit II:

#### Optical Mineralogy

Determination of length fast and length-slow characters of minerals. Determination of order of interference colours. Scheme of pleochroism and absorption of a given mineral in thin section. Determination of extinction angle and composition of plagioclase. Study of interference figures of uniaxial and biaxial crystals, determination of optic signs.

#### Suggested readings:

1. Minerals and Rocks-Exercises in Crystallography, Mineralogy and Hand Specimen Petrology by Cornelius Klein, 3<sup>rd</sup> Edition (2007) Wiley.
2. Mineralogy by Perkins Dexter, 3<sup>rd</sup> Edition (2012), Pearson Education, ISBN-13: 978-8120345089.
3. Dana's Textbook of Mineralogy (With Extended Treatise on Crystallography and Physical Mineralogy), by William E. Ford, 4<sup>th</sup> Edition, (2006), CBS Publishers & Distributors Pvt. Ltd., ISBN 10: 8123908091.

#### Further readings:

1. Mineralogy and Optical Mineralogy by Dyar MD, Gunter ME, Tasa D (2008), Mineralogical Society of America, ISBN 978-0-939950-81-2.

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2. Optical Crystallography, by Bloss, (1999), Mineralogical Society of America.
3. Crystallography and Crystal Chemistry by Bloss: (1994), Mineralogical Society of America.
4. Introduction to Mineralogy by William Nesse, 2<sup>nd</sup> Edition, (2011), Oxford University Press, ISBN: 9780199827381.
5. Introduction to Optical Mineralogy by William Nesse, 4<sup>th</sup> Edition, 2012, Oxford University Press, ISBN: 9780199846276.
6. Mineralogy by Berry, L.G., Mason, B. and Dietrich, R.V., 2004, CBS Publishers, ISBN 10: 8123911483, ISBN 13: 9788123911489.
7. Introduction to the Rock-Forming Minerals by W.A. Deer, R.A. Howie and J. Zussman, 3<sup>rd</sup> Edition (2013) Mineralogical Society of America.
8. Rutley's Elements of Mineralogy, by Gribble, 27<sup>th</sup> Edition (2005), CBS Publishers, ISBN-10: 8123909160.

L	T	P	Cr	Marks
-	-	4	2	<b>50</b>

**Course Title: Lab- II (Sedimentology and Paleontology)**

**Course Code: EGS. 506**

**Unit I:**

Study of clastic and non-clastic rocks in hand specimens. Microscopic examination of important rock-types. Grain-size analysis by sieving method: plotting of size-distribution data as frequency and cumulative curves; Computation of statistical parameters and interpretation. Heavy mineral separation; their Microscopic characters, graphic representation and interpretation. Assemblages of sedimentary structures and their paleo-environmental significance. Paleo-current analysis. Study of vertical profile sections of some selected sedimentary environment.

**Unit II:**

Construction of rank charts for lithostratigraphy, biostratigraphy & chronostratigraphy. Construction of graphical logs for text descriptions. Exercises in correlation from given data or logs. Study of morphology of brachiopods, bivalves and gastropods, cephalopods, echinoids. Separation, processing, wet sieve analyses, preparation of slides of microfossils (demonstration only). Morphology and morphological descriptions of planktonic & benthonic foraminifera, ostracods. Morphology of radiolaria, diatoms, pollen and spores. Construction of range charts.

**Suggested readings:**

1. Atlas of Sedimentary Rocks Under the Microscope by A. E. Adams, W. S. MacKenzie, C. Guilford, 1<sup>st</sup> Edition (1984), Prentice Hall, ISBN-13: 978-0582301184.
2. Principles of Invertebrate Paleontology by N. Shrock, 2<sup>nd</sup> Edition (2005), CBS; ISBN-13: 978-8123912189.

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3. A Practical approach to Sedimentology by Roy C. Lindholm, 1987, Allen and Unwin, London.
4. Microfossils by M.D. Braiser, 1980, Geogрге Allen and Unwin, ISBN 10: 0045620024

**Further readings:**

5. Elements of Micropaleontology by G. Bignot; 1985, Grahm and Trottmann, London.
6. Introduction to Marine Micropaleontology, by Haq and Boersma, 1978, Elsevier.
7. Systematics & Fossil Record – Documenting Evolutionary Patterns by Smith, A.B. (1994), Blackwell publisher.
8. Micropaleontology in Petroleum exploration by R.W. Jones, 1996, Clarendon Press Oxford.
9. Paleontology Invertebrate by Henry Wood , 8<sup>th</sup> Edition, 2004, CBS Publication ISBN: 9788123-910802.
10. Introduction to Sedimentology by Sengupta, S., 1997, Oxford-IBH.

**Course Title: Computer applications**  
**Course Code: EGS 507**

L	T	P	Cr	Marks
2	-	-	2	50

**Unit I: Fundamentals of Computers**

Block Diagram of Computer, Hardware Components, Introduction to computer network and World Wide Web, Sharing Data over Network, Computer Configuration, Memory Hierarchy, Software Structure. (7 Lectures)

**Unit II:**

Introduction to MS Paint, Notepad and Word, Introduction to Word Processing and Microsoft Office, Creating and Saving Documents, Text Formatting, Tables, Document Review Option, Mail Merge, Inserting Table of Contents, Reference Management. (7 Lectures)

**Unit III:**

Spreadsheet applications, Presentation applications, Internet browsers and Image processing applications. (7 Lectures)

**Unit IV:**

Application of Coral Draw, Sigma plot, Surfer software's, Map info, Google terrain image in geology. Use of GW kit, GCD kit, Rock ware and NORM calculation using spread sheet. (7 Lectures)

**Suggested readings:**

1. Gookin, D. (2007). MS Word for Dummies. Wiley.
2. Harvey, G. (2007). MS Excel for Dummies. Wiley
3. Sinha, P.K., Computer Fundamentals, BPB Publications

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**Semester II**

**Course Title: Geochemistry and Isotope Geology**

L	T	P	Cr	Marks
4	1	-	4	100

**Course Code: EGS. 511**

**Unit I**

**Geochemistry**

Introduction of geochemistry and cosmochemistry. Abundance of elements in the solar system and chemical composition and properties of Earth's layers. Atmosphere: its layers, chemical composition and evolution of atmosphere. Meteorites, classification, mineralogy, origin, significance and phenomena of fall. (10 Lectures)

**Unit II:**

Geochemical classification of elements. Periodic table with special reference to rare earth elements and transition elements. Principles of ionic substitution in minerals; Geochemistry of uranium and lithium. Elemental mobility in surface environment. Concept of geochemical-biogeochemical cycling: Minor cycle and major cycle. (14 Lectures)

**Unit III:**

**Isotope Geology**

Introduction and physics of the nucleus; radioactive decay; the law of radioactive decay; review of mineral structure; principles of mass spectrometry; K-Ar method: principles, methods and applications; Ar-Ar method: principles, method and advantages; Rb-Sr method: principles, Rb-Sr isochron and limitations. Sm-Nd Method: decay scheme, evolution of Nd with time, Nd model ages and application of Nd to petrogenesis; U-Th-Pb Method: decay schemes, U-Pb isochron, U-Pb mineral dating and application. (20 Lectures)

**Unit IV:**

Stable isotopes and their fractionation; ratio Mass Spectrometry; principles of oxygen, carbon and sulphur isotope geochemistry and their application in Geology. Application of Cosmogenic radionuclide's in the geosciences. Principles and application of Fission Track and Radiocarbon methods of dating. (12 Lectures)

**Suggested readings:**

1. Principles and applications of Geochemistry by Gunter Faure, 2<sup>nd</sup> Edition, 1998, Prentice Hall.
2. Essentials of Geochemistry by John V. Walther, 2010, Jones and Bartlett Publication.
3. Isotope Geology by Claude Allegre, 2008, Cambridge University Press.
4. Radiogenic Isotope Geology by A.P. Dickin, 2005, Cambridge University Press.
5. Stable Isotope Geochemistry by Jochen Hoefs, 7<sup>th</sup> Edition 2015, Springer International Publishing.

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**Further readings:**

6. Geochemistry: Pathways and Processes by H.Y. McSween Jr., S.M. Richardson and M. E. Uhle, 2003, Columbia University Press,
7. Geochemistry, An introduction by Francis Albarede, 2003, Cambridge University Press.
8. Principles of Isotope Geology by Gunter Faure, 2<sup>nd</sup> edition, 1986, Wiley.
9. Isotopes: Principles and Applications by Gunter Faure and Teresa M. Mensing, 3<sup>rd</sup> edition, 2004, Wiley
10. Geochemistry by William M. White; 1<sup>st</sup> edition, 2013, Wiley-Blackwell.
11. Introduction to Geochemistry by Mason, B. and Moore, C.B., 1991, Wiley Eastern.
12. Introduction to Geochemistry by Krauskopf K. B., 1967, McGraw Hill.

**Course Title: Igneous and Metamorphic  
Petrology**

L	T	P	Cr	Marks
4	1	-	4	100

**Course Code: EGS. 512**

**Unit I**

Magma: nature of magma, factors affecting magma and evolution, melting of mantle. Generation of magmas in different tectonic environments. The phase equilibrium of binary (Ab-An, Ab-Or, Di-An, Fo-Si) and ternary (Di-Ab-An, Di-Fo-Si, Di-Fo-An, Ne-Ks-Si, Fo-An-Si) systems and its relation to magma genesis and crystallization in the recent experimental works.

(14 Lectures)

**Unit II:**

Interpretation of igneous textures in terms of rate of nucleation and crystal growth. IUGS classification of the Igneous rocks. CIPW Norm. Petrology and petrogenesis of ultramafic, basaltic, granitic, alkaline igneous rocks including ophiolite, carbonatite, nephelinite-ijolite, lamproites, and layered igneous rocks with Indian examples. Plume magmatism and hot spots. Mantle metasomatism. Mantle heterogeneities. Partial melting (batch and fractional melting), crystal fractionation [equilibrium and fractional (Rayleigh) crystallization], contamination (AFC process) and dynamic melting.

(14 Lectures)

**Unit III:**

Mineralogical phase rule for closed and open systems. Nature of metamorphic reactions, concept and classification of metamorphic facies, Introduction to ultrahigh temperature and ultrahigh pressure metamorphism, description of each facies of low – Pressure, medium to high – pressure and very high pressure with special reference to characteristic minerals, subdivision into zones/sub-facies, Mineral assemblages, Metamorphic reactions and pressure – temperature conditions of metamorphism.

(14 Lectures)

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**Unit IV:**

Isograds and reaction isograds, Schrienemakers rule and construction of petrogenetic grids, Metamorphic differentiation, anatexis and origin of migmatites in the light of experimental studies, Regional metamorphism and paired metamorphic belts with reference to the theory of plate tectonics, Pressure – temperature – time paths. (14 Lectures)

**Suggested readings:**

1. An introduction to Igneous and Metamorphic Petrology by Winter J.D., 2001, Prentice Hall.
2. Principles of Igneous and Metamorphic Petrology by Philpotts, A.R. 1994, Prentice Hall.
3. The Interpretation of Igneous Rocks by Cox, K.G., Bell, J.D. and Pankhurst, R.J., 1993, Chapman & Hall, London.
4. Igneous and Metamorphic Petrology by Turner F. J., and Verhoogen J., 2<sup>nd</sup> edition, 1987, CBS.

**Further readings:**

5. Igneous and Metamorphic Petrology by Best, Myron G., 2002. Blackwell Science.
6. Origin of Igneous Rocks – The Isotopic Evidence by Faure, G., 2001, Springer.
7. Igneous Petrology by Hall A., 1997, Longman.
8. Igneous Rocks: A Classification and Glossary of Terms by LeMaitre, R.W., 2002, Cambridge University Press.
9. Igneous Petrology by McBirney, 1994, CBS Publishers, Delhi.
10. Modern Igneous Petrology by Sood M. K., 1982, Wiley-Interscience Publ., New York.
11. Magmatism in Relation to Diverse Tectonic Settings by Srivastava Rajesh K., Chandra R. & Balkema A.A., 1997, Oxford University Press.
12. Petrogenesis of Metamorphic Rocks by Bucher, K. and Martin, F. 7<sup>th</sup> Edition, 2002, Springer – Verlag.
13. An introduction to Metamorphic Petrology by Yardley, B.W.D., 1989, Longman Scientific & Technical, New York.
14. Mineralogical Phase Equilibria and pressure – temperature – time Paths by Spear, F. S. 1993, Mineralogical Society of America.
15. Equilibrium thermodynamics in Petrology: An Introduction by Powell, R. 1978, Harper & Row Publishers, London.
16. Igneous Petrology by Bose, M.K., 1997, World Press, Kolkata.

**Course Title: Structural Geology**

**Course Code: EGS. 513**

L	T	P	Cr	Marks
4	1	-	4	<b>100</b>

**Unit I**

Stress and analysis of stress in two and three dimension. Plane stress analysis and Mohr stress circle, and its relationship with faulting and fracture mechanics. Mechanical principle, properties of rocks and their controlling factors. Theory of rock failure: brittle failure – shear and tensile failures. Role of fluid

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pressure and effective pressure in brittle failure.

Strain and analysis of strain – finite and infinitesimal, homogeneous and inhomogeneous strains. General transformations and graphic representation of two and three dimensional strains. Strain and deformation paths. Determination of strain in naturally deformed rocks. (14 Lectures)

**Unit II:**

Description and geometric classification of folds. Mechanics of folding. Fold development and distribution of strains in folds. Brittle and ductile shear zones, Geometry and products of shear zones, Mylonites and Cataclasites; buckling of single layer, multilayer and anisotropic materials. Analysis and interpretation of superimposed folding. Fault bent folds, gravity induced structures and salt diapirism. (14 Lectures)

**Unit III:**

Planar and linear fabrics (Foliation and Lineation) in deformed rocks: description, classification, genesis and significance. Basic idea about petrofabrics and use of Universal stage. Stereographic and equal area projections for representing different types of fabrics,  $\pi$  and  $\beta$  diagrams. Non-diastrorphic structures: significance in the study and analysis of deformed rocks. (14 Lectures)

**Unit IV:**

Description and classification of faults and joints. Mechanics of faulting and jointing, and stress conditions for thrust, normal and strike-slip faults. Mechanics and geometric aspects of thrust, normal and strike-slip faults, and associated structural features. Thin-skinned deformation; Decollement. Geometrical analysis of simple and complex structures on macroscopic scale. Identification of top and bottom of the strata/rock. (14 Lectures)

**Suggested readings:**

1. Structural Geology by Marland P Billings, 3rd Edition, 2000, Phi Learning, ISBN-10-81203 00599
2. Structural Geology by Robert J. Twiss, Eldridge M. Moores, 2<sup>nd</sup> Edition 2006, W. H. Freeman publisher, ISBN-10: 0716749513
3. Structural Geology by Haakon Fossen, 1<sup>st</sup> Edition 2010, Cambridge University Press
4. Structural Geology: An Introduction to Geometrical Techniques by Donal M. Ragan 4<sup>th</sup> Edition, 2009, Cambridge University Press.

**Further readings:**

1. Techniques of Modern Structural Geology. Vol. I. Strain Analysis by Ramsay, J.G. and Huber, M.I., 1983, Academic Press.
2. Techniques of Modern Structural Geology. Vol. II. Folds and Fractures by Ramsay, J.G. and Huber, M.I., 1987, Academic Press.
3. Folding and fracturing of rocks by Ramsay, J.G., 1967, McGraw Hill.
4. Basic Methods of Structural Geology by Stephen Marshak and Gautam Mitra. 1988, Prentice Hall.



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5. An outline of Structural Geology by Hobbs, B.E., Means, W.D. and Williams, P.F., 1976, John Wiley and Sons. New York.
6. Structural Geology: Fundamental and Modern Developments by Ghosh, S.K., 1993, Pergamon Press.

**Course Title: Lab- III (Igneous and Metamorphic Petrology)**

L	T	P	Cr	Marks
-	-	4	2	<b>50</b>

**Course Code: EGS. 514**

**Unit I**

Rock analyses (rapid method of silicate analysis) and FeO determination by titration method. Determination of Loss on Ignition (LOI) of rock samples. Preparation of classificatory and variation diagrams and their interpretation. Study of non-silicate minerals and elements. Megascopic and microscopic study of different igneous rocks. Calculation of CIPW Norms.

**Unit II:**

A detailed study of textures in Rock Sections with reference to time relations between the phases of deformation and recrystallization of minerals, Calculation of ACF, AKF and AFM values from chemical and structural formulation of minerals and their graphical representation. Study of Metamorphic Rocks in hand specimens and thin sections belonging to different facies with emphasis on texture/structure, mineral composition, parent rock, metamorphic facies/subfacies/zone to which the rock can be assigned and graphical representation of the assemblage in ACF, AKF and AFM diagrams.

**Suggested readings:**

1. Igneous Rocks: A Classification and Glossary of Terms by LeMaitre, R.W., 2002, Cambridge University Press.
2. An introduction to Igneous and Metamorphic Petrology by Winter, J.D., 2001, Prentice Hall.
3. Principles of Igneous and Metamorphic Petrology by Philpotts, A.R. 1994, Prentice Hall.
4. The Interpretation of Igneous Rocks by Cox, K.G., Bell, J.D. and Pankhurst, R.J., 1993, Chapman & Hall, London.

**Course Title: Lab- IV (Structural Geology)**

L	T	P	Cr	Marks
-	-	4	2	<b>50</b>

**Course Code: EGS. 515**

**Unit I**

Preparation and interpretation of Geological maps and sections. Structural problems based on orthographic and stereographic projections, concerning economic deposit. Recording and plotting of the field data

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**Unit II:**

Study of the hand specimen of deformed structures, Strain estimation from the data already collected from the field. Study of dip-isogons from the fold profiles.

**Suggested readings:**

1. Basic Methods of Structural Geology by Stephen Marshak and Gautam Mitra. 1988, Prentice Hall.
2. Structural Geology: Fundamental and Modern Developments by Ghosh, S.K., 1993, Pergamon Press.
3. Techniques of Modern Structural Geology. Vol. II. Folds and Fractures by Ramsay, J.G. and Huber, M.I., 1987, Academic Press.

**Course Title: Basic Statistics**

**Course Code:** EGS. 518

L	T	P	Cr	Marks
2	-	-	2	50

**Unit I**

Descriptive Statistics: Meaning, need and importance of statistics. Attributes and variables. Measurement and measurement scales. Collection and tabulation of data. Diagrammatic representation of frequency distribution: histogram, frequency polygon, frequency curve, ogives, stem and leaf plot, pie chart. (8 Lectures)

**Unit II:**

Measures of central tendency, dispersion (including box and whisker plot), skewness and kurtosis. Data on two attributes, independence and association of attributes in 2x2 tables. Linear regression and correlation (Karl Pearson's and Spearman's) and residual plots. (6 Lectures)

**Unit III:**

Random experiments, sample spaces (finite and infinite), events, algebra of events, three basic approaches to probability, combinatorial problems. Axiomatic approach to probability. Product sample spaces, conditional probability, Bayes' formula. (8 Lectures)

**Unit IV:**

Correlation and Regression analysis, rank correlation coefficients, curve fitting. (6 Lectures)

**Suggested readings:**

1. Understanding Basic Statistics by Charles Henry Brase & Corrinne Pellillo Brase, 2013, 6<sup>th</sup> edition, Brooks/Cole, Cengage Learning, USA.
2. Introductory Probability and Statistical Applications by P.L. Meyer, 1975, Oxford & IBH Pub.
3. Introduction to mathematical statistics by Hogg, R.V. & Raise, A.T., 1978, Macmillan Pub. Co. Inc.
4. Applied General Statistics by Croxton, F.E. & Cowden, D.J., 1975, Prentice-Hall Inc.
5. Introduction to Mathematical Statistics by Hoel, P.G., 1997, John Wiley & Sons, Inc.

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**Elective Course: Select any one**

**Course Title: Natural Resource Management**

L	T	P	Cr	Marks
2	-	-	2	50

**Course Code: EGS. 521**

**Unit I**

Natural resources: Definition; Resource and Reserve; Classification of natural resources; natural resource degradation and conservation; Environmental impacts of resource depletion.

(07 Lectures)

**Unit II:**

Forest Resources: Forest cover of India and world; forest types, functions of forest – production and protection; Conservation of forests; forestry programmes – social forestry, farm forestry, urban forestry, community forestry; deforestation; Exploitation of forest resources; Afforestation; Desertification; Forest policy.

(07 Lectures)

**Unit III:**

Water Resources: Surface, ground water, marine and brackish water resources - assessment and utilization; Rivers and Lakes in India; hydrological cycle; Ground water depletion; Water logging and salinity; Water Conservation and management techniques; Rain water harvesting; Watershed management; Eutrophication; Restoration of Lakes; River cleaning, River action plans - Ganga and Yamuna action plan, Interlinking of rivers; conflicts over water.

(07 Lectures)

**Unit IV:**

Land resources: Land degradation due to mining, exploration, industrialization, irrigation and natural disasters; Soil Erosion, Loss of soil fertility, Restoration of soil Fertility, Soil Conservation Methods; restoration of degraded land; Wasteland reclamation, Organic farming, green manuring, Wetland – definition, classification, functions, ecological importance and conservation.

(07 Lectures)

**Suggested readings:**

1. Environmental economics and natural resource management by Anderson, David A., 4<sup>th</sup> edition, 2013, Routledge.
2. Land resource management by Gurdev Singh and Vinod Ahuja, 1992, Oxford & IBH Pub. Co.
3. Natural resources and sustainable developments by Kathy Wilson Peacock, 2008, Facts on file Inc.
4. Sustainable natural resource management for scientists and engineers by Lynch, Daniel R., 2009, Cambridge University press
5. Natural resources in 21<sup>st</sup> century by Jaidev Somesh, 2010, ABD Publisher
6. Essential Environmental Studies by S.N. Panday (Eds.), S.P. Misra (Eds.), 2008, CRC Press

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**Course Title: Oceanography**

L	T	P	Cr	Marks
2	-	-	2	<b>50</b>

**Course Code: EGS. 522**

**Unit I**

Origin and evolution of ocean basins; Palaeoceanography - Mesozoic, Palaeogene, and Neogene palaeoceans, sea-level fluctuations and their environmental response. Topographic features of the ocean floor; continental margin provinces, ocean basin provinces; coral reefs. Classification of marine sediments, sediment budget, sediment transport, accumulation of sediments in the ocean; sedimentation processes on continental shelves - physical processes, sediment response; sediment - organism interaction, deep-sea sediments. (7 Lectures)

**Unit II:**

Origin and evolution of the Indian Ocean, structure and physiography of the Indian Ocean, bathymetry and bottom characteristics, sediment distribution on the Indian Ocean floor. Marine exploration methods, direct methods and indirect methods; sea - bed deposits, oil and gas, petroleum potential of sea-bed provinces beyond the continental slope; petroleum occurrences and exploration activity around the margins of the Indian Ocean. India's Exclusive Economic Zone (EEZ); marine minerals in the EEZ of India. Wave dynamics, deep water waves, shallow water waves, wind waves; wave reflection, refraction and diffraction. (7 Lectures)

**Unit III:**

Ocean circulation: forces driving currents; surface currents – flow within a gyre, geostrophic gyres, current within gyres, counter currents and under currents, effects of surface currents on climate; thermohaline circulation - thermohaline circulation patterns, global heat connection. Wind induced vertical circulation - equatorial upwelling, coastal upwelling, downwelling; Coastal upwelling - its physical, chemical, biological characteristics, physical structure and dynamics, the chemical characteristics of upwelling systems, the biological characteristics of upwelling areas. Heat budget and Atmospheric Circulation- Composition and properties of the atmosphere, changes in the atmosphere, wind patterns, storms, jet streams, El Nino, land effects on winds. Tides - equilibrium theory of tides, dynamical theory of tides, tidal currents in coastal areas, observation and prediction of tides. (7 Lectures)

**Unit IV:**

Seawater chemistry - salinity, components of salinity, sources of ocean's salts, processes controlling the composition of sea water, determining salinity, dissolved gases - Nitrogen, Oxygen, Carbondioxide; Density structure of ocean, density stratification and water masses. Phytoplankton dynamics in the marine food web: inputs of organic carbon, concept of food chain; primary production, measuring productivity, factors limiting productivity-grazing pressure, losses to deep water, factors affecting growth rates - light, temperature, nutrients, physiological adaptations; application of remote sensing. Marine resources: Physical Resources - Petroleum and Natural Gas, sand and gravel, magnesium and magnesium compounds, salts, manganese and phosphate nodules, metallic sulfides and muds. (7 Lectures)

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**Suggested readings:**

1. Oceanography-An invitation to Marine Science by Garrison T., 1996, Wadsworth Publishing Company
2. Oceanography - A view of the Earth by Gross, M.G., 1972, Prentice-Hall.
3. Introductory Oceanography by Thurman, B.Y., 1978, Charles E. Merrill Publishing Company

**Further readings:**

4. Principles of Oceanography by S. Davis, R.A. Jr. 1972, Addison - Wesley Publishing Company.
5. The Indian Ocean: Exploitable mineral and petroleum Resources by Roonwal, G.S., 1986, Narosa Publishing House.
6. Geological Oceanography: Evolution of coasts, continental margins & the deep-sea floor by Francis P Shepard, 1977, Pan Publication.
7. Oceanography – Exploring the planet Ocean by Bhatt J. J., 1978, D. van Nostrand Company.

**Course Title: Watershed Management**

L	T	P	Cr	Marks
2	-	-	2	50

**Course Code: EGS. 523**

**Unit I**

Structure and relief, physiographic divisions, drainage systems and watersheds. Concept of watershed resource management, problems, approach and components. (7 Lectures)

**Unit II:**

Concept of small dams waste disposal practices and management; rainwater harvesting; Wetland and concept of Micro Watershed Management; Watershed Management using Geo-spatial technologies (14 Lectures)

**Unit III:**

Community participation, private sector participation; Watershed Management in India; Watershed management policies and decision making. (7 Lectures)

**Suggested readings**

1. Watershed Management in India by Murthy, K.S. 1998. 3<sup>rd</sup> Edition, Wiely Eastern Ltd. / New Age International Ltd.
2. Watershed Management: Guidelines for Indian Conditions by Tideman, E.M., 1996, Omega, New Delhi.
3. Water of Hope: Integrated Water Resource Development and Regional Co-operation within the Himalayan-Ganga-Brahamaputra-Barak Basin by Verghese, B.G., 1990, Oxford-IBH.

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**Course Title: Environmental Geology and  
Natural Hazards**

L	T	P	Cr	Marks
2	-	-	2	50

**Course Code: EGS. 524**

### Unit I

**Introduction to Environmental Geology:** Fundamental concepts of environmental geosciences, its scope and necessity; Definition, structure, composition and general characteristics of lithosphere, hydrosphere, atmosphere and biosphere; Concept of ecology, ecosystem, its structure and functions, types of ecosystem; Biogeochemical cycles of carbon, nitrogen, phosphorus and sulfur; Physiography, drainage, climate, soils and natural resources- the Himalaya, Ganga-Brahmaputra Plains, and peninsular India; Precambrian shield, the Gondwana rift basins, Deccan Plateau. (7 Lectures)

### Unit II:

**Environmental issues:** Water pollution : types of water pollution, groundwater pollution sources, pathways and mechanism, attenuation processes, case histories of natural (arsenic and fluoride poisoning) and man-made water pollution; water logging, causes, effects and remedial measures, aquifers; declining groundwater tables, subsidence and compaction of aquifers ; Soil formation, classification and properties, Soil pollution- sources, causes and effects; Soil pollution control measures; Air pollution : definition, terminology, sources and classification of air pollutants; effects of air pollution- acid rain, green house effects and ozone layer depletion; Air pollution control and management. (7 Lectures)

### Unit III:

**Introduction to Disasters:** Introduction to Natural and Manmade Disasters; Dimensions of Natural and Anthropogenic Disasters; Floods –nature and frequency of flooding, flood hazards, urbanization and flooding, flood hydrographs, Dams barrages and river diversions; Landslides; Coastal hazards – tropical cyclone, coastal erosion, sea level changes, coastal zone management; Earth quakes - Seismic waves, quake resistant buildings and dams; Tsunamis; Volcanoes; Wild fires; Oil spills; Urban hazards and disasters. (7 Lectures)

### Unit IV:

**Risk Assessment and Preparedness:** Pre-Disaster Management activities; Hazard and vulnerability analysis; Hazard zonation maps : preparation and utilization; capability assessment; emergency / contingency planning and post-disaster management activities; Development planning, planning environment, types of plans, MBO, SWOT analysis; Mitigation strategy : Relief measures, community health, casualty management Role of Government, Non-Governmental and media agencies, Reconstruction and Rehabilitation; Awareness through print and electronic media, involving youth in field observations. (7 Lectures)

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**Suggested readings:**

1. Environmental Geology by Barbar W. Murk et al., 1996, John Wiley & Sons, New York.
2. Introduction to Environmental Geology by Edward A. Keller, 5<sup>th</sup> Edition, 2011, Pearson Education publisher.
3. Environmental Geology by K. S. Valdiya, 2<sup>nd</sup> Edition, 2013, McGraw-Hill Education (India)
4. Disaster Management and Preparedness by Collins Larry R. and Schneid Thomas D., 2000, Taylor and Francis.

**Further readings:**

5. Earth Science and the Environment by Graham Thompson and Jon Turk, 4<sup>th</sup> Edition, 2007, Thomson and Brooks/cole.
6. Disaster Management by Goel S.L. and Kumar Ram, 2001, Deep and Deep Publications.
7. Living with Risk: A global review of disaster reduction initiatives, 2004 Vision, United Nations.
8. India Disasters Report: Towards a Policy Initiatives by Parasuraman S., 2004, Oxford University Press.

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**SEMESTER III**

**Course Title: Geophysics**

L	T	P	Cr	Marks
4	1	-	4	100

**Course Code: EGS. 601**

**Unit I**

Introduction to seismology, seismic body waves and ray theory, reflection and refraction seismology, Seismic surface waves, Earth velocity structure from seismograms, earth structure from crust to core, earthquake source theory, Determining earthquake source parameters, application of earthquake seismology to continental tectonics. (14 Lectures)

**Unit II:**

Geophysical fields: potential, electromagnetic and thermal; Review of scalar and vector fields; Inverse square law as a natural corollary of divergence free vector fields and their gradient driven flow equations: Diffusion, Fourier, Ohm's, Darcy's laws. Review of the magnetic induction field of electric current (Biot-Savart Law) and its potential analogous to dipolar magnetic charges. Laplace's, Poisson's, Diffusion and Wave equations, their solutions in rectangular and polar coordinates. (14 Lectures)

**Unit III:**

Basic boundary value problems with applications in delineating earth structure: electrical potential distribution produced on the earth's surface by a pair of grounded electrodes for a homogeneous half space of a given resistivity as well as those over a two-layer earth of different resistivity and a buried sphere, with applications to shallow earth exploration. Magnetic potentials and fields produced by a spherical magnetic ore body and a current carrying loop over a half space. (14 Lectures)

**Unit IV:**

Application of electromagnetic field theory to earth exploration using magneto-tellurics. Fourier Law and the heat flow equation with an internal heat source (radiogenic); Calculation of the equilibrium geotherm for a single layer crustal model. Heat flow measurements and oceanic and continental heat flows. Thermal structure of the lithosphere, mantle and the core. Geophysical signal analysis and inverse problem theory, Review of the elements of linear algebra and matrix inversion. Least squares, minimum norm and maximum likelihood estimators; singular value decomposition and regularization of solutions. Analysis of quality of solutions and role of Inverse theory in experiment design. (14 Lectures)

**Suggested readings:**

1. The Solid Earth: An Introduction to Global Geophysics by CMR Fowler, 2<sup>nd</sup> edition, 2005, Cambridge University Press.
2. Looking Into the Earth: An Introduction to Geological Geophysics By Alan E. Mussett, M. Aftab Khan, 2000, Cambridge University Press



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3. Principles of Applied Geophysics by D. S. Parasnis 4<sup>th</sup> edition, 1986, Chapman and Hall.

**Further readings:**

4. Introduction to Seismology, by Peter Shearer, 1999, Cambridge University Press, Cambridge.
5. Inverse Problem Theory and Model Parameter Estimation, by Albert Tarantola, 2005, SIAM.
6. Modern Global Seismology by Thorne Lay and Terry Wallace, 1995, Academic Press.

**Course Title: Ore Geology**

L	T	P	Cr	Marks
4	1	-	4	100

**Course Code: EGS.602**

**Unit I**

Modern concept of ore genesis; Concept of ore bearing fluids, their origin and mode of occurrence of ore bodies – morphology and relationship of host rock and Migration, Wall-rock alteration. Structural, physicochemical and stratigraphic controls of ore localization. Paragenesis, paragenetic sequence and zoning in metallic ore deposits. Spatial and temporal distribution of ore deposits – a global perspective. Earth's evolutionary history and evolutionary trends in ore deposits. Ore deposits in relation to plate tectonics. (14 Lectures)

**Unit II:**

Mineralogy, classification and genesis of petrological ore associations: Orthomagmatic ores of ultramafic-mafic association, ores of felsic-silicic igneous rocks: ores related to submarine volcanism, biochemical, chemical and clastic sedimentation; placers and residual concentration deposits. Ores of metamorphic affiliations. Principle of Fluid inclusions in ore: assumptions, limitations and applications. Geothermometry, geobarometry and isotope studies in ore geology. (14 Lectures)

**Unit III:**

A detailed study of ore minerals related to the following metals such as Fe, Mn, Cr, Cu, Pb, Zn, Al, Mg, Au, Sn, W, etc. with special reference to their mineralogy, genesis, uses in important industries and their distribution in India. Strategic, critical and essential minerals. Importance of minerals in national economy and national mineral policy. Mineral concessional rules of India. Law of the Sea. (14 Lectures)

**Unit IV:**

Fundamentals of coal petrology, peat, lignite, bituminous and anthracite coal. Microscopic constituents of coal. Indian coal deposits. Origin, migration and entrapment of natural hydrocarbons. Characters of source and reservoir rocks. Structural, stratigraphic and mixed traps. Techniques of exploration. Geographical and geological distributions of onshore and offshore petroliferous basins of India. Methods of petroleum exploration. Surface and subsurface exploration, gas hydrate and coal bed methane. Nuclear and Non-conventional source of energy, (14 Lectures)

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**Suggested readings:**

1. Introduction to Ore-forming processes by Robb L., 2005, Blackwell Publ., Oxford.
2. Ore geology and industrial minerals by Evans A. M., 1992, Blackwell Science.
3. Understanding mineral deposits by Misra K.C. 1999, Kluwer Academic Publishers.

**Further readings:**

4. Mineral economics by Sinha R. K. & Sharma N. L., 1970, Oxford & IBH.
5. Economic mineral deposits by Jensen M. L. & Bateman A. M., 1981, John Wiley & Sons.
6. Ore Petrology by Stanton R. L., 1972, McGraw Hill.
7. The Geology of Ore Deposits by Guilbert J. M. and Park, Jr. C. F., 1986, Freeman.
8. Ore Genesis – A Holistic Approach by Mookherjee A., 2000, Allied Publisher.
9. Hand Book of Stratabouond and Stratiform Ore Deposits by Wolf, K. H., 1976-1981, Elsevier.
10. Economic Geology and Geotectonics by Torling, D. H., 1981, Blackwell Sci. Publ.
11. Geochemistry of Hydrothermal Ore Deposits by Barnes, H. L., 1979, John Wiley:
12. Time and Strata Bound Ore Deposits by Klemm D. O. and Schneider H. J., 1977, Springer Verlag.

**Course Title: Remote Sensing and GIS in  
Geology**

L	T	P	Cr	Marks
4	1	-	4	100

**Course Code: EGS 603**

**Unit I**

**Remote sensing:** Fundamentals of Remote Sensing; Electromagnetic spectrum; Electromagnetic radiations; Spectral reflectance; Sensors; Active and passive remote sensing; Types of platform; Types of orbits (Geostationary, Polar, Sun-synchronous); Scanning Systems (Pushbroom and Whiskbroom); Types of Sensors; Data collection, Aerial Photography, Visual Image Interpretation, Digital image processing. (14 Lectures)

**Unit II:**

Introduction to Global Positioning System (GPS); Satellite remote sensing; Types of Satellites; Space Agencies in India; Global and Indian space missions. Different satellite exploration programs and their characteristics: LANDSAT, METEOSAT, MODIS, SPOT and IRS Satellite Series. Google Earth; Bhuvan; GPS; GAGAN. (14 Lectures)

**Unit III:**

**Concepts of GIS:** Elements of GIS; Map Projection; Data structures in GIS: Raster and Vector data; GIS softwares; Hierarchical, Network and relational data; Geo-relational and object oriented vector data structure; Vector and Raster based analysis; Overlays operations; Map algebra; Network Analysis; Spatial analysis. (14 Lectures)

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**Unit IV:**

**Applications of Remote Sensing and GIS in Geology:** Thermal Infra-red remote sensing in geological studies; microwave remote sensing for geological applications; Applications of remote sensing - identification of rocks, mineral explorations, geological surveys; alteration zones mapping; geomorphology applications, volcanic eruptions, surficial deposit / bedrock mapping; lithological mapping; structural mapping; sand and gravel (aggregate) exploration/ exploitation; hydrocarbon exploration; environmental geology; geobotany; sedimentation mapping and monitoring; event mapping and monitoring; geo-hazard mapping. (14 Lectures)

**Suggested readings:**

1. Remote sensing and image interpretation by Lillisand, T. M. and Keifer, R. W., 2007, John Willey and Sons, USA
2. Introduction to environmental remote sensing by Barrett, E. C. and Curtis L. F., 1999, Chapman and Hall Publishers, USA.
3. Fundamentals of remote sensing by Joseph G., 2003, Universities Press, Hyderabad.
4. Introduction to geographic information systems by Chang, Kang-taung, 2002, Tata McGraw-Hill, USA.

**Further readings:**

5. Environmental impact assessment: Practical solutions to recurrent problems by Lawrence, DP. 2003, John Wiley and Sons.
6. Methods of Environmental Impact Assessment by Morris, P, and Therivel R., 2001, Spoon Press.
7. Remote Sensing: Principles and Interpretation by Sabbins Jr, FF. 1986, WH Freeman & Co.
8. Aerial photography and Image Interpretation for Resource Management by Paine, D.P., 1981, John Wiley.
9. Principles and Applications of Photogeology by Pandey, S.N., 1987, Wiley Eastern, New Delhi.
10. Remote Sensing Geology, by Gupta, R.P., 1990, Springer Verlag.

**Course Title: Hydrogeology**

L	T	P	Cr	Marks
4	1	-	4	100

**Course Code: EGS. 604**

**Unit I**

**Hydrosphere and Groundwater exploration :** Hydrosphere – Evaporation, condensation, precipitation, interception, runoff (surface, subsurface and groundwater), infiltration; Scope and importance of Groundwater; Factors that affect occurrence of groundwater – Climate, topography, geology; Exploration techniques - Integrated approach to groundwater prospecting: Role of toposheets and Remote sensing in groundwater exploration; Hydrochemical methods: surface and subsurface Geophysical methods, Tracer techniques, Exploratory Borewell programme, use of computer software in exploration of groundwater. (14 Lectures)

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**Unit II:**

**Occurrence and distribution of Groundwater:** Vertical distribution of groundwater; Hydrologic properties of Rocks – Porosity, Hydraulic conductivity, Derivation of Darcys Law; Aquifers – Characteristics of unconfined and confined aquifers; Aquifer properties – Concepts of Transmissivity and Storativity; Behaviour of sedimentary, crystalline and volcanic rocks as aquifers – factors controlling hydrologic, aquifer properties and yield of wells in different rock types; Impact of drought and groundwater overexploitation on aquifers; Groundwater exploration and water pollution; Groundwater regimes in India. (14 Lectures)

**Unit III:**

**Groundwater flow and Pumping tests:** Principles of groundwater flow: concept of groundwater potential, validity of Darcy's law for laminar and turbulent flow – Tracing of groundwater movement with flow nets; Pumping tests – principles – types of pumping tests, procedures, concept of well hydraulics, determination of aquifer properties and well characteristics by simple graphical methods – significance of transmissivity and storativity data; Introduction to software in pumping tests. (14 Lectures)

**Unit IV:**

**Groundwater Recharge and Quality of groundwater:** Measurement of groundwater recharge; Artificial recharge techniques; surface water harvesting Techniques; structures for developing groundwater; Conjunctive use of surface and groundwater; Quality of groundwater – Geochemical processes in the groundwater, water types and water quality classification -Interaction of water with its ambient environment, Types of interaction: chemical, physical, kinetic; Assessment of groundwater quality; Use of software in water quality assessment; Fresh and salt-water relationships in coastal and inland areas; Seawater intrusion – Ghyben Herzberg relation – remedial measures; Groundwater provinces of India; Concept of groundwater legislation. (14 Lectures)

**Suggested readings:**

1. Groundwater Hydrology by Todd D.K., 2007, John Wiley and Sons
2. Modern Hydrology and Sustainable Water Development by S. K. Gupta, 2011, Wiley-Blackwell.
3. Groundwater Assessment Development and Management by Karanth K.R.,1987, McGraw Hill Publishers
4. Groundwater by Raghunath H.M. 1985, Wiley Eastern Ltd.
5. Groundwater by Freeze and Cherry, 1979, Prentice-Hall.

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**Course Title: LAB-IV (Ore geology and Geophysics)**

L	T	P	Cr	Marks
-	-	4	2	<b>50</b>

**Course Code: EGS. 605**

**Unit I:**

Megascopic study of Indian metallic ores and industrial minerals in hand specimens. Study of ore structures in hand specimens. Study of optical properties and identification of important ore minerals under ore-microscope. Preparation of maps showing distribution of metallic and industrial minerals in India and also classical world mineral deposits.

**Unit II:**

Location of A teleseismic earthquake. (*graphically*), Fault plane solution of an earthquake from teleseismic records. (*graphically*) Surface wave dispersion (*graphically*). Computational Geophysics problems : Spherical Earth distance, azimuth and backazimuth calculations (*computer*), Computing the focal/auxiliary plane geometry (*compute*r). Seismic wave propagation (*graphical*) problems: Seismic wave propagation in a layer over a halfspace with a horizontal interface, Seismic wave propagation in a layer over a halfspace with a dipping interface. Geophysical Inverse Problems: Earthquake epicentral location from travel time data (*computer*); Fissure Problem in AFAR (GPS measured displacement data) (*computer*); Travel Time tomography problem (*computer*).

**Suggested readings:**

1. Introduction to Seismology by Peter Shearer, 1999, Cambridge University Press.
2. Inverse Problem Theory and Model Parameter Estimation by Albert Tarantola, 2005, SIAM.
3. Mineral deposit evaluation by A.E. Annels, 1992, Chapman and Hall, London.
4. The Solid Earth: An Introduction to Global Geophysics by CMR Fowler, 2<sup>nd</sup> Edition, 2005, Cambridge University Press.
5. Ore geology and industrial minerals by Evans, A.M. 1992, Blackwell Science.

**Course Title: LAB-V (Hydrogeology and Remote Sensing)**

L	T	P	Cr	Marks
-	-	4	2	<b>50</b>

**Course Code: EGS. 606**

1. Determination of photo scale,
2. Determination of height of objects, dip of bed, slope and thickness of beds by Parallax bar.
3. Study of landforms and interpretation of lithology and structure from aerial photographs and satellite images
4. Identification of landforms on toposheets, aerial photographs and satellite images
5. Analysis of rainfall data

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6. Preparation of water level contour maps and their interpretation
7. Analysis of pumping test data by simple graphical methods for determination of aquifer and well characteristics
8. Plotting and analysis of hydrogeochemical data
9. Hydrogeological significance of morphometric parameters of a watershed

**Suggested readings:**

1. Groundwater Hydrology by Todd, D.K. 2007, John Wiley and Sons
2. Remote sensing and image interpretation by Lillisand, T. M. and Keifer, R. W., 2007, John Willey and Sons, USA

**ELECTIVE COURSES**

**Course Title: Petroleum Geology**

<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>	<b>Marks</b>
2	-	-	2	<b>50</b>

**Course Code: EGS. 621**

**Unit I**

**Occurrence and Source rocks:** Classification and composition of Petroleum; Physical properties of petroleum; Occurrence of petroleum; Nature of source rock, composition of biomass; Kerogen: Composition and types; Reservoir rocks, pore space and fluids; Reservoir Traps; Origin, migration and accumulation of petroleum. Basin Analysis. (14 Lectures)

**Unit II:**

**Indian Oil Fields- Prospecting and Drilling:** Oil bearing basins of India and the world; India's position as regards to petroleum and natural gas future prospects; Geophysical prospecting for petroleum; Drilling, logging and subsurface correlation. Importance of micropaleontology in the field of petroleum exploration. (14 Lectures)

**Suggested readings:**

1. Geology of Petroleum by Levenson, 2<sup>nd</sup> edition, 2006, CBS.
2. Elements of Petroleum Geology by Selley R.C., 1997, Atlantic publishers & distribution Pvt. Ltd, Delhi.
3. Geology of Petroleum by Emmons W. H., 2015, Sagwan press.

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**Further readings:**

4. Introduction to geophysical prospecting by Dobrin M. B. & Savit C. H., 4<sup>th</sup> edition, 1988, McGraw-Hill Inc.
5. An Introduction to Geophysical Exploration by Kearey P., Brooks M. and Hill I., 3<sup>rd</sup> edition, 2002, Wiley-Blackwell.
6. Principles of Applied Geophysics by D. S. Parasnis 4<sup>th</sup> edition, 1986, Chapman and Hall.
7. Geochemistry in mineral exploration by Hawkes H. E., Webb J. S., In eds., Croneis C., 2012, Literary Licensing, LLC.

**Course Title: Climatology**

L	T	P	Cr	Marks
2	-	-	2	50

**Course Code: EGS. 622**

**Unit I**

**Meteorology:** Fundamentals of meteorology, Scales of meteorology, Parameters of meteorology- pressure, wind, temperature, humidity, radiation; Radiations: Radiation laws, short wave and long wave radiations; Albedo; Emissivity; Radiation Budget of Earth; Application of meteorological principles to transport and diffusion of pollutants, Topographic effects. (14 Lectures)

**Unit II**

**Climatology:** The boundary layer; Inversion; Local microclimate; Greenhouse effect; Radiation balance; Precipitation; Atmospheric movements; Distribution of radiation; Rotation of earth- Coriolis acceleration, angular momentum; General meridional circulations: Hadley cells; Middle latitudes; Circulation of water and energy in atmosphere; Weather, and Climate in India; El Nino, La Nina, seasons and monsoons; Climatic classification schemes; Biogeographical regions of the world; Climate change-Emissions and Global warming, impact on sea level in south Asian region; Environmental disruptions and their implications; Indian climatology with special reference to seasonal distribution and variation of temperature, humidity, wind and precipitation; Agro-climatic zones of India. (14 Lectures)

**Suggested readings:**

1. Climatology, by Lal D. S., 2011, Sharda Pustak Bhavan.
2. General climatology by Critchfield H. J., 2009, PHI Learning, New Delhi.
3. Introduction to geomorphology by Kale, V. S. and Gupta, A., 2001, Orient Longman, Bangalore.
4. Physical geography by Singh S., 2011, Prayag Pustak Bhavan, Allahabad.
5. An introduction to physical geography by Strahler A.N. & Strahler, 1996, John Wiley & Sons, UK.

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**Course Title: Mineral Exploration and Mineral  
Economics**

<b>L</b>	<b>T</b>	<b>P</b>	<b>Cr</b>	<b>Marks</b>
2	-	-	2	<b>50</b>

**Course Code: EGS. 623**

**Unit I**

**Mineral Economics :** Distribution of mineral resources in India ; Magmatic, hydrothermal and surface processes of ore formation; Active ore-forming systems; Geological setting, characteristics, and genesis of ferrous, base and noble metals. Origin, migration and entrapment of petroleum; properties of source and reservoir rocks; structural, stratigraphic and combination traps; Petroliferous basins of India; Classification, rank and grading of coal; coal resources of India; Gas hydrates and coal bed methane.

(14 Lectures)

**Unit II:**

**Mineral Exploration Methods:** Geological, geophysical, geochemical and geobotanical methods of surface and sub-surface exploration on different scales; Sampling, assaying and evaluation of mineral deposits; methods of mineral deposit studies including ore microscopy, fluid inclusions and isotopic systematics; ores and metamorphism- cause and effect relationships; Methods of petroleum exploration.

(14 Lectures)

**Suggested readings:**

1. Mineral Exploration: Principles and Application by S. K. Haldar, 2013, Elsevier.
2. Introduction to Mineral Exploration by Moon C. J., Whateley M. K. G., and Evans, A.M., Blackwell Science.
3. Mineral deposits of India by Umathay R. M., 2007, Printasia.

**Further readings:**

4. Introduction to geophysical prospecting by Dobrin M. B. & Savit C. H., 4<sup>th</sup> edition, 1988, McGraw-Hill Inc.
5. An Introduction to Geophysical Exploration by Kearey P., Brooks M. and Hill I., 3<sup>rd</sup> edition, 2002, Wiley-Blackwell.
6. Geology of Petroleum by Leverson, 2<sup>nd</sup> edition, 2006, CBS.
7. Geochemistry in mineral exploration by Hawkes H. E., Webb J. S., In eds., Croneis C., 2012, Literary Licensing, LLC.



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**Course Title: Palaeobotany**

L	T	P	Cr	Marks
2	-	-	2	50

**Course Code: EGS. 624**

**Unit I**

**Introduction to Paleobotany :** Theories on origin of life; Introduction to Paleobotany; Formation of Plant Fossils; Application of fossils in age determination and correlation; Paleoecology, Life habitats and various ecosystems; Paleobiogeography; Modes of preservation of fossils and taphonomic considerations; Types of microfossils; Environmental significance of fossils and trace fossils; Use of microfossils in interpretation of sea floor tectonism; Application of micropaleontology in hydrocarbon exploration; Oxygen and Carbon isotope studies of microfossils and their use in paleoceanographic and paleoclimatic interpretation; Important plant fossils and microfossils in Indian stratigraphy.

(14 Lectures)

**Unit II:**

**Paleobotanical Methods :** Fossil Classification- Nearest Living Relatives, Physiognomy and CLAMP ; Climate and Elevation analysis - Mean Annual Temperature, Lapse Rate, Moist static energy

(14 Lectures)

**Suggested readings:**

1. An introduction to Paleobotany by Arnold A. C., 2011, Agrobios (India)
2. Paleobotany: A sketch of the origin and evolution of floras by Berry E. W., 2012, Nabu Press
3. Paleobotany, Second Edition: The biology and evolution of fossil plants by Taylor T. N., Taylor E. L. & Krings M., 2008, Academic Press.
4. Essential of Paleobotany by Shukla A.C., 1982, Stosius Inc/Advent Books Division.

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**SEMESTER IV**

**Course Title: Indian Stratigraphy**

L	T	P	Cr	Marks
4	1	-	4	100

**Course Code: EGS. 611**

**Unit I:**

**Archaeans-Precambrian stratigraphy of India:** Precambrian stratigraphic framework of India; Classification, structure and tectonics of the Dharwar craton; Ancient supracrustal (Sargur Type); Gold bearing schist belts of Eastern Karnataka (Kolar Type); Younger schist belts (Dharwar Type); Gneiss complex, granulites, charnockites; Structure, tectonics and stratigraphy of the OMG, OMTG, Iron Ore Group (Singbhum Craton); Stratigraphy of the Sukma, Bengpal, and Bailadila series from Central India; Ancient granites, viz. Singbhum, Chitradurga, etc.; Archaeans of the Extra Peninsular region; Archaean-Proterozoic boundary; Stratigraphy, geology, tectonics and evolution of the following Proterozoic basins / Purana formations in India - Delhi-Aravalli Supergroup, Singbhum Group, Sausar-Sakoli Groups, Vindhyaans, Cuddapah, Pranhita-Godavari, Bhima, Kaladgi. (22 Lectures)

**Unit II:**

**Palaeozoic stratigraphy:** Igneous activities and palaeogeography during the Palaeozoic Era. Stratigraphy, facies, and fossil contents of the Palaeozoic rock formations of Peninsular and extra-peninsular India. Permian-Triassic boundary.

**Gondawana stratigraphy:** Concepts, classification, fauna, flora and age limits of Gondwana Supergroup and related palaeogeography, palaeoclimate, depositional characteristics and igneous activity. (12 Lectures)

**Unit III:**

**Mesozoic stratigraphy:** Classification, depositional characteristics, fauna and flora, age limits, correlation of Triassic, Jurassic and Cretaceous systems in principal basins of Peninsular and extra-peninsular India. Stratigraphy of the Deccan volcanic province; Cretaceous-Tertiary boundary.

(8 Lectures)

**Unit IV:**

**Cenozoic stratigraphy:** Classification, depositional characteristics, fauna and flora of the Palaeogene and Neogene systems in their type localities and their equivalents in India. Epoch boundaries of the Cenozoic in India. Quaternaries of Peninsular India; Neogene-Quaternary boundary. Stratigraphy and tectonics of the Siwaliks. (14 Lectures)

**Suggested readings:**

1. Fundamentals of historical geology and stratigraphy of India by Ravindra Kumar, 1998), New Age, ISBN-13: 978-0852267455.

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2. Geology of India, Geological Society of India, Bangalore, by Ramakrishnan M. and Vaidyanathan R., 2008, Vol. 1 & 2, ISBN No: 978-81-85867-98-4.
3. Precambrian Geology of India by Naqvi, S.M. and Rogers, J.J.W., 1987, Oxford University Press.
4. Geology of India and Burma by Krishnan, M.S., 1982, C.B.S. Publishers & Distributors, Delhi.

**Further readings:**

5. Introduction to stratigraphy and paleontology, in Indian ocean geology and biostratigraphy (eds J.R. Heirtzler, H.M. Bolli, T.A. Davies, J.B. Saunders and J.G. Sclater), by Bolli, H. M. and Saunders, J. B., 1977, American Geophysical Union, Washington, D. C.
6. Principles of Stratigraphy by Danbar, C.O. and Rodgers, J., 1957, John Wiley & Sons.
7. A Manual of the Geology of India & Burma (Volume I – IV) by Pascoe, E.H., 1968, Govt. of India Press, Delhi
8. The Cenozoic Era? Tertiary and Quaternary by Pomerol, C., 1982, Ellis Harwood Ltd., Halsted Press.
9. Stratigraphy: Principles and Methods by Schoch, Robert, M., 1989, Van Nostrand Reinhold, New York.
10. Unlocking the Stratigraphic Record by Doyle, P. & Bennett. M.R., 1996, John Willey.

**Course Title: Engineering and Environmental  
Geology**

L	T	P	Cr	Marks
4	1	-	4	100

**Course Code: EGS. 612**

**Unit I**

Role of engineering geology in civil constructions. Various stages of engineering geological investigation for civil engineering projects. Soil mechanics – three phases of soil, consistency limits, particle size distribution, soil classification, consolidation and compaction, and shear strength of soil. Engineering properties of rocks; rock discontinuities. Physical characters of building stones. Metal and concrete aggregates. (14 Lectures)

**Unit II:**

Geological consideration for evaluation of dams and reservoir sites. Dam foundation rock problems. Geotechnical evaluation of tunnel alignments and transportation routes, method of tunneling; classification of ground for tunneling purposes; various types of support. (14 Lectures)

**Unit III:**

Mass movements with special emphasis on landslides and causes of hill slope instability. Earthquakes and seismicity, seismic zones of India. Aseismic design of building. Influence of geological conditions

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on foundation and design of buildings. Case history of engineering projects and geological causes for mishaps and failures of engineering structures. (14 Lectures)

**Unit IV:**

**Environmental Geology :** Concepts and principles. Natural hazards - preventive/precautionary measures - floods, landslides, earthquakes, river and coastal erosion. Impact assessment of anthropogenic activities such as urbanization, open cast mining and quarrying, river-valley projects, disposal of industrial and radio-active waste, excess withdrawal of ground water, use of fertilizers, dumping of ores, mine waste and fly-ash. Organic and inorganic contamination of ground water and their remedial measures. Soil degradation and remedial measures. Environment protection - legislative measures in India. (14 Lectures)

**Suggested readings:**

1. Fundamentals of Engineering Geology by Bell, F.G., 1992, Aditya Books Pvt. Ltd. Indian Edn.
2. Principles of Engineering Geology by Krynine, D.H. & Judd, W.R., 1998, CBS Edition. Delhi.
3. Environmental Geology by Bermett, M.R. and Doyle, P., 1999, John Wiley & Sons, N. York.

**Further readings:**

4. Fundamentals of Rocks Mechanics by Jaeger J., Cook N. G. & Zimmerman R., 4<sup>th</sup> edition, 2007, Wiley-Blackwell
5. Engineering Geology for Civil Engineers by Reddy, D.V., 1995, IBH Publishing Co. Pvt. Ltd.
6. Geology for Engineers by Arora, D.S., 1988, Mohindra Capital Publishers, Chandigarh
7. A text book of building construction by Sharma, S.K., 1965, S Chand & Co. Ltd., New Delhi.
8. Environmental Geology by Lundgren, L., 1986, Prentice Hall of India Pvt. Ltd., New Delhi.
9. Geological Hazards by Bell, F.G., 1999, Routledge, London.
10. Environmental Geology by Keller, E.A., 1978, Bell and Howell, USA.
11. Natural Hazards by Bryant, E., 1985, Cambridge University Press. London.
12. The Dynamic Earth System by Patwardhan, A.M., 1999, Prentice Hall.
13. Environmental Hazards by Smith, K., 1992, Routledge, London.
14. Textbook in Environmental Science by Subramaniam, V., 2001, Narosa International.
15. Environmental Geology – Indian Context by Valdiya, K.S., 1987, Tata McGraw Hill. New Delhi.

**Course Title: LAB-VI (Engineering Geology and Stratigraphy)**

**Course Code: EGS 613**

L	T	P	Cr	Marks
-	-	4	2	<b>50</b>

**Unit –I : Stratigraphy Practical**

Interpretation of palaeogeographic maps of all geological periods. Study of specimens of rock types of Indian formations showing typical characters (lithotype/structure/fossils) and geological age inference.

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Study of rocks in hand specimens from known Indian stratigraphic horizons and type localities. Exercises on stratigraphic correlation and classification. Study and understanding of plate-movements through important periods during Phanerozoic Eon. Evolution of ocean systems during Phanerozoic.

**Unit –II: Engineering and Environmental Geology**

Study of properties of common rocks with reference to their utility in engineering projects. Study of maps and models of important engineering structures as dam sites and tunnels. Interpretation of geological maps for landslide problems. Various problems of soil and rock mechanical properties. Study of seismic and flood-prone areas in India. Evaluation of environmental impact of air pollution groundwater, landslides, deforestation, cultivation and building construction in specified areas.

**Suggested reading:**

1. Fundamentals of Engineering Geology by Bell, F.G., 1992, Aditya Books Pvt. Ltd. Indian Edn.
2. Principles of Engineering Geology by Krynine, D.H. & Judd, W.R., 1998:. CBS Edition. Delhi.
3. Earth Science and the Environment by Graham Thompson and Jon Turk, 4<sup>th</sup> Edition, 2007, Thomson and Brooks/cole.

**Course code: EGS 699**

**Dissertation/Project work, Presentation and Viva voce**

**[Total Marks: 300]**

Each candidate required to submit a dissertation/ project report based on his/her research work carried out towards the fulfillment of his/her M.Sc. dissertation.

It will have following components:

- (a) Origin of the research problem and literature review
- (b) Objective of the research work
- (c) Methodology of the work, field observations (if any) and data recorded by the candidate,
- (d) Details of laboratory investigation (if any) carried out by the candidate,
- (e) Synthesis of results and interpretation
- (f) Concluding remarks and future direction

The 60 % of the marks will be awarded by the teacher(s) who supervised the respective student. A board of examiners will conduct viva-voce, and would consist of the supervisor, faculty member(s) of the department, and other faculty members appointed by the competent authority. The committee will award the rest 40% of the marks including those of presentation and viva-voce. A candidate who does not submit the project report or fails to get pass marks in it will appear again in viva-voce examination of the same class M.Sc. II Year in a subsequent year as per university rule.