

## Ph.D Pre-Registration Course work Programme, 2017

### Course – I Research Methodology (Core) Marks- 100

**Theory = 60 marks**

**Unit – I.**

- |   |    |
|---|----|
| A. Concept of research, information survey, sources of information, field mapping, Techniques of sampling, data collection, processing and tabulation of data.<br>marks | 10 |
| B. Effective writing- scientific and technical report writing.<br>marks   | 10 |
| C. Objective, hypothesis, methodology, proposed sources of data, chapterization.<br>marks   | 10 |
| D. Laboratory facilities in India, importance of impact factors and citation index of publication.  | 5  |
| E. Bibliography / References.   | 5  |

**Unit – II.**

**Experimental techniques :**

- |  |    |
|--|----|
| A. Computer application, Use of various scientific equipments in geological science. | 15 |
| B. Statistical analysis of data.   | 5  |

**Internal assessment = 40 marks**

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**Course -II**

**Optional Paper**

**Paper I - Standard field and Laboratory Techniques in Geology**

Marks:-60

Internal Assessment:- 40

1. Remote Sensing and GIS application in Geology 20
2. Field Techniques:- 15  
Traverse mapping, contact mapping, Exposure mapping, Recording procedures of salient features of Igneous, Sedimentary and metamorphic rocks at different scales. Stratigraphic Section measurement. Sampling Methods.
3. Laboratory Techniques:- 15  
Stereonet plots, preparation of Geological Cross Section, Rose diagrams for Paleocurrent data, Grain size Analysis, Preparation of Petrographic thin section, Point Counting, Heavy Mineral separation, Micropaleontological Techniques for microfossils and Palynomorphs, XRD and XRF techniques.
4. Philosophy of science. 10

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**Course -II  
Optional Paper**

**Paper II - Petroleum Geochemistry**

1. Introduction to petroleum geochemistry
2. Use of Petroleum Geochemistry in Exploration of hydrocarbons.
3. Use of Petroleum Geochemistry in Development of Oil Fields.
4. Use of Petroleum Geochemistry in Production of hydrocarbons.
5. Petroleum System Analysis.

**Introduction to Petroleum Geochemistry**

1. Definition
2. History
3. Use

**Use of petroleum geochemistry in exploration**

1. Biogenic/Abiogenic theories of petroleum generation.
2. Changing concepts of source rocks.
3. Concepts of pseudo-source rock.
4. Exploration risk reduction by basin models.
5. Surface geochemical studies.
6. Resource assessment of unconventional hydrocarbons

#### **Use of Petroleum geochemistry in development of oil fields**

1. Monitoring OWC, GOC
2. Characteristics of hydrocarbons
3. Identification of reservoir compartments
4. Oil-Oil and Oil-source correlation
5. Reservoir alteration of oil
6. Identification of trapping mechanism of CBM

#### **Use of petroleum geochemistry in production of hydrocarbons**

1. Study the reservoir water geochemistry for water injection
2. Study the reservoir depletion in comingled production
3. Confirmation of casing or tubing leakage
4. Identification of the source of poisons for proper control of production

#### **Petroleum System Analysis**

1. Introduction
2. Scientific use of elements and processes of the system
3. Economic use of petroleum system analysis

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**Course -II  
Optional Paper**

**Paper III - Earth's Systems, Resources & Geophysical Tools**

**Unit 1: Earth's Systems**

System approach in understanding earth's processes, The Hydrologic System (This includes the Atmosphere-Ocean System, Weathering, Slope Systems, River Systems, Groundwater Systems, Glacier Systems, Shoreline Systems and Eolian Systems), The Tectonic System (This includes Seismicity and Earth's Interior, Divergent Plate Boundaries, Transform Plate Boundaries, Convergent Plate Boundaries, Hotspots and Mantle Plumes, Tectonics and Landscapes)

**Unit 2: Earth's Resources**

Mineral resources' concentration vis-a-vis hydrologic and tectonic systems, Ore deposits in relation to igneous, sedimentary, metamorphic and weathering processes; Metallic ores involving transport and deposition of metals in a hydrothermal fluid. Principal non-renewable energy resources like coal, oil, natural gas and nuclear power; Principal renewable energy resources solar energy, wind power, hydroelectric power, and geothermal energy.

**Unit 3: Shallow subsurface problems and geophysical tools**

Defining shallow subsurface problems, Transverse and horizontal variability of geophysical properties, Layered earth, Lithofacies and different geophysical property based facies like electrofacies, seismic facies etc, An overview of commonly used geophysical tools to understand shallow subsurface problems like, Self potential, Resistivity, Induced polarization, Ground Penetrating Radar, Refraction and Uphole survey

**Unit 4: Basin scale problems and geophysical tools**

Defining basin scale problems, Basin analysis, Basic concepts of Sequence Stratigraphy, Understanding basin evolution by combining sequence stratigraphy and tectonic forcings, an overview on the techniques of interpretation of different types of geophysical logs, log correlations and seismic sections.

## Unit 5: Earth's deep interior and geophysical tools

Earth's internal layering, Seismically defined layers of the earth, Crust, Mantle , Core; Defining earth layers based on rheologic behaviour, Lithosphere, Asthenosphere, Isostasy; Basic Plate Kinematics, Plate-driving forces; An overview of geophysical imaging of the continental lithosphere.

### References:

1. Catuneanu, O., 2006. Principles of Sequence Stratigraphy. Elsevier.
2. Einsele, G., 1992. Sedimentary Basins – Evolution, Facies and Sediment Budget, Springer-Verlag
3. Hamblin, W.K., Christiansen, E.H., 2003. Earth's Dynamic Systems, 10th edition, Prentice Hall.
4. Huddart, D., Stott, T., 2010. Earth Environments – Past, Present and Future, Wiley-Blackwell.
5. Kearey, P., Brooks, M., Hill, I., 2002. An Introduction to Geophysical Exploration, 3rd Edition, Blackwell Science.
6. Lowrie, W., 2007. Fundamentals of Geophysics, 2nd Edition, Cambridge University Press
7. Mussett, A.E., Khan, M.A., 2000. Looking into the earth- an introduction to geological geophysics, Cambridge University Press.
8. Ruddiman, W.F., 2001. Earth's climate: past and future, W.H. Freeman and Company, New York.
9. Telford, W.M., Geldart, L.P., Sheriff, R.E., First South Asian Edition 2010. Applied Geophysics Second Edition, Cambridge University Press.
10. Veeken, P.C., 2007. Seismic Stratigraphy, Basin Analysis and Reservoir Characterisation, Volume 37 from the series 'Handbook of Geophysical Exploration-Seismic Exploration' (Eds. Klaus Helbig and Sven Treitel), Elsevier.

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**Course III (Subject):- Economic Geology**

1. Earth building processes through ages: impact on global metallogeny.
2. Mineral formation and distribution since Achaean. Influence of atmospheric growth on mineral formation.
3. Global metallogeny.
4. Role of plate tectonics in the distribution of mineral deposits.
5. Magmatism- tracing chronologic history of mineral growth in the evaluation of mineral formation in an unknown terrain.
6. Rock chemistry and mineral formation
7. Base metal deposits of India: chronology of major magmatic/metamorphic events of mineral formation.
8. Introduction to the Iron ore deposits: their types, age of formation and distribution- both Indian and Global iron ore formations. Precambrian iron ore deposits of India
9. Magmatic/ metamorphic history of the shields of NE India.
10. Base metal mineral occurrences in NE India and exploration possibilities.

1. Fundamentals of coal geology and petrology
  - a. The geological basis of coal formation
    - i. Origin of peat swamps
    - ii. Peat growth, compression and the time of coal formation
    - iii. Development of coal facies
    - iv. Diagenesis of peat and coalification
  - b. Age and occurrence of coal
2. Coal as a substance
  - a. Physical description of coal (Lithotypes)
  - b. Coalification (Rank)
  - c. Coal quality
  - d. Classification of coals
3. Coal sampling and analysis
4. Coal Exploration and Data Collection
5. Coal as an Alternative Energy Source
  - a. Gas in coal
  - b. Underground coal gasification
  - c. Coal as a liquid fuel
  - d. Coal as an oil-prone source rock
6. Microscopically recognizable constituents of coal (Petrography)
  - a. The macerals of coal
  - b. The microlithotypes of coal
  - c. Minerals and Trace Elements in coal
  - d. Origin of the Petrographic constituents of coal
  - e. Methods and tools of examination
  - f. Application of coal petrography
7. Coal and the environment
8. Utilization of coal



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**Course III (Subject):- Coal Geology**

Theory

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7. Coal and the environment
8. Utilization of coal

**Internal Assessment**

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**Books :**

1. Francis, W., Coal, its formation and composition, Edward Arnold Ltd., London, 1961.
2. Stach, E., Mackowsky, M. Th., Teichmuller, M., Taylor, G.H., Chandra, D., Teichmuller, R. Stach's Text Book of Coal Petrology, 3<sup>rd</sup> revised and enlarged edition, Gebruder Borntraeger, Berlin, Stuttgart, 1982.
3. Van Krevelene, D.W., Coal, Elsevier Publishing Company, Amsterdam, 1961.
4. Ward, R.C. (edited), Coal Geology and Coal Technology, Blackwell Scientific Publication, 1984.
5. Singh, R.M. (Ed), Proceedings Volume of National Seminar on Coal resources of India, Banaras Hindu University, Published by Dr. R.M. Singh, Deptt. of Geology, BHU, 1987.
6. International Hand-book of Coal Petrology, ICCP, 1963 (2<sup>nd</sup> Ed.), Centre National de la Recherche Scientifique, Paris.
7. Chandra, D., Singh, R.M., Singh, M.P., Text Book of Coal (India context), Tara Book Agency, Varanasi, 2000.
8. International Journal of Coal Geology, ISSN 0166-5162, Elsevier Publishing Company.
9. Larry Thomas; Coal Geology, John Wiley & Sons Ltd., England, 2002
10. Tissot & Welte; Petroleum Formation and occurrence, Springer-Verlage, 1984
11. D. Chandra, S.G. Choudhury, N. Choudhury, Chandra's Textbook of Applied Coal Petrology, Jijnasa Publishing House, Kolkata, 2007

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**Course III (Subject):- Stratigraphy**

**Theory**

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Course Requirements: Students will be expected to attend class and lab regularly and to participate in discussions.

**Topics of current interdisciplinary research in sedimentary geology. Sequence stratigraphy, facies models, sea-level change, unconformities/hiatuses, tectonics, climate change, Palynology, Palynostratigraphy.**

**Sedimentology** – Analysis of sedimentary environments, facies models and environment reconstruction. Non marine environments: Fluvial Transitional: Deltaic, Beach and Tidal Flats. Marine: Shelf (Clastic and Non clastic) and deep sea sediments, turbidites. Evolution of sedimentary basins – Sedimentary basins, geosynclinal concept. Plate movements and basin formation.

Sedimentary Textures and Rock Classification

Fluid Dynamics

Lab : Sedimentary Rock Classification

Sediment Entrainment and Deposition

Sedimentary Structures and their Interpretation

Lab: Particle Size Analysis

Facies Models and Architectural Analysis

Wet Site Sampling and Core Analysis

Marginal Marine Systems

Deep Marine and Carbonate Systems

Lab: Site Interpretation

**Palaeontology** – Origin and evolution of life, uses of microfossils, study of microfossils of Foraminifera, Spores and Pollens, Dinoflagellates. Gondwana flora and their significance.

**Stratigraphy -**

Stratigraphy of the Mesozoic formations of N E India with special reference to type localities. Mesozoic formations of NE India with special reference to their history of sedimentation, fossil content and palaeogeography. Gondwana System. Cenozoic formations of NE India. Rise of the Himalayas and evolution of Siwalik/Tertiary basin and Boundary problems in Indian stratigraphy

Nature of the Stratigraphic Record and Geological Time

Lithostratigraphy

Geochronology

Lab : Geological Sections FT

Biostratigraphy

Borehole Stratigraphy: Logs

Lab : Biostratigraphy

Seismic and Sequence Stratigraphy

Phanerozoic Stratigraphy and Sedimentation

Integrated Stratigraphy and Sedimentology

Lab : Well-log Interpretation

Environmental Applications

Lab: Correlation and Fence Diagrams

Facies study:

1. Modern Facies and facies models. An Overview
2. Global sea-level and sequence stratigraphy: Definitions and concepts
3. Terrestrial facies models
4. Marine facies models
5. Stratigraphic record of sea-level change: The margin record
6. Carbonate facies models
7. Stratigraphic record of sea-level change: Atolls, isotopes, unconformities/hiatus
8. Tectonics and the stratigraphic record. R.E. Sheridan: Drift basins; active margin basins. R.W. Schlische: Rift basins; Discussion

### Internal Assessment

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### **Required text:**

Walker and James (1992), Facies Models

Boggs, S. Jr. 2001. Principles of sedimentology and stratigraphy. 4th edition. Prentice Hall, Upper Saddle River, NJ. 662 pp.

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**Course III:- (Engineering Geology)**

**Theory**

**60**

1. The role of Engineering Geology in civil construction. Stages of engineering geological investigation for civil engineering projects.
2. Engineering properties of intact rock and rock mass.
3. Engineering properties considered for rock classifications. Engineering classification of rocks – intact rock classification and rock mass classification.
4. Engineering properties for soil. Universal Soil Classification System (USCS).
5. Geological considerations for selection of sites for construction of dams, reservoirs, tunnels, roads and bridges. Support Design for underground excavation
6. Mass movements with special emphasis on landslides and causes of hill-slope instability.
7. Geological considerations for evaluation of foundation of buildings.
8. Earthquakes and seismicity, seismic risk zones of India. A seismic design of buildings.

**Internal Assessment**

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**Course-III:-Igneous and Metamorphic Petrology**

**Theory**

**60**

Unit- I : Field technique of collection of samples.

Unit- II : Petrography and Petrogenesis (Thermodynamic consideration)

Unit- III : Petrochemistry – Major, trace and REES. Isotopic analysis particularly Rb, Sr, Sm, Nd and U

Unit- IV : Isotope geochemistry- Sr, Sm, Nd, O<sub>2</sub> and H<sub>2</sub>

Geochronology-Rb-Sr, FTD Methods

Unit- V : Graphical representation of Chemical data. ACF, AKF, AFM etc diagram

Unit- VI : Geothermometry & Geo barometry

**Book List :**

1. Principles of Igneous and Metamorphic Petrology by A.R. Philpott
2. Igneous and Metamorphic Petrology by M.G. Best
3. Isotope Geology by Guntur Faur (2<sup>nd</sup> Edition)
4. Monograph series of "Mineralogical Society of America" by Frank S. Spear

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**Course-III :-SEDIMENTOLOGY AND PETROLEUM GEOLOGY**

**Theory**

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1. Grain size determination and interpretation
2. Sedimentary petrography
3. Diagenesis of sedimentary rocks
4. X- ray powder diffraction of sediments
5. Use of Scanning electron microscope in sedimentology
6. Chemical analysis of sedimentary rocks
7. Heavy mineral analysis
8. Sedimentary facies
9. An overview of well logs and its application in Sedimentology
10. Petrophysical properties of reservoir rocks
11. Geochemical studies for source rock characterization

**Internal Assessment**

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**Books Recommended :**

1. Allen, J.R.L., Physical processes of Sedimentation. Allen and Unwin, London, 1970.
2. Bathrust, R.G.C., Carbonate sediments and their diagenesis, Amsterdam, Elsevier, 1971.
3. Bouma, A.H., Methods for the study of Sedimentary structures, Wiley Interscience, New York 1969.
4. Chilingar, G.V., et al., Carbonate rocks. Elsevier, 1967.
5. Conypear, C.E.B. and Crook, K.A.W., Manual of sedimentary structures, Springer and Verlag 1975.
6. Carver, R.E., Procedure in Sedimentary
7. Degens, E.T., Geochemistry of Sediments, New Jersey, Prentice Hall, 1865.
8. Dunber, C.O., and Rodgers, J. Principles of Stratigraphy, Wiley and Sons, New York, 1957.
9. Folk, R.L., Petrology and Sedimentary rocks, Hemphills, Austin, 1980.
10. Greensmith, J.T., Petrology of Sedimentary rocks, CBS publications, 6<sup>th</sup> Ed., 1985.
11. Krumbein, W.C. and Pettijohn, F.J., Manual of Sedimentary Petrography, Appleton Country, New York, 1938.
12. Krumbein, W.C. and Sloss, L.L., Stratigraphy and Sedimentation, New York, Appleton Country, 2<sup>nd</sup> Ed., 1968.
13. Kukal, Z., Geology of Recent Sediments, Pragucl Academia, 1970.
14. Lindholm, R., Sedimentology, Allen and Unwin, London, 1987.
15. 15. Shormugam- Paper on Turbidites

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**Course III:-Micropalaeontology**

**Theory**

**60**

1. Different fossil types
  - a. Calcareous microfossils
  - b. Siliceous microfossils
  - c. Phosphatic microfossils
  - d. Organic walled microfossils (palynomorphs)
2. Biostratigraphy and palaeoenvironment interpretation
  - a. Introduction
  - b. Biostratigraphy
  - c. Quantitative biostratigraphy
  - d. Palaeoenvironment interpretation --- Clastic environments  
Carbonate environments
3. Biostratigraphic controls on hydrocarbon habitat
  - a. Source
  - b. Reservoir
  - c. Trap
4. Sequence Biostratigraphy
  - a. General and clastic sequence biostratigraphy
  - b. Genetic stratigraphic sequences
  - c. Systems tracts
  - d. Micropalaeontological characterization of systems tracts in clastic sequences
  - e. Carbonate sequence biostratigraphy
  - f. Detached carbonate platform sequences
  - g. Attached carbonate platform sequences
  - h. Micropalaeontological characterization of systems tracts in carbonate sequences

**Internal Assessment**

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**Course III:- Structural Geology**

**Marks**

**60**

1. Stress and strain; Mohr circle construction; Progressive deformation; Measurement of deformation; strain analysis.
2. Shear zones: types and products; shear sense indicators.
3. Folds: Shape analysis; interference patterns; strain analysis of folds.
4. Faults: Types; ramp -flat geometry, fold and thrust belts.
5. Foliations and lineations: Use of foliations and lineations in structural analysis.
6. Structural analysis: Analysis of different phases of deformation. Relation between deformation and metamorphism. Dating of orogenic belts; exhumation history; orientation analysis of joints.
7. Brief overview :experimental structural geology, AMS studies

**Internal Assessment**

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**Books recommended:**

- Davis, G.H. and Reynolds, S.J.1996: Structural geology: rocks and regions, John Wiley and Sons INC, 776pp
- Ghosh, S.K. 1993: Structural Geology: fundamentals and modern developments, Pergamon Press, 597pp
- Price, N.J and Cosgrove, J., 1990: Analysis of geologic structures, Cambridge University Press, 597pp
- Ramsay, J.G., 1967: Folding and fracturing of rocks McGraw Hill Book Co, New York 568pp
- Ramsay, J.G. and Huber, M.J. 1983: The techniques of modern structural geology: Strain analysis, Academic Press, London, 307pp
- Ramsay, J.G. and Huber, M.J. 1987: The techniques of modern structural geology: Fold and fractures, Academic Press, London, 400pp
- Turner, F.J. and Weiss, L.E 1963: structural analysis of metamorphic tectonites, McGraw hill Book Co, New York, 545pp
- Twiss, R.J. and Moores, E.M. 1992: Structural Geology, W.H. Freeman co., New York, 531pp

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**Course -IV (Assignment)**

Marks- 100

Unit-I

Assignment

80

1. Literature survey
2. Synopsis writing

Unit-II

Presentation

20