

**UNIVERSITY OF NORTH BENGAL**  
**DEPARTMENT OF GEOLOGY**

**SYLLABUS FOR PhD COURSE WORK 2019**

**COMPULSORY PAPER**

**(4 credits)**

**COURSE TITLE: RESEARCH METHODOLOGY**

**(2 credits)**

Concept and definition of Research; Academic research, basic and fundamental research, applied research, theoretical, conventional and experimental research. Concepts and needs of research hypothesis. Objective processes and steps in research methodology; Research proposal and concepts. Developing research proposal in the field of Geosciences.

Literature survey and review, research literatures and electronic media including internet, use of digital library, online resource; necessity of review of literatures. Research approach and identifying gap areas from literature review; problem formulation and statement of research objectives; Developing of bibliography.

Concepts on plagiarism, ISSN and ISBN numbers, impact factors and citation index of research articles and assessing the quality of research articles.

Pre-field preparations: preparation of maps, survey of the study area through satellite imageries, google earth, etc. Field mapping and documentation. Procedure of sampling-grap sampling, random sampling, stratified random sampling, stratified profile sampling, lateral sampling, sampling documentation. Introduction to field mapping and section measurement. Introduction on laboratory techniques of data analysis and their limitations.

Types of data: primary and secondary data. Source and authenticity of secondary data.

Introduction on the techniques of data representation, documentation and representation tools, basic presentation structures, writing a scientific paper, developing arguments, abstract and summary writing and organizing thesis, project reports; formulation of research proposals. Scientific research funding organizations in India.

**Suggested reading:**

1. Qualitative Research Methods for Social Sciences by Bruce, L. B. 2001, Allyn and Bacon, Boston.
2. Computer Applications in the Social Sciences by Edward, E.B., 1990, Temple University Press, Philadelphia.
3. Survey Methodology by Robert, M. B, et al., 2009, Wiley, New Jersey.
4. Social Research Methods by Bryman, A. 2008, Oxford University Press, New York.

5. Research Design: Qualitative, Quantitative and Mixed Methods Approaches by John, W. C., 2011, Sage Publications, Thousand Oaks.
6. Principles of Writing Research Papers by Lester, James, D. and Lester Jr. J. D., 2007, Longman, New York.
7. Against Method: Outline of an Anarchist Theory of Knowledge by Paul F., 1975, New Left Books, London.
8. Power/Knowledge: Selected Interviews and Other Writings by Michel, F., edited by Colin Gordon, 1980, Vintage, New York.
9. The Structure of Scientific Revolutions by Thomas K., 1996, University of Chicago Press, Chicago.
10. Social Research Methods: A Reader by Seale C., 2004, Routledge, London.

**COURSE TITLE: Computer Application and statistical techniques (2 credits)**

**Fundamentals of computers:** Parts of computers, Hardware, BIOS, Operating systems, Binary system, Logic gates and Boolean algebra Application software: Spreadsheet applications, word processing applications, Presentation applications, Internet browsers, Reference Management, and

**Computer Language:** Basic DOS commands, Auto Hot Key scripting language, HTML and basic structure of a webpage, Designing websites. World Wide Web: Origin and concepts, Latency and bandwidth, Searching the internet, Advanced web-search using Boolean logic, Cloud computing.

**Experimental design and analysis:** Sampling techniques, Sampling theory, Steps in sampling, Collection of data-types and methods. Comparing means of two or more groups: Student's t-test, Paired t-test, Mann-Whitney U-test, Wilcoxon signed-rank, One-way and two-way analysis of variance (ANOVA), Critical difference (CD), Least significant difference (LSD), Kruskal Wallis one-way ANOVA by ranks, Friedman two-Way ANOVA by ranks,  $\chi^2$  test.

**Use of software:** Remote sensing software application; Geostatistical software, Image processing software

**Suggested reading:**

1. An Introduction to Operating Systems: Concepts and Practice by Bhatt, Pramod Chandra P., 2<sup>nd</sup> edition, 2008, PHI Learning Pvt. Ltd., New Delhi.
2. Elementary Statistics for Geographers by Burt J. E. Barber. G.E. Rigby D. L., 2009, Guilford Press, New York.
3. An Introduction to Database Systems by Date C. J., 7<sup>th</sup> edition, 2000, Addison-Wesley Longman, Massachusetts.
4. Information Technology: Inside and Outside by David Cyganski, John, A. Orrand R. F. Vaz, 2000, Prentice Hall, New Jersey.

5. Fundamentals of MS Office 2007 by Douglas, Gretchen and Mark Connell, 2<sup>nd</sup> edition, 2007, Kendall Hunt Publication Company, Dubuque.
6. MS Word for Dummies by Gookin, D. 2007, Wiley.
7. MS Excel for Dummies by Harvey, G. 2007, Wiley.
8. Database Management System by Narang R., 2006, PHI Learning Pvt. Ltd., New Delhi.
9. Fundamentals of Computers by Rajaraman V., 2003, PHI Learning Pvt. Ltd., New Delhi.
10. Analyzing talk and text. In N. Denzin and Y. Lincoln, eds. Handbook of Qualitative Research by Silverman D., 2000, Sage Publications, Thousand Oaks, CA.

## **ELECTIVE PAPER**

**(4 credits)**

### **COURSE TITLE: SEDIMENTOLOGY**

**(4 credits)**

#### **Carbonates through ages – its physical, chemical & biological perspectives:**

Distribution and distinction of carbonate deposits in rock record. Distinctions between Precambrian and Phanerozoic Carbonate deposit: Physico-chemical and biological control on carbonate deposition in Precambrian and Phanerozoic sequence. Isotopic signatures of carbonate deposits.

#### **Sequence stratigraphy in the light of basin evolution:**

Understanding basin forming processes and basin architecture. Stratigraphic Signature of a basin: Sea level change, Basin-floor wobbling, Sedimentation rate and climate. Depositional facies, Seismic Facies Seismic Expression & Configuration and log-based Sequence, Correlation Sequence, Stratigraphic Principles & Facies Tracts Carbonate Sequence Stratigraphy and Drowning Unconformity. Application of sequence stratigraphy to basin evolution

#### **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 Basins by Einsele G., 1992, Springer Verlag.
3. Principle of sequence stratigraphy by Catunaenu O., 1<sup>st</sup> edition, 2006.. Elsevier.
4. Carbonate Sedimentology by Tucker M. E. and Wright V. P., 1991, Publisher Wiley, ISBN 0632014725, 9780632014729.
5. Principles of Sedimentary Basin Analysis by Miall A.D., 2000, Springer-Verlag.
6. Depositional Sedimentary Environments by Reineck H.E. and Singh I.B., 1980, Springer-Verlag.
7. Origin of Carbonate Sedimentary rocks, James, N.P. and Jones, B., 2015, Wiley Publ. ISBN: 978-1-118-65270-1

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PAPER I

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PAPER II

**1) MINERALOGY AND PETROLOGY:**

Concept of point group, space group, reciprocal lattice, diffraction and imaging. Concepts of crystal field theory and mineralogical spectroscopy. TEM and SEM applications. Lattice defects (point, line and planar). Electrical, magnetic and optical properties of minerals. Bonding and crystal structures of common oxides, sulphides, and silicates. Transformation of minerals –

polymorphism, polytypism, and polysomatism. Solid solution and exsolution; Steady-state geotherms. Genesis, properties, emplacement and crystallization of magmas. Phase equilibrium studies of simple systems, effect of volatiles on melt equilibria. Magma-mixing, -mingling and -immiscibility.

Metamorphic structures and textures; isograds and facies. Mineral reactions with condensed phases, solid solutions, mixed volatile equilibria and thermobarometry. Metamorphism of pelites, mafic-ultra mafic rocks and siliceous dolomites. Material transport during metamorphism. P-T-t path in regional metamorphic terrains, plate tectonics and metamorphism. Petrogenetic aspects of important rock suites of India, such as the Deccan Traps, layered intrusive complexes, anorthosites, carbonatites, charnockites, khondalites and gondites.

## **2) STRUCTURAL GEOLOGY AND GEOTECTONICS:**

Theory of stress and strain. Behaviour of rocks under stress. Mohr circle. Various states of stress and their representation by Mohr circles. Different types of failure and sliding criteria. Geometry and mechanics of fracturing and conditions for reactivation of pre-existing discontinuities. Paleostress analyses. Common types of finite strain ellipsoids. L-, L-S-, and S-tectonic fabrics. Techniques of strain analysis. Particle paths and flow patterns. Progressive strain history and methods for its determination. Deformation mechanisms. Role of fluids in deformation processes. Geometry and analyses of brittle-ductile and ductile shear zones. Sheath folds. Geometry and mechanics of development of folds, boudins, foliations and lineations. Interference patterns and structural analyses in areas of superposed folding. Fault-related folding. Gravity induced structures. Major tectonic features and associated structures in extensional-, compressional-, and strike-slip-terranes. Geological and geophysical characteristics of plate boundaries. Geodynamic evolution of Himalaya.

## **3) PALEONTOLOGY AND ITS APPLICATIONS:**

Theories on origin of life. Organic evolution – Punctuated Equilibrium and Phyletic Gradualism models. Mass extinctions and their causes. Application of fossils in age determination and correlation. Paleocology, 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 invertebrate fossils, vertebrate fossils, plant fossils and microfossils in Indian stratigraphy.

## **4) SEDIMENTOLOGY AND STRATIGRAPHY:**

Clastic sediments- gravel, sand and mud; biogenic, chemical and volcanogenic sediments. Classification of conglomerates, sandstones and mudstones, and carbonate rocks. Flow regimes and processes of sediment transport. Sedimentary textures and structures. Sedimentary facies and environments, reconstruction of paleoenvironments. Formation and evolution of sedimentary basins. Diagenesis of siliciclastic and carbonate rocks. Recent developments in stratigraphic classification. Code of stratigraphic nomenclature – Stratotypes, Global Boundary Stratotype Sections and Points (GSSP). Lithostratigraphic, chronostratigraphic and biostratigraphic subdivisions. Methods of stratigraphic correlation including Shaw's Graphic correlation. Concept of sequence stratigraphy. Rates of sediment

accumulation, unconformities. Facies concept in Stratigraphy – Walther's law. Methods for paleogeographic reconstruction. Earth's Climatic History. Phanerozoic stratigraphy of India with reference to the type areas– their correlation with equivalent formations in other regions. Boundary problems in Indian Phanerozoic stratigraphy.

### **5) GEOCHEMISTRY:**

Structure and atomic properties of elements, the Periodic Table; ionic substitution in minerals; Phase rule and its applications in petrology, thermodynamics of reactions involving pure phases, ideal and non-ideal solutions, and fluids; equilibrium and distribution coefficients. Nucleation and diffusion processes in igneous, metamorphic and sedimentary environments, redox reactions and Eh-pH diagrams and their applications. Mineral/mineral assemblages as 'sensors' of ambient environments. Geochemical studies of aerosols, surface-, marine-, and ground waters. Radioactive decay schemes and their application to geochronology and petrogenesis. Stable isotopes and their application to earth system processes.

### **6) ECONOMIC GEOLOGY:**

Magmatic, hydrothermal and surface processes of ore formation. Metallogeny and its relation to crustal evolution; Active ore-forming systems, methods of mineral deposit studies including ore microscopy, fluid inclusions and isotopic systematics; ores and metamorphism- cause and effect relationships. 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. Methods of petroleum exploration. Petroliferous basins of India. Origin of peat, lignite, bitumen and anthracite. Classification, rank and grading of coal; coal petrography, coal resources of India. Gas hydrates and coal bed methane. Nuclear and non-conventional energy resources.

### **7) APPLIED GEOLOGY:**

**(i) Remote Sensing and GIS:** Elements of photogrammetry, elements of photointerpretation, electromagnetic spectrum, emission range, film and imagery, sensors, geological interpretations of air photos and imageries. Global positioning systems. GIS- data structure, attribute data, thematic layers and query analysis.

**(ii) Engineering Geology:** Engineering properties of rocks and physical characteristics of building stones, concretes and other aggregates. Geological investigations for construction of dams, bridges, highways and tunnels. Remedial measures. Mass movements with special emphasis on landslides and causes of hillslope instability. Seismic design of buildings.

**(iii) Mineral Exploration:** Geological, geophysical, geochemical and geobotanical methods of surface and sub-surface exploration on different scales. Sampling, assaying and evaluation of mineral deposits.

**(iv) Hydrogeology:** Groundwater, Darcy's law, hydrological characteristics of aquifers, hydrological cycle. Precipitation, evapotranspiration and infiltration processes. Hydrological classification of water-bearing formations. Fresh and salt-water relationships in coastal and inland areas. Groundwater exploration and water pollution. Groundwater regimes in India.