SYLLABUS

(w.e.f. ACADEMIC SESSION 2023-2024)

for

Ph.D.

GEOLOGY

DEPARTMENT OF GEOLOGY

DR. NITYANAND HIMALAYAN RESEARCH & STUDY CENTRE
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GUIDELINES

(As per the UGC Regulations)

COURSE STRUCTURE

Course Number	Course Title	L-T-P	Credit
GEC-1	Statistics in Earth Science Research	3-0-1	4
GEC-2	Field, Laboratory, and Satellite based analysis in Earth Science	3-0-1	4
GEC-3	Research Methodology	2-0-0	2
RPE	Research & Publication Ethics	2-0-0	2
GEE-4	Elective: Course on Area of Specialization (Remote Sensing & GIS, Hydrology, Natural Disasters)	3-0-1	4

Paper – GEC 1
STATISTICS IN EARTH SCIENCE

Total Credits	**: 04 (Theory: 03 + Practical: 01)**
Total Hours	**: 45 Theory + 30 Practical**
Lectures	**: 02 per week**
Practical	**: 01 per week**

THEORY

UNIT-I: Accuracy and Precision, Significant digits, detection limits, limit of quantification, Univariate vs. Multivariate statistics.

UNIT-II: Concept of Uncertainty, Measures of spread, variance, standard deviation, standard error of mean, coefficient of variation, quantiles

UNIT-III: Data regression: Linear vs non-linear, Data averaging, outlier, measures of shape, Concept of probability distribution

UNIT-IV: Data Visualization, Frequency Table, Histogram, Descriptive analysis, probabilistic analysis, scatter vs box plots, data clustering, simulation

COURSE OUTCOME:
Candidates will learn some more theoretically sound and convincing ways to prepare results. Candidates will be aware of both; the uncertainties commonly associated with geological modeling and of the multiple ways that statistics offers for quantifying such uncertainties.

PRACTICAL
Plotting of statistical data through descriptive, clustering, regression, and probability concepts.

SUGGESTED READINGS:
1. Eidsvik, J., Mukerji, T. and Bhattacharjya, D., 2015. Value of information in the earth sciences: Integrating spatial modeling and decision analysis. Cambridge University Press.
2. Sen, Z., 2016. Spatial modeling principles in earth sciences (Vol. 10, pp. 978-3). Berlin/Heidelberg, Germany: Springer International Publishing.
3. Dekking, F.M., Kraaikamp, C., Lopuhaä, H.P. and Meester, L.E., 2005. A Modern Introduction to Probability and Statistics: Understanding why and how (Vol. 488). London: Springer.

Paper – GEC 2
FIELD, LABORATORY, SATELLITE, and MODELING BASED ANALYSIS

Total Credits	**: 04 (Theory: 02 + Practical: 02)**
Total Hours	**: 30 Theory + 60 Practical**
Lectures	**: 02 per week**
Practical	**: 01 per week**

THEORY

UNIT-I: Structural mapping and data interpretation, Soil/Rock/Water/fossil samples collection in field, Stratigraphic sequence reconstruction, Preparation of landslide, earthquake, flood inventory

UNIT-II: Basics of geochemical analysis, types of geochemical analysis, micro vs macro fossils qualitative and quantitative analysis, index and strength analysis of soil/rock samples, water-geochemistry analysis, mineral identification in thin sections

UNIT-III: Types of satellite imagery, Satellite imagery vs UAV imagery, Object recognition, temporal analysis, micro vs macro scale mapping, limits of satellite & UAV mapping

UNIT-IV: Synthesis of data in GIS platforms, Pattern recognition and plotting of datasets, Error evaluation in datasets

COURSE OUTCOME:
Candidates will learn fundamental and applied aspects of research standard in various disciplines involving field, satellite imagery, and laboratory components.

PRACTICAL
Field data mapping, Satellite imagery analysis, UAV imagery analysis, Plotting of statistical data through descriptive, clustering, regression, and probability concepts, geochemical data plots

SUGGESTED READINGS:
1. Catt, J. A. (1986). Soils and Quaternary geology: a handbook for field scientists. Oxford University Press
2. Knödel, K., Lange, G., & Voigt, H. J. (2007). Environmental geology: handbook of field methods and case studies. Springer Science & Business Media
3. Kidwell, S.M., Fuersich, F.T. and Aigner, T., 1986. Conceptual framework for the analysis and classification of fossil concentrations. Palaios, pp.228-238.

Paper – GEC 3
RESEARCH METHODOLOGY

Total Credits	**: 02 (Theory: 02+ Practical: 00)**
Total Hours	**: 30 Theory**
Lectures	**: 02 per week**

THEORY

UNIT-I: History, methodology and philosophy of Science, Epistemology, Scientific Methods, Hypotheses Generation and Evaluation, Code of Research Ethics, Definition and Objectives of Research

UNIT-II: Types of Research, Various Steps in Scientific Research, Primary Data, Secondary, and Tertiary Data, Survey and Experiments, Design of Survey and Experiments, Art of scientific communication

UNIT-III: Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism

UNIT-IV: Development of research proposal; Aims and objectives decision, methodology design, Results & Discussion rationalization, Budget, Appendices

COURSE OUTCOME:
Ability to choose methods appropriate to research aims and objectives. Understanding the limitations of particular research methods. Developing skills in qualitative and quantitative data analysis and presentation.

SUGGESTED READINGS:
1. Kothari, C.R., 2004. Research methodology: Methods and techniques. New Age International.
2. Snyder, H., 2019. Literature review as a research methodology: An overview and guidelines. Journal of business research, 104, pp.333-339.

Paper – RPE
RESEARCH & PUBLICATION ETHICS

Total Credits	**: 02 (Theory: 02+ Practical: 00)**
Total Hours	**: 30**
Lectures	**: 02 per week**

THEORY

UNIT-I: Introduction to Philosophy (definition, nature, scope, concept, branches), Ethics (definition, moral philosophy, nature of moral judgements & reactions)

UNIT-II: Ethics with respect to science & research, intellectual honesty & research integrity, scientific misconduct (falsification, fabrication, and plagiarism), redundant publications (duplicate & overlapping publications), salami slicing, selective reporting and data misrepresentation

UNIT-III: Definition, introduction, and importance of Publication Ethics, Best practices/standards setting initiative & guidelines (COPE, WAME, etc), Conflicts of Interest.

UNIT-IV: Open Access Publication, SHERPA/RoMEO online resources to check publisher copyright & self-archiving policies, Software tools to identify predatory publications developed by SPPU, Journal finder, journal suggestion tools.

UNIT-V: Group Discussions (Subject specific ethical issues, FFP, authorship, Conflict of interest, Complaints and appeals). Software tools (Plagiarism softwares).

UNIT-VI: Indexing databases, Citation databases, Impact Factor of Journals, metrics (h index, i10 index, altmetrics).

COURSE OUTCOME:
Ability to rationalize research and its variations. Understanding of research ethics and publication metrics.

SUGGESTED READINGS:

1. Kara, H., 2018. Research ethics in the real world (pp. 109-120). Bristol: Policy Press.
2. Beisiegel, U., 2010. Research integrity and publication ethics. Atherosclerosis, 212(2), pp.383-385.

Paper – GEE 4
ELECTIVE COURSE: NATURAL DISASTERS

Total Credits	**: 04 (Theory: 03 + Practical: 01)**
Total Hours	**: 45 Theory + 30 Practical**
Lectures	**: 02 per week**
Practical	**: 01 per week**

THEORY

UNIT-I: Difference between susceptibility, hazards, risk, vulnerability. Difference between natural vs anthropogenic disasters.

UNIT-II: Human development & natural hazards, Human dimensions, Complexity Science, Sustainability Science, and Human Vulnerability

UNIT-III: Major natural hazards of India. Case studies (04).

UNIT-IV: Major natural hazards of World. Case studies (04).

COURSE OUTCOME:
Describe the underlying processes that give rise to natural hazards such as earthquakes, flood, wildfires, hurricanes, landslides, and how these affect human populations

PRACTICAL
Satellite imagery analysis, Plotting of statistical data through descriptive, concepts, climatic and seismic data interpretation

SUGGESTED READINGS:
1. UNISDR, C., 2015. The human cost of natural disasters: A global perspective.
2. Alexander, D., 1991. Natural disasters: a framework for research and teaching. Disasters, 15(3), pp.209-226.
3. Phalkey, R.K. and Louis, V.R., 2016. Two hot to handle: How do we manage the simultaneous impacts of climate change and natural disasters on human health?. The European Physical Journal Special Topics, 225, pp.443-457.

Paper – GEE 4
ELECTIVE COURSE: HYDROLOGY

Total Credits	**: 04 (Theory: 04+ Practical: 0)**
Total Hours	**: 60 Theory**
Lectures	**: 02 per week**

THEORY

UNIT I: 'The main content of hydrology, Hydrology as a science, the relation of Hydrology to other sciences, Historical development of Hydrology. The significance of water in different fields of anthropogenic human activities and its role in the development of civilization. Water resources of the earth. Global water budget. Interrelation between hydrological processes and atmosphere, hydrosphere and lithosphere, Hydrologic cycle.

UNIT-II: Formation of surface water resources; streams, rivers, lakes, swamps, caves, seas and oceans. Definition of river, river basin and water divide, formation of river valleys, flood plains, fluvial deposits, alluvial fans, meandering of rivers, formation of ox-bow or horse shoe lakes, deltas, solution valleys and karst topography (8 Hours) Sediment discharge, sediment transportation, sediment yield of watersheds, suspended load and bed load measurements.

UNIT III: Hydrographs: Discharge hydrograph, features of a hydrograph, factor affecting shape of hydrograph, components of hydrograph, base flow separation methods.

UNIT IV: Man and environment-scope of environmental hydrology-relation with other sciences Ecosystem, ecological stability, ecological imbalance and pollution. Global threat-EInino effect -Green House Effect-Ozone layer depletion and its impact on hydrological environment-Global Warming-precipitation and eco distribution-aquatic ecosystems anthropogenic impact on aquatic ecosystem- acid rain- its cause and impact on environment

SUGGESTED READINGS:

1.Advances in Hydrosciences Vol.2, Ven te Chow.
2. Hand Book of Applied Hydrology , Ven Te Chow (ed.)
3. Applied Hydrology , R.K.Linsley, M. A. Kohler & Paulhus
4. Handbook on the Principles of Hydrology , Donald M Grey
5. Engineering Hydrology , R.S.Varshney

Paper – GEE 4
ELECTIVE COURSE: APPLICATION OF REMOTE SENSING & GIS IN GEOLOGY

Total Credits	**: 04 (Theory: 03 + Practical: 01)**
Total Hours	**: 45 Theory + 30 Practical**
Lectures	**: 02 per week**
Practical	**: 01 per week**

THEORY

UNIT-I: Introduction to aerial photography, photogrammetry, and basics of remote sensing principles, types, steps and elements of image interpretation. Techniques of visual interpretation, types and their characteristics scanning and sensors. Earth Resources Satellites, Meteorological satellites, concept of resolution - spatial, spectral, temporal, radiometric. Basic concept and principles of thermal, microwave and hyperspectral sensing.
UNIT-II: Introduction- definition, historical perspective, components of GIS and types of GIS Technology trends in GIS, relationship between geoinformatics, information technology and sensor technology, distributing computing. Concept of data, geographic data sources, introduction to spatial decision problem.
UNIT-III: Digital Image Processing, Image Errors, Rectification and Restoration, FCC, Image Enhancement (Contrast manipulation; Spatial feature manipulation; multi-image manipulation Filtering), Image Rationing, Image classification and accuracy assessment.
UNIT-IV: Thermal radiation principles, thermal process and properties, Characteristics of thermal IR images and factors affecting thermal images. Microwave remote sensing concept and principle, backscattering, cross section, wavelength, incidence angle. Application of microwave remote sensing and microwave image interpretation.

COURSE OUTCOME:
In the course describe the fundamentals of remote sensing and GIS. Including understanding the principles of remote sensing, such as the different types of sensors and platforms used to acquire data, as well as the methods for analyzing and interpreting this data using GIS software.

PRACTICAL
Aerial Photo interpretation, identification of rocks and various aeolian, glacial, fluvial and marine landforms. Digital Image Processing exercises, interpretation of various objects on the basis of their spectral signatures creating a FCC from raw data, Georeferencing. Generating NDVI images and other image ratio and its interpretation Classification of images. DEM analysis: generating slope map, aspect map and drainage network map and its applications, Microwave image processing.

SUGGESTED READINGS:
1. Lillesand, T. M. & Kiefer, R.W., 2007. Remote Sensing and Image Interpretation, Wiley.
2. Sabins Jr, Floyd F., and James M. Ellis. Remote sensing: Principles, interpretation, and applications. Waveland Press, 2020.
3. Gupta, R. P. (2003). Remote Sensing Geology. 2' Edition. Springer