**DEPARTMENT OF APPLIED GEOLOGY**
**DIBRUGARH UNIVERSITY**

Rationale, Course structure, & Syllabus
MSc Tech. in Applied Geophysics (AGP) Programme
of 3 years' (6 Semesters') duration
[With complete blow up of 1st and 2nd semesters]

(New Syllabus discussed and accepted in the BOS Meeting held on 12th November, 2020)

# 2020

# (NEW CBCS SYLLABUS)

# RATIONALE

The department of Applied Geology is located within the triple junction of the Eurasian, Indian and the Burmese plates which is structurally dynamic, rich in natural resources, (Some of these resources are already proven and some are prognosticated) diverse in its demographic content, highly promising for further exploration and utterly vulnerable for unmindful exploitation and plunder. Unless high quality knowledge is cultivated by the indigenous institutions and the people with a faster pace, programmes of developments cannot touch the projected heights. Geophysics forms the backbone of the tools for exploration in the subsurface. Keeping a watchful eye on the fast changing scenario of the world economy and the importance of the states of the NE India in this overall perspective, the presence of earth science in general and Exploration geophysics in particular needs a strong footing and steady growth in the institutes of higher education so that the frontier problems of the earth science related research works may attract curious and intelligent students and they are encouraged to take up Geophysics as their passion and profession in more numbers.

From its very inception, the Department of Applied Geology, Dibrugarh University had put its effort to groom good geoscientists having expertise in oil, water and mineral resource exploration. This was done for a considerable length of time by offering a three years' MTech Course in Applied Geology that was subsequently modified to a two years' MSc. Course in Applied Geology. Introducing a post-MSc. two years' MTech. Course in Petroleum Geology in 2003, the department could extend its vision towards the needs to focused studies and research in the field of oil exploration. Interestingly, the effort could draw national attention from the students from Kashmir to Kerala. In extension to the same vision, the department introduced Advanced Post Graduate Diploma in Petroleum Exploration Geophysics (APGDPEG) of one (1) year duration in 2009. The response was good. Subsequently, the department took a decision to upgrade and broad-base the existing Diploma course to a Two-Year MTech. (Exploration Geophysics) Programme from 2012-13 academic session onward with active collaboration from the OIL and the ONGCL. A drive was given to modernize the syllabus in 2018 based on the counseling from the Stanford University, USA. However, continuing global recession, drastic fall in the oil price, affected the number of candidates joining the post-MSc. MTech programme. Accordingly, it was decided to offer a three years' Master programme MSc Tech (Applied Geophysics) from 2020 session at par with other Universities in India.

The basic objective behind offering Applied Geophysics as an MSc. Tech Programme principally to the students having major in Physics and Geology (with Mathematics and Physics) at the graduation level is three-fold. First, to generate quality human resources in the 'high skill' segment of workers who are supposed to explore, develop and exploit principal natural resources like oil, water and minerals in a sustainable manner and increasing thereby the practical importance of higher education in nation building. Secondly, introduction of more down-to-earth steps so that the academia-industry symbiosis becomes more meaningful as well as useful. Developing the software-based learning skill has been given additional weightage. Initiation of building up a good infrastructure to conduct research in basin analysis of the Assam & Assam Arakan area as a part of the principal thrust area of the department in the field of 'Tectonics and basin Evolution' studies is the third objective. In conformity with these objectives, the first year of the Programme is devoted to introduce the philosophy of scientific exploration in general and exploration geophysics in particular. Earth System Science approach with emphasis on climate change has been included which is supposed to act as a broader perspective. To develop the computational skill besides 'Numerical Analysis and Computer programming', a course 'Geoscientific data analysis with MATLAB' has been introduced. The second year is principally devoted to core issues like Seismology and Seismic methods of data acquisition & processing. Besides this, there is in-depth coverage of Gravity and Magnetic Methods. Electrical methods along with Electromagnetic methods are given sufficient weightage. Elective papers include Hydrogeology and ground water investigations, and Principles of Stratigraphy. Moreover, there is a 'Field Visit' component which is planned as per convenience. The third year is devoted principally to more specialized issues of exploration applications like seismic data interpretation, well logging and Reservoir Geophysics. Options were given to choose from latest fields of concern like 'Decision Analysis and Value of Information' and 'Simulation modeling in environmental science' etc. Besides the regular field work, serious project works of six months' duration having strictly monitored periodic submission of progress reports related to exploration under the joint supervision of the Department of Applied geology, Dibrugarh University and reputed organizations (OIL, ONGCL, CSIR- NEIST etc.) are conducted in the final sixth semester to promote research aptitude of the candidates.

PROGRAMME STRUCTURE- MSc.Tech (Applied Geophysics)

**SEMESTER-I**

| Course No. | Course | L | P | Cr | Marks | | |
|---|---|---|---|---|---|---|---|
| | | | | | IS | ES | Total |
| **Core Courses** | | | | | | | |
| AGP-101 | Philosophy of Science & Exploration | 3 | - | 3 | 40 | 60 | 100 |
| AGP-102 | Earth System Science | 3 | - | 3 | 40 | 60 | 100 |
| AGP-103 | Applied Mathematics for Geophysics | 3 | - | 3 | 40 | 60 | 100 |
| AGP-104 | Geoscientific Data Analysis with Matlab | 3 | - | 3 | 30 | 45 | 75 |
| **Practical** | | | | | | | |
| AGP-104-P | Geoscientific Data Analysis with Matlab | 1 | | 1 | 10 | 15 | 25 |
| **Discipline Specific Elective Courses (DSE)** | | | | | | | |
| AGP-1D-1 | Physics Essential | 4 | - | 4 | 40 | 60 | 100 |
| AGP-1D-2 | Geology Essential | 4 | - | 4 | 40 | 60 | 100 |
| **Generic Elective Courses (GE)** [offered by the Applied Geology Department] | | | | | | | |
| AGP-1G-1 | | | | | | | |
| **Generic Elective Courses (GE)** [offered by other departments] | | | | | | | |
| | | | | | | | |
| Ability Enhancement Courses (AEC) [offered by the department] | | | | | | | |
| AGP-1A-1 | Technical English & Professional Communication | 2 | | 2 | 20 | 30 | 50 |

Total Marks for Semester-I: 550

Total Credits: **19(Minimum)**

**SEMESTER - II**

| Course No. | Course | L | P | Cr | Marks | | |
|---|---|---|---|---|---|---|---|
| | | | | | IS | ES | Total |
| **Core Courses** | | | | | | | |
| AGP-201 | Geophysical Inversion | 3 | - | 3 | 40 | 60 | 100 |
| AGP-202 | Geophysical Prospecting | 3 | - | 3 | 40 | 60 | 100 |
| AGP-203 | Geophysical signal theory | 3 | - | 3 | 40 | 60 | 100 |
| AGP-204 | Numerical Analysis and Computer programming | 3 | - | 3 | 30 | 45 | 75 |
| **Practical** | | | | | | | |
| AGP-204-P | Numerical Analysis and Computer programming | 1 | - | 1 | 10 | 15 | 25 |
| **Discipline Specific Elective Courses (DSE)** | | | | | | | |
| AGP-2D-1 | Hydrogeology & Ground water investigations | 3 | 1 | 4 | 40 | 60 | 100 |
| AGP-2D-2 | Principles of Stratigraphy | 4 | - | 4 | 40 | 60 | 100 |
| **Generic Elective Courses (GE)** [offered by other departments] | | | | | | | |
| | | | | | | | |
| Ability Enhancement Courses (AEC) [offered by the department] | | | | | | | |
| | | | | | | | |
| **Ability Enhancement Courses (AEC)** [offered by other departments] | | | | | | | |
| AGP-2A-1 | Summer Training-I: Field/Industrial visit | | 2 | 2 | 20 | 30 | 50 |

Total Marks for Semester-II: 550

Total Credits: **19(Minimum)**

**SEMESTER: III**

| Course No. | Course | L | P | Cr | Marks | | |
|---|---|---|---|---|---|---|---|
| | | | | | IS | ES | Total |
| **Core Courses** | | | | | | | |
| AGP-301 | Seismology | 3 | | 3 | 30 | 45 | 75 |
| AGP-302 | Geophysical Tools I: Seismic Methods (Data Acquisition & Processing) | 3 | | 3 | 30 | 45 | 75 |
| AGP-303 | Geophysical Tools II: Electrical & Electro Magnetic Methods | 3 | | 3 | 30 | 45 | 75 |
| AGP-304 | Image Processing & Geographic Information System | 3 | | 3 | 30 | 45 | 75 |
| **Practical** | | | | | | | |
| AGP-301-P | Seismology | - | 1 | 1 | 10 | 15 | 25 |
| AGP-302-P | Geophysical Tools I: Seismic Methods (Data Acquisition & Processing) | - | 1 | 1 | 10 | 15 | 25 |
| AGP-303-P | Geophysical Tools II: Electrical & Electro Magnetic Methods | _ | 1 | 1 | 10 | 15 | 25 |
| AGP-304-P | Image Processing & Geographic Information System | _ | 1 | 1 | 10 | 15 | 25 |
| **Discipline Specific Elective Courses (DSE)** | | | | | | | |
| AGP-3D-1 | Decision Analysis and Value of Information | 4 | | 4 | 40 | 60 | 100 |
| AGP-3D-2 | Fluvial Dynamics and Tectonic Geomorphology | 4 | - | 4 | 40 | 60 | 100 |
| **Generic Elective Courses (GE)** [offered by the Applied Geology Department] | | | | | | | |
| AGP-3G-1 | Water Science, Policy & Governance | 4 | - | 4 | 40 | 60 | 100 |
| **Generic Elective Courses (GE)** [offered by other departments] | | | | | | | |
| PT-3G-4 | Petroleum Reservoir Engineering | 2 | 2 | 4 | 40 | 60 | 100 |
| PT- 3G-5 | Basic Drilling Technology | 3 | 1 | 4 | 40 | 60 | 100 |
| | | | | | | | |
| **Ability Enhancement Courses (AEC)** [offered by other departments] | | | | | | | |
| AGP-3A-1 | Winter Training-Lab visit | | 2 | 2 | 20 | 30 | 50 |

Total Marks for Semester-III: 750

Total Credits: **22(Minimum)**

**SEMESTER- IV**

| Course No. | Course | L | P | Cr | Marks | | |
|---|---|---|---|---|---|---|---|
| | | | | | IS | ES | Total |
| **Core Courses** | | | | | | | |
| AGP-401 | Geophysical Tools III: MT & GPR Methods | 3 | | 3 | 30 | 45 | 75 |
| AGP-402 | Geophysical Tools IV: Gravity & Magnetic Methods | 3 | | 3 | 30 | 45 | 75 |
| AGP-403 | Geophysical Tools V: Well Logging | 3 | | 3 | 30 | 45 | 75 |
| AGP-404 | Reservoir Geophysics | 3 | | 3 | 30 | 45 | 75 |
| **Practical** | | | | | | | |
| AGP-401-P | Geophysical Tools III: MT & GPR Methods | | 1 | 1 | 10 | 15 | 25 |
| AGP-402-P | Geophysical Tools IV: Gravity & Magnetic Methods | | 1 | 1 | 10 | 15 | 25 |
| AGP-403-P | Geophysical Tools V: Well Logging | | 1 | 1 | 10 | 15 | 25 |
| AGP-404-P | Reservoir Geophysics | | 1 | 1 | 10 | 15 | 25 |
| **Discipline Specific Elective Courses (DSE)** | | | | | | | |
| AGP-4D-1 | Marine Geophysics | 4 | | 4 | 40 | 60 | 100 |
| AGP-4D-2 | Geothermics and Geodynamics | 4 | - | 4 | 40 | 60 | 100 |
| **Generic Elective Courses (GE)** [offered by the Applied Geology Department] | | | | | | | |
| AGP-4G-1 | Environmental Geophysics | 4 | - | 4 | 40 | 60 | 100 |
| **Generic Elective Courses (GE)** [offered by other departments] | | | | | | | |
| | | | | | | | |
| **Ability Enhancement Courses (AEC)** [offered by the department] | | | | | | | |
| | | | | | | | |
| **Ability Enhancement Courses (AEC)** [offered by other departments] | | | | | | | |
| AGP-4A-1 | Summer Training-II- Field/Industrial visit | | 2 | 2 | 20 | 30 | 50 |

Total Marks for Semester-IV: 650

Total Credits: **22(Minimum)**

**SEMESTER- V**

| Course No. | Course | L | P | Cr | Marks | | |
|---|---|---|---|---|---|---|---|
| | | | | | IS | ES | Total |
| **Core Courses** | | | | | | | |
| AGP-501 | Formation Evaluation | 3 | 1 | 4 | 30 | 45 | 75 |
| AGP-502 | Seismic Data Interpretation and Basin Analysis | 3 | 1 | 4 | 30 | 45 | 75 |
| AGP-503 | Sequence Stratigraphy | 3 | 1 | 4 | 30 | 45 | 75 |
| AGP-504 | Simulation modeling in environmental science | 3 | 1 | 4 | 30 | 45 | 75 |
| **Practical** | | | | | | | |
| AGP-501-P | Formation Evaluation | | 1 | 1 | 10 | 15 | 25 |
| AGP-502-P | Seismic Data Interpretation and Basin Analysis | | 1 | 1 | 10 | 15 | 25 |
| AGP-503-P | Sequence Stratigraphy | | 1 | 1 | 10 | 15 | 25 |
| AGP-504-P | Simulation modeling in environmental science | | 1 | 1 | 10 | 15 | 25 |
| **Discipline Specific Elective Courses (DSE)** | | | | | | | |
| AGP-5D-1 | Advanced Seismology | 4 | | 4 | 40 | 60 | 100 |
| AGP-5D-2 | Geomagnetism | 4 | - | 4 | 40 | 60 | 100 |
| **Generic Elective Courses (GE)** [offered by the Applied Geology Department] | | | | | | | |
| | | | | | | | |
| **Generic Elective Courses (GE)** [offered by other departments] | | | | | | | |
| | | | | | | | |
| **Ability Enhancement Courses (AEC)** [offered by the department] | | | | | | | |
| AGP-5A-1 | Research Methodology & Science Writing | 2 | - | 2 | 20 | 30 | 50 |
| **Ability Enhancement Courses (AEC)** [offered by other departments] | | | | | | | |
| AGP-5A-2 | Industrial Management | 2 | - | 2 | 20 | 30 | 50 |

Total Marks for Semester-V: 600

Total Credits: **22(Minimum)**

**SEMESTER- VI**

| Course No. | Course | L P Cr | Marks | | |
|---|---|---|---|---|---|
| | | | IS | ES | Total |
| **Core Courses** | | | | | |
| AGP-601 | Dissertation/Project Work | 12 | | | 500 |
| AGP-602 | Seminar | 2 | | | 50 |
| AGP-603 | Comprehensive Viva Voce | 2 | | | 50 |
| AGP-604 | Grand Comprehensive Test | 4 | | | 100 |

Total Marks for Semester-VI: 700
Total Credits: **20**

Cumulative Total Marks (I+II+III+IV+V+VI semesters)
=550+550+750+650+600+700=3800
Cumulative Total Credits (I+II+III+IV+V+VI semesters)
=**19+19+22+22+22+20=124 (Minimum)**

| Semester | Courses with Credits | | | | | |
|---|---|---|---|---|---|---|
| | Core (Fixed) | | Elective (minimum one) | | AEC (minimum) | Total (Minimum) |
| | Theory | Practical | DSE | GE | | |
| I | 4 Courses × 3 Credits=12 | 1 Course ×1 Credit =1 | 1 Course × 4 Credit =4 | 1 Course × 4 Credit =4 | 1 Course × 2 Credit =2 | 19 |
| II | 4 Courses × 3 Credits=12 | 1 Course ×1 Credit =1 | 1 Course × 4 Credit =4 | | 1 Course × 2 Credit =2 | 19 |
| III | 4 Courses × 3 Credits=12 | 4 Courses ×1 Credit = 4 | 1 Course × 4 Credit =4 | 1 Course × 4 Credit =4 | 1 Course × 2 Credit =2 | 22 |
| IV | 4 Courses × 3 Credits=12 | 4 Courses ×1 Credit = 4 | 1 Course × 4 Credit =4 | 1 Course × 4 Credit =4 | 1 Course × 2 Credit =2 | 22 |
| V | 4 Courses × 3 Credits=12 | 4 Courses ×1 Credit = 4 | 1 Course × 4 Credit =4 | | 1 Course × 2 Credit =2 | 22 |
| VI | Dissertation/Project work (12) | Seminar (2) | Composite Viva Voce (2) | | Grand Composite Test (4) | 20 |

Note:
Core: Core Courses (Compulsory) / Credits: 3 (Only Theory) / Credits: 4 (Theory + Practical)
DSE: Discipline Specific Elective (Intra-Departmental / Credit: 4)
GE: Generic Elective (Inter-Departmental / Inter-Disciplinary / Credits: 4)
AEC: Ability Enhancement Courses (Inter-Disciplinary / Credits: 2)
L: Numbers of weekly lectures (Each of 1 hr duration and 1 Credit)
P: Numbers of weekly practical (Each of 2hrs duration and 1 Credit)
IS: In-semester marks/ ES: End-semester Marks/ TM: Total Marks

**SYLLABUS FOR MSC.TECH IN APPLIED GEOPHYSICS PROGRAMME UNDER CHOICE BASED CREDIT SYSTEM DURING THE ACADEMIC SESSION 2020-2023**

# Semester I

## AGP-101: Philosophy of Science & Exploration

| L | Cr | IS | ES | TM |
|---|---|---|---|---|
| 3 | 3 | 40 | 60 | 100 |

Unit 1: *Rationale for studying philosophy of science* ***(6 hours)***
The concerns of science, how science differs from theology, philosophy and humanities? The objectives of scientific research; Facts, theories, laws and concepts, experiments and the nature of theories, what is meant by the *state* of a physical system? What constitutes a *field*? What exactly is meant by the *arrow of time*? Scientific and philosophical approaches to knowledge development and knowledge application.

Unit 2: *Philosophy of exploration in science* ***(4 hours)***
The problem of the 'Empirical basis'; Scientific objectivity and subjective conviction; Causality; Explanation and the deduction of predictions; Theoretical systems; Inductive logic and probability logic; Verification and falsification; Discovery and justification; The Path of science

Unit 3: *Structural development of Science and Scientific Thinking* ***(12 hours)***
Essential elements of unity and diversity between Eastern and Western thought pattern and the development of scientific way of thinking; Religion versus Science; Struggle between Science and Religion; Ideas of Plato, Aristotle, Francis Bacon, Rene Descartes, David Hume, Karl Popper, Thomas Kuhn, Lakatos, Feyerabend, J D Bernal, Bruno Latour; Scientific ideas of Eastern philosophers

Unit 4: *Convergence of Science and Philosophy* ***(6 hours)***
Existential issues and broad involvement of science; The Newtonian world; Unified Theory, Space Time Relationship; Relativity, Uncertainty principle; wave-particle duality; quantum theory; Darwin's theory of evolution; Plate Tectonics; Epistemic and ontological aspects.

Unit 5: *Philosophy of application of Geophysical Tools* ***(12 hours)***
Brief history of development of geophysical exploration; General assumptions involved in the geophysical prospecting; Difference between the observation and the interpretation; Elements of surveying; Geodesy and GPS; Basic philosophy of mathematical formulation and Programming; Passive and Active tools, Invasive and non-invasive techniques; Significance of 1-D, 2-D and 3-D problems; reservoir studies involving space-time variability; Application of geophysical methods in oil, mineral and ground water exploration; Geophysical exploration and nation building.

***Activities*****:** Quick reading of selective passages and answering questions, writing essays on contributions of thinkers and philosophers contributing to the development of scientific thinking

References:


1) Popper, K.R., 1959. The logic of scientific discovery, Hutchinson, London.
2) Kuhn, Thomas S., 1962. The Structure of Scientific Revolutions, The University of Chicago Press.
3) Cahn, Steven M. (Edited by), 2000. Exploring philosophy: an introductory anthology, Oxford University Press.
4) Silver, Brian L.,1998. The ascent of science, Oxford University Press.
5) Dobrin, M.B., Savit, C.H., 1988. Introduction to Geophysical Prospecting, 4th Ed. McGraw Hill.
6) Telford, M., Geldart, L.P., and Sheriff R.E., 1990 Applied Geophysics, 2nd Edition, Cambridge University press.
7) Lowrie, W., 2007. Fundamentals of Geophysics, 2nd edition, Cambridge University Press.
8) Lowrie, W., 2011. A Student's Guide to Geophysical Equations, Cambridge University Press.
9) Barnes, John W., 2004. Basic Geological Mapping, 4th Edition, John Wiley & Sons, Ltd.

## AGP-102: Earth System Science

| L | Cr | IS | ES | TM |
|---|---|---|---|---|
| 3 | 3 | 40 | 60 | 100 |

Unit 1: *Framework of Earth System Science.* ***(6 hours)***
A brief introduction to different spheres; primary causal mechanisms located in individual spheres and their influence on different spheres, Climate forcing, Climate system responses, Feedbacks in the climate system, Climate archives, Data, and models.

Unit 2: *Scales of climate change.* ***(12 hours)***
Gaia hypothesis; Greenhouse earth, Icehouse earth, BLAG hypothesis, Monsoon circulation, Insolation control of ice sheets, Milankovitch Theory, Orbital scale changes in Carbon dioxide and Methane, The Last Glacial Maximum, Millenial oscillations in climate. Climatic changes during the last 1000 years; Pre and post-industrial revolution climatic changes; Anthropogenic factors contributing to global warming; Future climatic change.

Unit 3: *Geologic Systems* ***(8 hours)***
Closed systems; Open systems; Direction of change in Geologic Systems; The hydrologic system; Major subsystems of the hydrologic system like atmosphere-ocean system, river systems, glacial systems, groundwater systems, shoreline systems and Eolian systems; Tectonic systems

Unit 4: *Global Tectonics* ***(6 hours)***
The framework of plate tectonics, Plates and plate margins, Distribution of earthquakes, Direct measurement of relative plate motions, Triple junctions, measurement of relative plate motion, Plate tectonics and economic geology -Autochthonous and allochthonous deposits, Deposits of sedimentary basins, Deposits related to climates.

Unit 5: *Basin Evolution* ***(8 hours)***
An introduction to basin-forming tectonics, depositional sequences and basin-modifying tectonics, types of basin classification, an overview of Indian sedimentary basins, Evolution of Assam Arakan Basin

References:


1. Ruddiman, W.F., Earth's Climate: Past and Future, Freeman and Company, 2013.
2. Allen, P.A., Allen, J.R., 2005. Basin Analysis, Principles and Applications, 2nd edition, Blackwell Publishing
3. Hamblin, W. Kenneth., Christiansen, Eric H., Earth's Dynamic Systems, Tenth edition
   Source: http://www.prenhall.com/hamblin
4. Edited by Jacobson, Michael C., Charlson, Robert J., Rodhe Henning., Orians, Gordon H., 2006. Earth System Science – From Biogeochemical Cycles to Global Change. International Geophysics Series VOLUME 72, Elsevier.

## AGP-103: Applied Mathematics for Geophysics

| L | Cr | IS | ES | TM |
|---|---|---|---|---|
| 3 | 3 | 40 | 60 | 100 |

Unit 1: *An introduction to Applied Mathematics* ***(6 hours)***
Summaries of basic concepts like Determinants, Vector analysis, Matrix analysis, Complex numbers, Method of least squares, Finite differences and Partial fractions. Linear systems, Digital systems

Unit 2: *Analysis of Complex Variables* ***(10 hours)***
Limit. Continuity and differentiability of function of complex variables; Analytic functions; Cauchy-Riemann's and Cauchy's in tergal theorem; Moreira's theorem; Cauchy's integral formula; Expansion of function of complex variables in Taylor's and Laurent's series; singularities and poles; Residue theorem; Contour integration; Conformal mappings and its application; Bilinear transformation

Unit 3: *Fourier Analysis* ***(6 hours)***
Fourier series and Fourier coefficients; simple examples; use of exponential representation for harmonic oscillations; expression for Fourier coefficients; Non-periodic disturbance; representation by Fourier integral, Fourier Transform

Unit 4: *Special Functions* ***(10 hours)***
Solution of Bessel and Legendre equations; Recurrence relations and generating function for $J_n(X)$. Elliptic integrals and Error function and their properties
Laplace Transform of simple functions, first and second shifting theorems, t-multiplication and t-division theorems; Laplace transform of derivatives, integrals and periodic functions.
Inverse Laplace transform and convolution property; Use of Laplace transform in evaluating complicated and improper integrals and solutions of ordinary differential equations related to engineering problems

Unit 5: *Partial Differential Equations* ***(8 hours)***
Classification of partial differential equations, solutions of one-dimensional wave equation; one dimensional unsteady heat flow equation and two-dimensional steady heat flow equation in Cartesian and polar coordinates by variable separable method with reference to Fourier trigonometric series and by Laplace transform technique

## AGP-104: Geoscientific Data Analysis with Matlab

| L | Pr | Cr | IS | ES | T |
|---|---|---|---|---|---|
| 3 | 1 | 4 | 40 | 60 | 100 |

Unit 1: *Introduction to Matlab* ***(10 hours)***
Common functions and operations; Arrays: vectors and matrices; Array indexing: subscript indexing, linear indexing and logical indexing; Visualizing data: line plots, scatter plots, polar plots, rose plots, compass plots, contour plots, surface plots, histograms and images; Matrix operations and manipulations; Vectorization; Scripts and Functions.

Unit 2: *Image processing using Matlab* ***(8 hours)***
Transforms: Fourier transform, discrete cosine transform, radon transform, wavelet transform; Filters: Gaussian filter, Laplacian filter, moving average filter, median filter; Frequency responses; Speckle noise removal; Image reconstruction; Edge detection; Image thresholding; Properties of image regions.

Unit 3: *Signal processing using Matlab* ***(8 hours)***
Fast Fourier transform; Sampling and aliasing; Spectral analysis; Power spectral density; Cross correlation and auto correlation; Time-frequency spectrogram; High-pass and low-pass filters; Downsampling and removing trends in data; Principal component analysis.

Unit 4: *Simulation* ***(4 hours)***
2D random walk; Monte Carlo simulation; Bootstrapping; Kernel density estimate; Probability density functions; Empirical cumulative distribution.

Unit 5: *Regression, classification and optimization* ***(10 hours)***
Linear least squares regression; Eigenvectors and eigen values; Polynomial fitting; Non-linear least squares regression; Classification: Logistic regression, Classification trees, Neural networks, Support vector machines; Optimization; Objective functions; Numerical solution of ODEs; Numerical integration and discretization.

References:


1) Menke, W. and Menke, J. (2016). *Environmental Data Analysis with Matlab*. Academic Press.
2) Hanselman, D. and Littlefield, B. (2011). *Mastering Matlab*. Prentice Hall.
3) Moler, C. (2004). *Numerical Computing with Matlab*. SIAM.
4) Van Loan, C.F. and Fan, K.Y.D. (2010). *Insight Through Computing: A Matlab Introduction to Computational Science & Engineering*. SIAM.
5) Middleton, G.V. (2000). *Data Analysis in the Earth Sciences using Matlab*. Prentice-Hall.
6) Johnson, R.K. (2011). *The Elements of Matlab Style*. Cambridge University Press.
7) Online resources at http://www.mathworks.com.

## AGP-104-P: Practical: Geoscientific Data Analysis with Matlab

| L | Cr | IS | ES | T |
|---|---|---|---|---|
| 2 | 1 | 20 | 30 | 50 |

1. Matrix manipulations and matrix indexing, various types of plots, simple data statistics, data gridding and interpolation.
2. Writing m-files.
3. Image processing: 2D discrete cosine transform, Gaussian filter and Laplacian filter, edge detection, median filter, tomography.
4. Signal processing: sampling and aliasing, spectral analysis, cross-correlation and auto-correlation, Fourier transform, time-frequency spectrogram, low-pass filter.
5. Randomized affine transformations, linear equations, linear least squares regression, polynomial fitting.
6. Non-linear least squares regression, numerical solution of ODEs, symbolic toolbox, numerical integration and discretization.
7. Simulation, bootstrap.
8. Multivariate data analysis using cell arrays and structure arrays

## AGP-1D-1: Physics Essential

| L | Cr | IS | ES | TM |
|---|---|---|---|---|
| 4 | 4 | 40 | 60 | 100 |

Unit 1: *Introduction* ***(4 hours)***
Field concept, The coordinate systems, Scalar and Vector fields, Differential elements of length, surface and volume, Line, surface and volume integrals, The gradient of a scalar function, Divergence of a vector field, The Laplacian operator, Some fundamental theorems and field classifications, Vector identities

Unit 2: *Static fields* ***(12 hours)***
Laws and concepts associated with electrostatics (Coulomb's law, Electric field intensity, Electric flux and electric flux density, The electrical potential, Electric dipole, materials in an electric field, Energy stored in an electric field, Boundary conditions, Capacitors and capacitance, Poisson's and Laplace's equations, Method of images), Laws and concepts associated with magnetostatics (Biot-Savart law, Ampere's force law, Magnetic torque, Magnetic flux and Gauss's law for magnetic fields, Magnetic vector potential, magnetic field intensity and Ampere's circuital law, Boundary conditions for magnetic fields, Magnetic circuits)

Unit 3: *Steady electric currents and time varying electromagnetic fields* ***(12 hours)***
Nature of current and current density, the equation of continuity, Boundary conditions for current density, the electromotive force, Faraday's law of induction, self-inductance, mutual inductance, inductance of coupled coils, energy in a magnetic field, Maxwell's equations and boundary conditions, time harmonic fields, applications of electromagnetic fields

Unit 4: *Plane wave propagation* ***(6 hours)***
General wave equations, Plane wave in a dielectric medium, plane wave in free space, plane wave in a conducting medium, plane wave in a good conductor, plane wave in a good dielectric, polarization of a wave, normal incidence of uniform plane waves, oblique incidence on a plane boundary

Unit 5: *Interaction of fields and matter* ***(6 hours)***
Plasma Oscillations, Wave Propagation in Plasma, Polarization of Dielectric Materials,
Equivalent Volume and Surface Charges, The Permittivity Concept, Magnetic Polarization, Equivalent Volume and Surface Currents, The permeability Concept, Frequency Responses of Dielectric Materials

References:

1) Guru, Bhag and Hüseyin Hiziroğlu, Electromagnetic Field Theory Fundamentals, 2nd Edition, Cambridge University Press, 2004.
2) Jordan, Edward C., Balmain, Keith G. Electromagnetic waves & Radiating Systems, 2nd Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 1990.
3) Roy, K.K., Potential Theory in Applied geophysics, Springer, 2008.

## AGP-1D-2: Geology Essential

| L | Cr | IS | ES | TM |
|---|---|---|---|---|
| 4 | 4 | 40 | 60 | 100 |

Unit 1: *Earth Materials: Mineralogy, Rocks and the Rock Cycle* ***(4 hours)***
Mineral definition, types and examples, Rocks and the rock cycle, Vulcanicity and igneous rocks, Sedimentary rocks, fossils and sedimentary structures, Metamorphic rocks.

Unit 2: *Earth Surface Processes* ***(6 hours)***
Overview of the Earth, Production of sediment at the Earth's surface, Weathering, Fundamentals of fluid flow, sediment transport, erosion and deposition, Environments of erosion and deposition, Diagenesis, Long-term large-scale processes: mountains and sedimentary basins.

Unit 3: *Mesoscopic structures and methods of their analysis* ***(12 hours)***
Description of folds, shear zones, faults and fault zones, foliations, lineations, & Veins. Characteristics, style, age analysis and interpretation of Joints. Fault and lineament –array analysis. Fold styles and section lines, construction of profiles for plunging and non plunging folds.

Unit 4 : *Quantitative surface and subsurface map interpretation* ***(12 hours)***
Structure contour maps from profiles fold trend and recognition of cylindrical and conical folds on a tangent diagram, faults- calculations of heave and throw from stratigraphic separation, basic concepts of 3-D structural interpretation, fault cut-off maps & Allan diagrams.

Unit 5: *Sedimentary Basins* ***(6 hours)***
Types of Sedimentary basins, Depositional Systems and facies Models, Subsidence, Denudation and Sediment Budget, , An introduction to 'Petroleum Geology'- Petroleum source, Kerogen types, migration, accumulation and trapping mechanism etc.

Reference:


1. Blyth, F.G.H., Fritas, M.H. de, 1984. A Geology for Engineers, Elsevier.
2. Das Gupta, A. B., Biswas, A.K., 2000. Geology of Assam, Geological Society of India, Bangalore.
3. Gopendra Kumar, 1997. Geology of Arunachal Pradesh, Geological Society of India.
4. Haakon Fossen, 2010. Structural Geology, Cambridge university press.
5. Johnson, Robert B., DeGraff, Jerome V., 1988. Principles of Engineering Geology, Wiley.
6. Mathur, L.P., Evans, P., 1964. Oil in India: a review prepared by the staff of the Oil and Natural Gas Commission, the Assam Oil Co. Ltd., and Oil India Ltd.
7. Miall, Andrew D., 2010. Principles of Sedimentary Basin Analysis, Springer.
8. Miall, Andrew D., 2016. Stratigraphy – A modern synthesis, Springer.
9. Nandy, D.R., 2017. Geodynamics of Northeastern India and the adjoining region, Scientific Book Centre.
10. Ruddiman, W.F., Earth's Climate: Past and Future, Freeman and Company, 2013.
11. Sengupta, S.M., 2018. Introduction to Sedimentology, CBS.

# AGP-1A-1: Technical English & Professional Communication

| L | GD | Cr | IS | ES | T |
|---|---|---|---|---|---|
| 2 | 1 | 2 | 20 | 30 | 50 |

Unit 1: *An introduction to scientific communication* ***(8 hours)***

How is scientific communication different from providing information or education? Difference between expressing and communicating; Distinction between target group and readers/ listeners/ viewers; Communicating for impact on target group and to engage media consumers;
Communicating to elicit community action: Dictyostelium model for understanding essential principles; Nature of political, religious and commercial communication; Communicating science to elicit action, change or reform.
***Activities*:** Writing CV, writing proposal for conducting scientific research

Unit 2: *Language and Science* ***(6 hours)***
Nature of scientific language: Removal of first person, removal of identities, names of scientists ; Use of passive voice; Lack of attention to spelling and grammar in teaching and learning science ; Essentials of punctuation ; Parts of speech ; Tense; Transitions between hypothesis, experiments and results; Connecting words, sentences and paragraphs; Converting complex nouns into simple verbs.
***Activities:*** Learning grammar using web tools, Vocabulary increasing exercises, Phrasal verbs.

Unit 3: *Scientific Communication* ***(6 hours)***
Understanding the structure of a scientific paper;
Searching for and researching scientific content: Google, Google Scholar, Academia.edu, Research gate, Databases, Directories
Reading, writing, rewriting, restructuring
Art of preparing impressive Power Point Presentations
***Activities:*** Asking questions, formulating key words, searching, bookmarking, using a web-clipper, organizing PDF files, bibliography management

Unit 4: *Group Discussion (GD)* ***(8 hours)***
Nature of group discussions, uses and importance; Leadership function in GD; developing leadership qualities and positive group behaviour; Starting discussions: opening the discussion, stating objectives, suggesting good group procedure (time management, speaking procedure, etc.; giving opinions, asking for opinions and supporting opinions in GD; making suggestions and asking for suggestions; Balancing points of view, expressing advantages, disadvantages and consequences; some pitfalls in discussions, fallacies in argument and rebuttal, concluding and controlling discussions.

## Suggested Materials & References

Brigitte Markner-Jäger, 2008. Technical English for Geosciences, A Text/Work Book, Springer
David Horner & Peter Strutt, 1996. Words at work, Vocabulary development for Business English, Cambridge University Press
Durant, Will, 1926. The Story of Philosophy, Simon & Schuster.
Fowler, H.W., 1996. Fowler's Modern English Usage, revised third edition, edited by R.W. Burchfield, Oxford University press
Ibbotson, Mark, 2009, Professional English in Use, Cambridge University Press
Jordan, R.R., 1999. Academic Writing Course, Study skills in English, Pearson Education Limited, UK.
Kuhn, Thomas S., 1962. The Structure of Scientific Revolutions, The University of Chicago Press.
Lewis, Norman, 2011.Word Power Made Easy (Indian Publisher: GOYL SAAB)
Lewis, Norman, 1978, How to read better and faster (Indian Publisher: GOYL SAAB)
Popper, K.R., 1959. The logic of scientific discovery, Hutchinson, London.
Cambridge International Dictionary of Phrasal Verbs
Ready consultation: https://www.wikipedia.org

# Semester-II

## AGP-201: Geophysical Inversion

| L | Cr | IS | ES | T |
|---|---|---|---|---|
| 3 | 3 | 40 | 60 | 100 |

Unit 1: *Introduction to inverse theory* ***(8 hours)***
Model space and data space; Definition of the forward and inverse problems; Continuous and discrete inverse problems; Mathematical background; Rank of a matrix; Eigen values and eigen vectors; Inverse of a matrix; Singular Value Decomposition (SVD); Probability; A priori information.

Unit 2: *Linear inversion* ***(10 hours)***
Formulation of linear inverse problems; Least squares method: steepest descent and conjugate gradient; Norms; Misfit; Gradient and Hessian; Overdetermined and underdetermined; Existence, uniqueness and stability; Tikhonov regularization; Variance and prediction error; Generalized inverses; Maximum likelihood solution; Examples.

Unit 3: *Non-linear inversion* ***(10 hours)***
Newton's method; Gauss-Newton (GN) and Levenberg-Marquardt (LM) methods; Occam's inversion; Parameterizations; Linearizing parameterizations; Convergence and nonuniqueness; Examples.

Unit 4: *Probabilistic inversion* ***(6 hours)***
Bayesian approach; Prior and posterior distributions; Sampling methods: Rejection sampling, Markov chain Monte Carlo.

Unit 5: *Global optimization* ***(6 hours)***
Particle Swarm Optimization (PSO); Simulated annealing; Genetic algorithm; Neighbourhood algorithm.

References:


1) Menke, W. (2018). *Geophysical Data Analysis: Discrete Inverse Theory*. Academic Press.
2) Aster, R.C., Borchers, B., and Thurber, C.H. (2013). *Parameter Estimation and Inverse Problems*. Academic Press.
3) Tarantola, A. (2005). *Inverse Problem Theory and Methods for Model Parameter Estimation*. SIAM.
4) Scales, J.A., Smith, M.L. and Treitel, S. (2001). *Introductory Geophysical Inverse Theory*. Samizdat Press.
5) Gubbins, D. (2004). *Time Series Analysis and Inverse Theory for Geophysicists*. Cambridge University Press.
6) Wunsch, C. (2006). *Discrete Inverse and State Estimation Problems*. Cambridge University Press.

## AGP-202: Geophysical Prospecting.

| L | Cr | IS | ES | T |
|---|---|---|---|---|
| 3 | 3 | 40 | 60 | 100 |

Unit 1: *Subsurface studies-issues at different depths* ***(6 hours)***
Geophysical problems in different depth ranges - Shallow subsurface, basin scale, plate scale and deeper; Building blocks of geophysical concepts - Contrast, anomaly and overburden; Forward problems and inverse problems, layers and boundaries, geophysical models, causative bodies and their geometrical analogy

Unit 2: *Geophysical properties of sediments, rocks and minerals* ***(6 hours)***
Pore space properties, Densities, Magnetic susceptibilities, electrical potential differences having different origins, electrical resistivities, dielectric constants, velocities of seismic waves, reflection coefficients, Radioactive properties, Thermal Properties, contrasts and anomalies, Geophysical anomalies for different geological situations.

Unit 3: *An introduction to Exploration Geophysics* ***(10 hours)***
The questions frequently faced by the geophysicists, the nature of geophysical problems, Fields of Exploration Geophysics: Regional geophysics, Oil and gas geophysics, Ore geophysics, Ground water geophysics, Engineering geophysics,

Unit 4: *Geophysical Field Practices* ***(12 hours)***
Problem types and planning for data acquisition; Random data collection and systematic data collection on grids; means to bring random data on grids; Resolution - vertical and horizontal; Drift correction for gravity data; Misties and their removal from the airborne magnetic data; Sounding and Profiling; Different types of array designs used for electrical and electro-magnetic surveys; Pseudo-sections and electrical tomography; 2D and 3D seismic data acquisition; Multi-component Seismics

Unit 5: *Elements of open-hole wireline logging* ***(6 hours)***
Borehole environment; Significance of different types of resistivities; Archie's equations for sandstones and carbonates; General methods of qualitative and quantitative interpretations; introductory aspects of log correlation using sequence stratigraphic approach

## Suggested materials and references


1. Adams, S., Lambert, D., Earth Science: An Illustrated Guide to Science, Chelsea House Publishers, 2006.
2. Bhimasankaram, V.L.S., Exploration Geophysics-An Outline, Association of Exploration Geophysicists (AEG), Hyderabad, 1977.
3. Dobrin, M.B., Savit, C.H. Introduction to Geophysical Prospecting, 4th Ed. McGraw Hill, 1988.
4. Dewan, J. T., Essentials of Modern Open-hole Log Interpretation, PennWell Books, 1983.
5. Kearey, P., Brooks, M., Hill, I. An Introduction to Geophysical Exploration, 3rd Ed. Blackwell, 2002.
6. Lowrie, W., Fundamentals of Geophysics, 2nd edition, Cambridge University Press, 2007.
7. Milsom, J., Eriksen, A., Field Geophysics, John Wiley & Sons, 2011.
8. Mussett, A. E., Khan, M.A., Looking into the earth: An introduction to geological geophysics, 1st Published, Cambridge University Press, 2000.
9. Rider, Malcolm, The Geological Interpretation of Well Logs, 2nd Edition, Rider-French Consulting Ltd, Scotland, 2002.
10. Robinson, E.S., Coruh, C., Basic Exploration Geophysics, 1st ed., Wiley, 1988.
11. Stein, S., Wysession, M., An Introduction to Seismology, Earthquakes and Earth Structure, Blackwell, 2003.
12. Williams, L., Earth Science Demystified, McGraw-Hill, 2004

## AGP-203: Geophysical Signal Theory

| L | Cr | IS | ES | T |
|---|---|---|---|---|
| 3 | 3 | 40 | 60 | 100 |

Unit 1: *Digital Signals* ***(8 hours)***
Classification of digital signals, Wavelets, Convolution, Properties of convolution, Transfer function for a causal system, Transfer function for a non-causal system, Laplace Transform and z-transform, The inverse z-transform.

Unit 2: *Frequency Analysis* ***(8 hours)***
Frequency domain representation of Digital Signals and Systems, Fourier Transform for Discrete Time Signals, Properties of the Fourier Transform, Minimum delay and Minimum phase, All-Pass Systems

Unit 3: *Deconvolution* ***(8 hours)***
The Autocorrelation and the Spectrum, The cross correlation, The Convolutional Model, Signature Deconvolution, Deterministic Reverberation Deconvolution, Predictive Deconvolution, Maximum Entropy Spectral Analysis.

Unit 4: *Optimum Linear Filtering and FK techniques* ***(8 hours)***
Least Squares Filtering, Linear Prediction, Spiking and Shaping Filters for Seismic Data, Adaptive Filtering. The FK Transform, Aliasing, FK Transforms related to seismic data, FK Filtering, FK Migration

Unit 5: *Data-Processing* ***(8 hours)***
Processes to improve signal-to-noise ratio, Processes to reposition data, Special processing techniques, typical processing sequence and Interactive processing, Data processing of 3-D data, 3-D Migration.

References:

1. Sheriff, R.E., & Geldart, L.P., Exploration Seismology Vol. 1 & 2, Reprint ed. Cambridge, 1986, 1987.
2. Telford, M., Geldart, L.P., Sheriff, R.E. and Keys, D.A., Applied Geophysics, 1st Indian ed. Oxford & IBH, 1988.
3. Yilmaz öz, Seismic Data Analysis: Processing, Inversion and Interpretation of Seismic Data, Society of Exploration Geophysics, 2000.

# AGP-204: Numerical Analysis & Computer Programming

| L | Pr | Cr | IS | ES | T |
|---|---|---|---|---|---|
| 3 | 1 | 4 | 40 | 60 | 100 |

Unit 1: *Solution of algebraic and transcendental equations* ***(4 hours)***
Different methods like Bisection, Iteration, False Position. Newton-Raphson Method, Muller's Method, The Quotient-Difference Method, Solution of Systems of Nonlinear Equations.

Unit 2: *Interpolation* ***(6 hours)***
Forward differences, Backward differences, Central differences; Detection of errors by use of Difference tables; Differences of a polynomial; Gauss's Central Difference formulae, Stirling's, Bessel's, Everett's formula; Lagrange's Interpolation Formula, Hermite's Interpolation Formula; Newton's General interpolation formula; Interpolation by iteration; Method of successive approximations

Unit 3: *Numerical solution of differential and integral equations* ***(10 hours)***
Numerical solution of ordinary differential equations (Solution by Taylor's Series, Picard's Method of Successive Approximations, Euler's Method, Runge-Kutta Methods, Adams-Moulton Method, Milne's Method), Numerical solution of partial differential equations (Laplace's equation, Jacobi's Method, Gauss-Seidel Method, Iterative methods for the solution of equations) , Numerical Solution of Integral equations (Finite difference methods, A method of degenerate Kernels, Method of Invariant Imbedding, Method using generalized quadrature)

Unit 4: *Fundamental concepts related to Computer Programming* ***(4 hours)***
Basic philosophy of mathematical models and statistical models in Programming; Architecture of digital computers, number systems, data representation, binary arithmetic, Classification and overview of operating system modules; Introduction to UNIX and LINUX operating systems, Window environment, algorithm and flowcharts.

Unit 5: *FORTRAN and C languages* ***(16 hours)***
FORTRAN: Control structures- selective and repetitive, arrays, format statements; subprogram functions, subroutines, DATA, SAVE, COMMON and EQUIVALENCE statements; file processing; additional data types, logical, double precision and complex types.
C: Introduction, constants, variables and data types, operators and expressions, I/O operations, decision making and branching; decision making and looping; arrays, structures and unions, user defined functions, pointers, file management, dynamic allocations and linked lists, the preprocessors.
Introductory elements of JAVA and PYTHON

## AGP-204-P: Practical: Numerical Analysis & Computer Programming

| L | Cr | IS | ES | T |
|---|---|---|---|---|
| 2 | 1 | 20 | 30 | 50 |

1. Numerical solution of non-linear algebraic and transcendental equation by bisection, iteration, false position, secant and Newton Raphson methods
2. Numerical solution of a system of linear simultaneous equation by Gauss elimination and Gauss Seidel methods
3. Interpolation by Lagrange's interpolation formula
4. Numerical evaluation of definite integral by Trapezoidal, Simpson's $1/3^{rd}$, Simpson's $3/8^{th}$, Weddle and Gaussian quadrature formulae.
5. Numerical solution of first order ordinary differential equation by Euler's Modified Euler's second and fourth order Runge-Kutta, Adams-Moulton and Milne's methods.
6. For FORTRAN Language: Execution of programs using the following:
   i) Control Structures – Logical IF, Arithmetic IF, Nested Block IF, Computer GOTO
   ii) Repetitive Structures – IF loop, DO-loop, Nested DO loop
   iii) Arrays – Traversing, Sorting, Searching, Inserting, deleting operations, Use of two or more-dimensional arrays
   iv) Subprograms: Functions – Statement functions, Function Subprograms, Subroutine Subprograms
   v) Use of DATA, SAVE, COMMON and EQUIVALENCE statements
   vi) File processing
7. For C-Language: Execution of programs using the following:
   i) Decision making and branching- if statement, Nested if, Else if ladder, Block if, Switch statement
   ii) Decision making and looping – while, do-while, for.
   iii) Arrays- Traversing, Sorting, Inserting, deleting operations, Processing arrays with more than one dimensions
   iv) User defined functions – Recursive functions, Nesting of functions
   v) Structures – Use of structure data type, array of structures, Unions.
   vi) Handling files in C-sequential, random access files.

## AGP-2D-1: Hydrogeology and Groundwater Investigations

| L | P | Cr | IS | ES | T |
|---|---|---|---|---|---|
| 3 | 1 | 4 | 40 | 60 | 100 |

| Units | Hydrogeology and Groundwater Investigations |
|---|---|
| 1 | Definition of Hydrology and its relation with other sciences. Hydrologic cycle. Origin, occurrence and distribution of subsurface water. Porosity and different types of pore spaces in rocks. ***(4 hours)*** |
| 2 | Concept of water table and piezometric surface. Importance of water table in hydrogeological studies.<br>Aquifer - its definition, different types and characteristics. ***(6 hours)*** |
| 3 | Dynamics of subsurface water: Darcy's law and its range of validity. Basic concepts of permeability/hydraulic conductivity, specific yield, transmissivity and storage coefficient. ***(6 hours)*** |
| 4 | Basics of well hydraulics related to a pumping well: Concepts of drawdown, cone of depression, specific capacity, specific drawdown and boundary conditions.<br>Equilibrium and non-equilibrium conditions. ***(8 hours)*** |
| 5 | Groundwater investigations: Geological, hydrogeological and geophysical approaches; Groundwater inventory.<br>Study of flow nets and its importance in groundwater investigation. Hydrogeological studies carried out in drilled wells. ***(12 hours)*** |
| 6 | Basic concept of groundwater management - equation of hydrologic equilibrium. Safe yield and overdraft. ***(4 hours)*** |

**Suggested Books**:


1) **Groundwater Hydrology** (2nd Edn) - D.K. Todd, *John Wiley & Sons, New York*
2) **Hydrogeology** - Davis, S. N., and DeWiest, R. J. M., *John Wiley & Sons, New York*
3) **Ground Water** - *H.M. Raghunath* (1983), Wiley Eastern Ltd., New delhi
4) **Introduction to Ground Water Hydrology** - R.C. Heath and F.W. Trainer, John Wiley & Sons, New York.
5) **Ground Water Assessment Development and Management** - *K.R. Karanth,* (1987), *Tata McGraw-Hill, New Delhi*
6) **Hydrogeology Principles and Practice** - *K. M.Hiscock*, (2005), *Blackwell Publishing*

## AGP-2D-2: Principles of Stratigraphy

| L | Cr | IS | ES | T |
|---|---|---|---|---|
| 4 | 4 | 40 | 60 | 100 |

| Units | Topic |
|---|---|
| 1. | Principles of stratigraphy, Modern development in stratigraphy, Steps in stratigraphic studies. Evolution of Geological Time Scale. Significant events in geological time ***(6 hours)*** |
| 2. | Formal stratigraphic classifications: rock, time and time-rock units. The Stratigraphic Code, Local Example: the Jaintia Group. Lithostratigraphy. Biostratigraphy, Chronostratigraphy, Magnetostratigraphy. ***(10 hours)*** |
| 3. | Methods of Correlation: physical and time (isochronous/ diachronous patterns), Correlation of lithostratigraphic units, Shaw's Graphic correlation. Sediment accumulation and gaps in the stratigraphic record: diastems, unconformities. ***(8 hours)*** |
| 4. | Stratotypes, Facies in stratigraphy. Walther's Law of succession of facies. Types of Stratigraphic facies. ***(4 hours)*** |
| 5. | Stratigraphy and Distribution of Tertiary rocks of upper Assam and Surma basins, Assam Arakan Mobile Belt, Meghalaya Basin and Arunachal foredeep. ***(6 hours)*** |
| 6. | Generalised stratigraphic successions of different petroliferous basins of India.***(6 hours)*** |

Reference:


1) Sam Boggs, 1995, Principles of Sedimentology and Statigraphy, Printice Hall, New Jersey, 765p.
2) Mial A.D. 1999. Principles of Sedimentary Basin Analysis. 3rd edition.Springer-Verlag.
3) Schoch, R. M. 1989. Stratigraphy, principles and methods.
4) Weller, J. Marvin 1960. Stratigraphic principles and practice. Harper's Geoscience series.

5) Krishnan, M.S. 1982. Geology of India and Burma, CBS Publishers, Delhi