Electromagnetic Methods

1.1. Course Number: GE421

1.2. Contact Hours: 3-0-0 Credits: 9

1.3. Semester Offered: 4th Year-Odd

1.4. Prerequisite: Basic understanding electromagnetic theory

1.5. Syllabus Committee Members: Dr. Satish Sinha and Dr. Piyush Sarkar

2. Objective: Understanding the physics of the electromagnetic waves in the earth and its manifestation. Intricacies of data acquisition, interpretation and modelling for the entire spectrum of geo-electromagnetic methods. Understanding the concept of static shift.

3. **Course Content:** Unit-wise distribution of content and number of lectures

Unit	Topics	Sub-topics	Lectures
1	Basic Principles and Theory	Maxwell's equations, electromagnetic potential and wave equations, boundary conditions, long wavelength, approximation, depth of penetration, electromagnetic field due to straight wire, rectangular and circular loops, elliptical polarisation, amplitude and phase relations, real (in phase) and imaginary (quadrature) components.	8
2	Methods of Prospecting	Bieler Watson method, Dip angle methods- fixed vertical loop transmitter, broadside and shoot back methods, two frame method, compensator method, Turam method, Moving source- receiver methods- horizontal loop (Slingram) method, AFMAG and VLF methods, airborne EM systems- rotary field method, INPUT method, EM profiling and sounding.	8
3	Interpretation of Data	Principles of EM similitude and modelling, response of conducting sphere to uniform alternating magnetic field and infinitely long horizontal cylinder to line source, response of sheet conductors to dip angle, Turam and horizontal loop EM systems, dip angle characteristic curves and phasor diagrams for horizontal loop EM system for sheets, effect of overburden on EM anomalies, principles and practices of Ground Penetrating Radar (GPR).	10
4	Magnetotelluric (MT) method	Origin and characteristic of MT fields, MT instrumentation, field practices, MT effect over a conducting half space and two layer model. Interaction of signal with the earth- uniform earth, horizontal layers, anisotropy, inhomogeneity, impedance tensor and tipper, topographic	8

		and regional effects, static shift.	
5	Ground Penetrating Radar (GPR)	Basic of GPR, antennas, pulse width and central frequency, time windows and samples; propagation of electromagnetic waves in group- Q and loss tangent, reflection and transmission coefficients. Field procedure and interpretation: monostatic and bistatic arrangements, profiling and stacking, reflection and diffraction, distance determination, migration; depth of penetration and resolution.	6
		Total	**40**

4. Readings:

4.1. Textbook:

- Dobrin, M. B., and Savit, C. H., Introduction to Geophysical Prospecting (Fourth Edition), Tata McGraw Hill.
- Nabighian, M. N., Electromagnetic Methods in Geophysics, Volume 1, SEG Publication.

4.2. Reference Books:

- Nabighian, M. N., Electromagnetic Methods in Geophysics, Volume 2, Parts A and B, SEG, Publication.
- Parasnis, D. S., Principles of Applied Geophysics (Fifth Edition), Chapman and Hall.
- Simpson, F., and Bahr, K., Practical Magnetotellurics: Cambridge University Press.
- Telford, W. M., Geldart, L. P., Sheriff, R. E., and Keys, D. A., Applied Geophysics.
- Vozoff, K., The Magnetotelluric Method; in Nabighian, M. N., Ed., Electromagnetic Method in Applied Geophysics: 2, Soc. of Explor. Geophys., 641-711.

5. Outcome of the course:

The purpose of this course is to expose the students with the geo-electromagnetics methods which cover electromagnetic, magnetotelluirc and ground penetrating radar (GPR) methods. These methods are used hydrogeological, environmental, mineral exploration and hydrocarbon exploration. The ultimate goal of the course is to utilize the concepts of electromagnetism and Maxwell's equation in understanding the Mother Earth.