Applied Geophysics

Course instructor

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Course description

Sheriff, in *Encylopedic Dictionary of Exploration Geophysics*, defined applied geophysics as, "Making and interpreting measurements of physical properties of the Earth to determine subsurface conditions, usually with an economic objective, e.g., discovery of fuel or mineral depositions." Geophysical methods are concerned with the measurement of physical fields passing through the Earth's surface. The most important fields are gravity, electromagnetic, and seismic fields. There are several ways to carry out non-invasive subsurface investigations using geophysical methods. Depending on the desired property/properties, such as resistivity, for instance, and the feasibility of its/their measurement, we may employ one or more methods in conjunction to get a better approximation or interpretation of the subsurface. The same property can also be measured by different methods. Mutually consistent results enhance the confidence in the derived subsurface model.

Applied geophysics I and II will cover topics on various geophysical methods that are in use today. These methods may be employed for various applications like oil and natural gas exploration, regional geological studies, in the exploration or development of mineral deposits, in engineering and environmental site investigations, in hydrogeological investigations, in the detection of subsurface cavities, in mapping of leachate and contaminant plumes, in the location and definition of buried metallic objects, in forensic geophysics, in slope stability studies, and many others. It is hoped that after undergoing this two-part course, the learner would be equipped to decide on the appropriate technique/s to be used in the field.

Pedagogy

Self-study from references and reading material provided by the course instructor, with weekly or bi-weekly discussions to assess the students' understanding and fill knowledge gaps. The reading assignments and discussions will also provide feedback on the students' learning styles and progress, and help customise the course to cater to the individual needs of the graduate students and ensure that they are fairly conversant with the topics by the end of the course.

Course outcomes (CO)

CO1: The student would know the various geophysical tools available to him/her and be able to assess a given real-world situation and decide the suitable method/s to be used
CO2: The student should be able to plan a geophysical survey
CO3: Geophysical models are non-unique. The student should be able to contribute towards a meaningful interpretation of the results of a geophysical survey
CO4: The student should be able to use the knowledge acquired to participate in landslide field studies

Evaluation pattern

As already mentioned in the pedagogy, continuous evaluation of the students will take place from the initial meetings till the end of the semester. In addition, there will be two mid-semester tests and one final exam to assess the understanding and progress of the students. The students must score at least 40% in each of the mid-semester tests to be eligible for the final exam. They must also score at least 40% in the continuous evaluation segment. In case a student is unable to appear for one of the mid-semester tests due to legitimate reasons, s/he will be allowed to appear for another test. Failure to do so will result in the student being disqualified from the

course and s/he would have to reregister whenever the course is next offered. The minimum score to pass the final examination will be 60%.

Activities/Content with direct bearing on employability/entrepreneurship/skill development

The knowledge gained in this course would enable the student to participate in site investigations for various applications, with emphasis on the use of the various geophysical methods for slope instability investigations.

Applied Geophysics I

Learning objectives

- To enable a deeper appreciation of the physical properties of the Earth and its layers
- To introduce the student to various geophysical techniques used in ground surveys and monitoring
- To identify structural features with an understanding of their significance in the geological setup

Syllabus

Code	Title	L	T	P	C
CE811	Applied Geophysics I	3	0	0	3

Unit I: INTRODUCTION

Geophysics and its branches; exploration geophysics; geophysical methods: active and passive; overview of geophysical techniques: gravity methods, magnetic methods, seismic methods, electrical methods, electromagnetic methods, and radiometric methods; matching geophysical techniques to applications; brief comparison of the various techniques; case studies

Unit II: GRAVITY METHODS

Introduction; factors affecting gravity; measurement of gravity; corrections to gravity observations; interpretation methods; applications

Unit III: MAGNETIC METHODS

Introduction; magnetic properties of minerals and rocks; magnetic instruments; processing and interpretation of data; applications

Unit IV: SEISMIC METHODS

Introduction; seismic waves: types, sources, detection, and recording; seismic refraction and reflection surveying; interpretation of data; applications

Unit V: ELECTRICAL METHODS

Introduction; electrical methods: resistivity, self-potential, and induced polarisation; resistivity: electrode configurations and geometric factors, modes of deployment; self-potential: origin and measurement of self-potentials, corrections; induced polarisation: origin and measurement of induced polarisation; interpretation of data; applications

References

1. Reynolds, J. M. (2011), *An Introduction to Applied and Environmental Geophysics*, John Wiley & Sons
2. Telford, W. M., Geldart, L. P., and Sheriff, R. E. (1990), *Applied Geophysics*, Cambridge University Press
3. Knödel, K., Lange, G., and Voigt, H. J. (2007), *Environmental Geology: Handbook of Field Methods and Case Studies*, Springer Science & Business Media
4. Gadallah, M. R., and Fisher, R. (2008), *Exploration Geophysics*, Springer Science & Business Media

5. Milsom, J., and Eriksen, A. (2013), *Field Geophysics*, John Wiley & Sons
6. Lowrie, W. (2007), *Fundamentals of Geophysics*, Cambridge University Press
7. Fowler, C. M. R. (2005), *The Solid Earth: An Introduction to Global Geophysics*, Cambridge University Press
8. Lillie, R. J. (1999), *Whole Earth Geophysics: An Introductory Textbook for Geologists and Geophysicists*, Prentice Hall

Applied Geophysics II

Learning objectives

- To familiarise the student with some advanced geophysical techniques used in ground surveys and monitoring
- To learn about the methods used in landslide studies and how they are applied in the field

Syllabus

Code	Title	L	T	P	C
CE812	Applied Geophysics II	3	1	0	4

Unit I: INTRODUCTION
Brief recapitulation of gravity, magnetic, seismic, and electrical methods of geophysical surveying and their applications

Unit II: ELECTROMAGNETIC METHODS
Introduction; principles of electromagnetic surveying; types of electromagnetic surveys: airborne, seaborne, and borehole surveying; electromagnetic systems: continuous-wave and pulse-transient systems; very-low-frequency methods, telluric and magnetotelluric methods, and magnetic resonance sounding; electromagnetic equipment; interpretation of data; applications

Unit III: RADAR METHODS
Introduction to ground-penetrating radar; principles of operation; propagation of radio waves; dielectric properties of earth materials; modes of data acquisition; data processing; interpretation of data; applications

Unit IV: RADIOMETRIC METHODS
Introduction; natural radiation; radioactivity of rocks; radiation detectors: Geiger-Müller counter, scintillometers, gamma-ray spectrometers, radon detectors, and borehole logging tools; data correction methods; data presentation; applications

Unit V: APPLIED GEOPHYSICS FOR LANDSLIDES
Introduction; comparison of geophysical techniques; reading literature describing the use of geophysical techniques for various kinds of landslide in diverse terrain

References

1. Reynolds, J. M. (2011), *An Introduction to Applied and Environmental Geophysics*, John Wiley & Sons
2. Telford, W. M., Geldart, L. P., and Sheriff, R. E. (1990), *Applied Geophysics*, Cambridge University Press
3. Knödel, K., Lange, G., and Voigt, H. J. (2007), *Environmental Geology: Handbook of Field Methods and Case Studies*, Springer Science & Business Media
4. Milsom, J., and Eriksen, A. (2013), *Field Geophysics*, John Wiley & Sons
5. Review articles and journal papers on the use of geophysical methods in landslide studies