Course Type	Course Code	Name of the Course	L	T	P	Credits
DE	NGPD 509	Time Series Analysis in Geosciences	3	0	0	3

Course Objective

- Practical knowledge on geophysical/geological time/space series data analysis.
- Practical knowledge on periodicity, how to design a filter, algorithm for signal enhancement and noise removal. Practical knowledge on signal processing techniques for exploration of geoscience

Learning Outcomes

- The primary objective of the course is to introduce fundamental and advanced aspects of time series analysis techniques for geo-record analysis and processing.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1.	Signal Processing: Basic Theory and Introduction, types of signals and noises; Properties of time signal (time invariance, causality, linearity). Autoregressive (AR), Moving-Average (MA) and Autoregressive Integrated Moving Average (ARIMA), Random-Walk, additive and multiplicative, stochastic/random, chaotic model for time series analysis and forecasting.	7	Understanding of basic types of signals and noises and properties. Linear and non-linear models for time series modelling and analysis.
2.	Data Analysis: Z- transform, sampling theorem, antialiasing filter, discrete Fourier Transform, Fast Fourier Transform; Inverse Transform.	7	Introduction to various transform techniques and data analysis theory for time series.
3.	Digital Filters: Characterization of digital filters (non-recursive and recursive filters), properties of some commonly used analog filters for low pass, high pass and band pass operation.	7	Characterization and designing of different filters for time series data.
4.	Realization of Filters: Transformation for realization of digital filters from transfer functions of analog filters (matched Z-transform, bilinear transform etc.), some commonly used non recursive filter windows.	4	Realization of filters with transform theory and use of transfer functions.
5.	Convolution: Convolution theorem, unit impulse response and transfer function, convolution in time domain and in frequency domain; Interpolation and decimation of digital data; Correlation and Power Spectrum Estimation; Application in processing of geo-records.	7	Understanding of convolution, correlation and power spectrum analysis.
6.	Processing and Applications: Interpolation and decimation, Correlation and Power spectral estimation, processing procedure of geophysical data. Time series analysis with Wavelet and Walsh transform techniques and hybrid algorithm.	10	Processing and application of time series analysis techniques in geosciences.
	Total	42	

Text Books:

1. Menke, W., 1989, Geophysical data analysis: Discrete inverse theory, Academic Press, International Geophysical series, Vol. 45, 3rd Edition. MATLAB Edition
2. Sen, M.K., 2013, Global Optimization Methods in Geophysical Inversion. Second Edition.

Reference Books:

1. Gubbins, D. 2004, Time series analysis and Inverse theory for Geophysicists, Cambridge Univ. Press,
2. Scales, J. A., Smith M. L. and Trietel, S., 2001, Introductory Geophysical Inverse Theory, Samizdat Press, Golden Colarado, USA,
3. Tarantola, A, 1987, Inverse Problem Theory, Elsevier Publishers, New York.