Course Type	Course Code	Name of Course	L	T	P	Credit
DC	NGPC521	**Earthquake Seismology**	**3**	**0**	**0**	**3**

Course Objective
The course presents fundamental concepts of applied earthquake seismology with the objective to provide the students with a broad overview. The topics are particularly relevant to students that continue with research within earthquake seismology. However, the concepts and methods taught are also relevant to the general geophysics student interested in Earth structure and earthquake physics.
Learning Outcomes
Upon successful completion of this course, students will: Students will gain a deeper understanding of approaches such as forward modelling and inversion from the topics addressed within the earthquake seismology context. The student can demonstrate how the earthquake mechanism is derived from waveform data. Students will be able to the earthquakes, which will lead to improve Earth models. The student can discuss the different aspects of inverse problems in earthquake seismology.

Unit No.	Details of Lectures	Lecture Hrs.	Learning Outcomes
1.	Introduction to seismology, fracturing of rocks under different stresses, causes of earthquakes, Elastic Rebound Theory for earthquake generation. Classification of earthquakes. Earthquake, nuclear explosion, rock burst, volcanic earthquake. Wadati-Benioff zone, Intra and inter plate earthquakes, Intra-plate strain-hardening model and inter-plate model for mega-earthquakes along subduction zone.	**5**	Basic knowledge of earthquakes, causes and types of earthquakes. Global distribution of earthquakes
2.	Temporal and geographical distribution of earthquakes, seismicity and seismotectonics of India and the Himalaya. Effects of earthquake and tsunami Foreshocks, Mainshocks, Aftershocks and Earthquake swarm. Omri's Law. Frequency - magnitude relation for b-value estimation. Significance of b-values. Micro-earthquakes, induced seismicity.	**6**	Indian earthquakes and its historical perspective. Impact of Earthquakes. Earthquake magnitude scale and related parameters.
3.	Wadati diagram for computation of origin time. Localizing of magnitude scale, various magnitude scales and their limitations, seismic energy, seismic moment, slip, slow slip, stress drop and dimension of rupturing of rock during earthquakes. MM and MSK intensity scales. Earthquake hazard and risk. Seismic zonation of India.	**5**	Quantitative analysis of source characteristics. Qualitative size of earthquakes and hazards
4.	Body and surface forces. Law of equivalent body force. Single and double couple mechanisms for earthquake generation. Radiation patterns of P- and S-waves. Elastic, inelastic and plastic behavior of materials. Definitions of stress and strain. Generalized Hooke's law and Lame's constants for elastic materials. Stoke's law for ductile materials. Derivation of stress and strain matrices.	**5**	Earthquake mechanisms, Elasticity of Materials, Basic laws of elasticity and inelasticity

5.	P-, S- and surface waves, Momentum equation, Derivation of P- and S-wave equations. The effects of gravity on seismic wave propagations. Propagation of various seismic body and surface waves inside the Earth. Dispersion and Attenuation of seismic waves. Determination of phase and group velocities.	**8**	Governing equations of seismic waves, Nature of seismic waves inside the earth, Characteristics of seismic wave inside the Earth.
6.	Ray paths for horizontally and spherically stratified Earth. Travel Time Curves, Delay Time and Triplication, Ray Paths for Low Velocity Zone (LVZ). Velocity structure and V_P/V_S study. Principle and construction of seismometers. Damping, amplitude and phase characteristics.	**6**	Wave phenomenon within the earth, Amplitude and phase characteristics of seismogram.
7.	Short-period, Long-period and Broad-band seismometers, and their limitations. Earthquake prediction: dilatancy theory, short-term, middle-term and long-term prediction. Earthquake Early warning System. Fault plane solutions and their interpretation. Moment tensors for different fault patterns. Introduction to free oscillations of the Earth.	**7**	Understanding of Seismograph, Earthquake precursors and prediction, Source dynamics and kinematics, Free oscillations of Earth during great Earthquake.
	Total	**42**	

Text books

1. Shearer, P. 1999. Introduction to Seismology, Cambridge: Cambridge University Press.
2. Lowrie, W., 2007. Fundamental of Geophysics, Cambridge: Cambridge University Press.

Reference books

1. Stein, S. and Wysession, M. 2003. An Introduction to Seismology, Earthquakes and Earth Structure, Oxford: Blackwell Publishing.
2. Båth, M., 1976. Introduction to Seismology, Birkhäuser Basel.
2. Agustin, U., 2000. Principles of Seismology, Cambridge: Cambridge University Press.
3. KIyoo Mogi, 1985. Earthquake Prediction, Academic Press.
4. Kasara, K., 1981. Earthquake mechanics, Cambridge University Press.
5. Bullen, K. E. and Bolt, B. A. 1985. An Introduction to the Theory of Seismology, Cambridge: Cambridge University Press.
6. Richter, C. F. 1945. Elementary Seismology,W H Freeman, San Francisco, W. H. Freeman & Co.
7. Kulhanek, O. 1970. Anatomy of Seismograms, Seismological section, University of Uppsala, Uppsala, Sweden.
8. Leon Reiter, 1991. Earthquake Hazard Analysis, Columbia University Press.
9. Scholz, C.H., 2019. The mechanics of earthquakes and faulting, Cambridge University Press.
10.Gubins D., 1990. Seismology and Plate Tectonics, Cambridge University Press, 348pp.