Annexure - 3 - Summary of Selected five Lectures/Classes attended

Lecture–1 - A Geophysical Interactive session with the students

The lecture was taken by our mentor for Group-9 of Project-1, Prof. Debasis D. Mohanty and it was an interactive session where we were introduced to the main Aim/objective of the Project-1 i.e. **"Frequency-Magnitude Relations and Hazard Estimation"** and we were provided a brief description of the various techniques and mathematical tools that we would be using in this project. Prof. Mohanty introduced the *Gutenberg-Richter Relation*

$$\log_1 0N = a - bM$$

Where N is the number of events having magnitude $\geq M$ i.e. Cumulative Frequency; M is the Magnitude of the earthquake; a and b aare constants for a given value of N and M. Essentially a is an indicator of the total events that took place and b is the b-value which essentially gives information about how stressed that particular region is as far as seismic activity is concerned.

This relation is also known as the Frequency-Magnitude Relation obtained using Frequency-Magnitude distritbution curve and he informed us about the importance of this relationship in Seismology and how we use the b-value in this relation (i.e. the slope of the semi-log plor of N with M) for Hazard Estimation.

He gave a brief introduction to the Spatio-Temporal variation of b-values and how these variations can be analysed for a given region and the hazard estimation of that region can be carried out. Prof. Mohanty also gave a brief introduction to the following 2 techniques

- The Least Square Fit Method
- The Maximum Likelihood Method

These are two distinct methods used independently for the b-value estimation from the Frequecy-Magnitude ditribution. He mentioned the benefits and drawbacks of each method. The final part of the Lecture focused on the b-values in different parts of the world and also an overview of Seismo-tectonics and b-value study in the Indian context.

Lecture-2 – Various Catalog studies for downloading the seismic data and their use.

This lecture was a Hands on session focused on the introduction to seismic catalogues used all over the world by Seismologists for data analysis and visualisation specifically for Hazard Estimation. The students were introduced to the importance of Seismic Catalogue and how these catalogues are maintained and recorded by institutions all over the world.

We were given a brief inrtroduction to different Magnitude Scales in which earthquake magnitude is measured, such as moment magnitude (M_w), Body wave magnitude ((M_b)), etc. And relative advantages and disadvantages of each of theses scales.

After this we were introduced to the main catalogue of Seismic Catalogue, i.e. **Internationa Seimological Center or ISC catalogue**. We were provided the estimation of Andaman Region as the region for study and we were trained how to download the seismic data for this region from the ISC catalogue and how to prepare and clean this data to be used in Zmap software and MATLAB. We were also shown the disadvanteges of using small datasets.

Lecture-3 – Basics of Gutenberg-Richter Relation and different methods of estimation of b-value

This lecture was centered around the topics discussed on Lecture-1 but going into a more detailed and in-depth understanding of the GR-Law and its importance and the physical meaning of the mathematical constants a and b in the GR relation.

A large emphasis was also paid on the understanding of the Geo-tectonics and Seimo-tectonics of the Andaman region and the Western Himalayas region which were the two regions whose seismic data was downloaded to analyse for Hazard estimation in Project-1. The Seismic history of these regions were also discussed briefly.

Further detailed instructions were given on the two methods of b-value of estimation was also provided.

Lecture-4 – Hands session on softwares such as MATLAB, Zmap, etc.

MATLAB and Zmap are standard pieces of software for analysis of Seismic data for Hazard estimation and in this session, we were introduced to the use of MATLAB and Zmap for analysing the seimic data we downloaded in the previous lectures. We were shown how to download and install Zmap on our computers and how to intialise the Zmap library in MATLAB and how to use the various options available in Zmap to analyse the data properly to get the best estimation for b-value.

We were introduced to concept such as declustering of data to reduce data dependency on minor events such as fore-shocks and after-shocks. We were introduced to concept of using Zmap for data visulaisation and also how to use Sampling options ot divide the data and by extension the region under study into different seismic zones (based on the distribution of data) and how to do b-value and Hazard estimation for these different Seismic zones.

Lecture-5 - Applications of study of Frequency-Magnitude relation in a seismotectonic area/spatial and temporal variations of b-value

The lecture was carried out after me and other students in group 9 of Project 1 of CSIR-SRTP 2020 were asked to download the seismic data and analyse the data using Zmap software themselves. This lecture focused on the inferences that we can draw from the data analysis and visualisation. It focused on concepts such Magnitude of Completion (M_c), b-value variation with depth and magnitude, but most importantly it was focused in the variation of b-values with different hypocenters in the region and with time, i.e. spatio-temporal variation of b-value.

One major aspect of this lecture was to understand how these spatio-temporal variation graphs can be used along with the known seismic history (seismo-tectonic and geo-tectonic history) of the region to do hazard estimation for the different entire region and/or of the different seismic zones in which the region was divided into. The lecture was given by our mentor – Prof. Debasis D. Mohanty who emphasised the importance of using b-value for hazard estimation and gave us a brief overview and explaination of all the graphs obtained from the analysis and visualization of data from the regions of Andaman and Western Himalayas.