The Open University of Sri Lanka

B.Sc. Degree Programme (Level 05) 2014/15
Final Examination
PYU3168 - Fundamentals of Geophysics

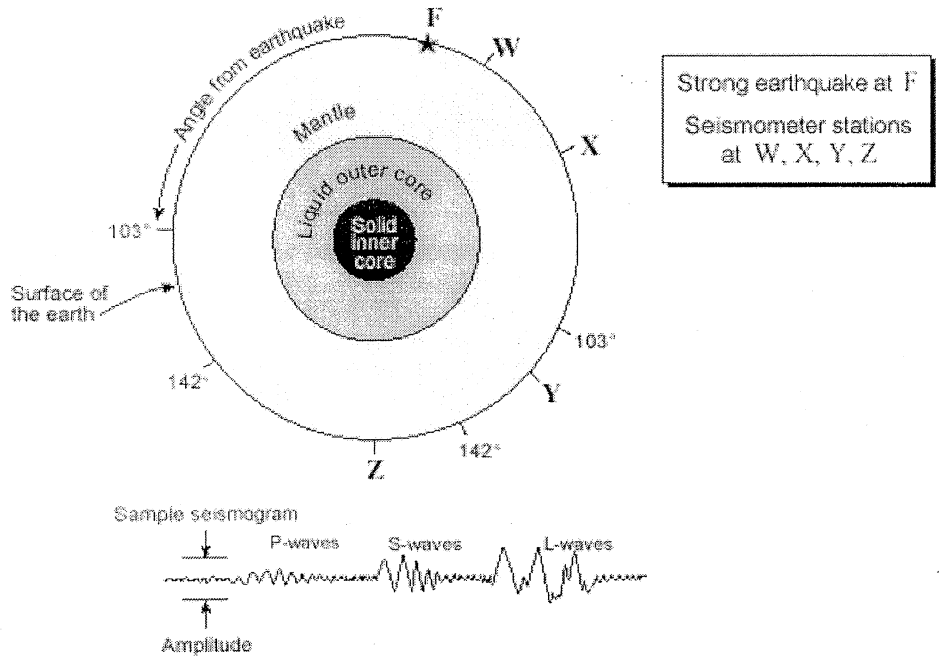
Date: 24th October 2015

Duration: 2 Hours
(9.30 am - 11.30 am)

Answer ***FOUR (04)*** questions. Answers should be illustrated with sketch maps and diagrams where appropriate. Each question is allocated 25 marks, and the marking scheme is given in brackets. Non-programmable calculators are permitted. Graph sheets and log-log sheets are provided. Supplementary sheet should be used for question No. 4.

1. (a) Describe how the P and S-wave shadow zone forms. What does it tell us about the earth's interior? *(5 marks)*

Use the following sketch of the cross section of the earth to answer questions.



A strong earthquake occurred at location F.

(b) Describe how the P- and S-wave interval varies between stations **W** and **X**. *(5 marks)*

(c) Describe the difference in amplitude between direct path P-waves at station **W** and at station **X**. *(5 marks)*

(d) Using the illustrative diagram, explain why no direct path S-waves would be recorded at station **Z**. *(5 marks)*

(e) Using the illustrative diagram, explain why no direct path P-waves would be recorded at station **Y**. *(5 marks)*

2. (a) From first principles, show that the travel time equation used in refraction seismology for a horizontal, planar and homogeneous two-layer case is given by

$$t_x = \frac{x}{v_2} + \frac{2h\sqrt{v_2^{\,2} - v_1^{\,2}}}{v_1 v_2}$$

where v_1 – seismic velocity of the first layer; v_2 - seismic velocity of the second layer; h – thickness of the first layer; t_x – time taken to receive the signal to the geophone; x - distance from the seismic source and the geophone *(10 marks)*

(b) A 200 m long seismic refraction profile was acquired on the site of the ground of OUSL to determine the depth to the underlying bedrock for piling project. Assuming horizontal planar layers, calculate the velocity of each layer and the depth to the bedrock beneath the profile. *(use separate graph sheet for calculation)*

(15 marks)

Offset (m)	**Travel time (s)**
0.0	0.0
20.0	33.3
40.0	57.2
60.0	70.6
80.0	83.9
100.0	97.2
120.0	110.6
140.0	123.9
160.0	137.2
180.0	150.6
200.0	163.9

3. (a) What is a Bouguer anomaly used in gravity method? *(5 marks)*

(b) Gravity reading (corrected for instrumental drift and tidal effects) of 978 Gal was measured at latitude 15°N. (Measured gravity of equator is 978.03185 g/m^2. A=0.005278895 and B=0.000023462)

(i) Calculate absolute gravity ($g_{predicted}$) at this place. *(5 marks)*

(ii) Calculate the resulting anomaly value when the reading was taken on the land (flat area) at an elevation of 150 m with rock density of 2.15 g/cm^3.

(5 marks)

(iii) Calculate the resulting anomaly value of the reading that was obtained with a sea bottom gravimeter at water depth of 20 m in an area with rock density of 1.19 g/cm^3. The seawater density is assumed as 1.02 g/cm^3.

(10 marks)

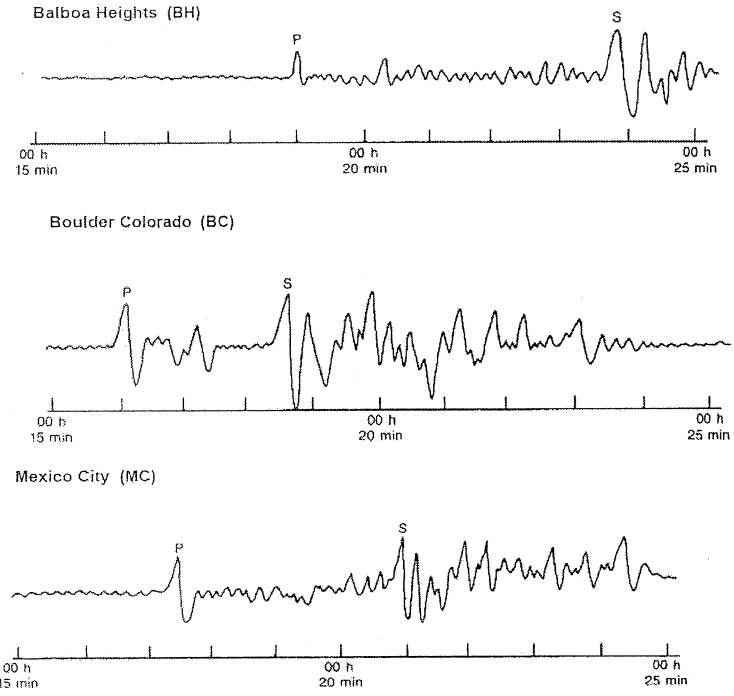
Formulae and Constants

1 *Gal* $= 10^{-2}$ m/s^2;
Gravity effect of horizontal cylinder $= \triangle g = 2\pi G\rho z$;
uniform density = ρ;
G = Universal Gravitational Constant = 6.67×10^{-11} Nm^2/Kg^2

4. (a) Define focus and epicentre of an earthquake. *(5 marks)*

(b) Describe in detail how to locate an Epicentre using seismograph data. *(5 marks)*

(c) Three seismic monitoring stations [Balboa Heights (BH), Boulder Colorado (BC) and Mexico City (MC)] located in USA have reported the first P – and S wave signals from an earthquake, which is shown in the graphs below.



Calculate the S-P time difference of each station with respect to each seismo-meters using above graphs. *(5 marks)*

(d) Use time-travel Graph given to you in the supplementary sheet to find the distance of each station from the epicentre of the earthquake. *(5 marks)*

(e) Locate and label the epicentre of the earthquake *(please detach supplementary page from the question paper and attach with the answer sheet)*. *(5 marks)*

5. (a) Derive the expression used to calculate apparent resistivity from field electrical measurements using the Schlumberger electrode array. Include a sketch to define all terms. *(10 marks)*

(b) Describe how you would carry out a resistivity sounding test to determine the depth to the water table. Explain how the method of images can be used to derive model data as part of the interpretation process. *(5 marks)*

(c) What are the advantages and disadvantages of EM compared to DC surveying? What property of the Earth do they measure? *(5 marks)*

(d) Describe for what kind of subsurface target you would use GPR. *(5 marks)*

6. (a) Explain the Global Positioning System (GPS). What are the main components of GPS? *(5 marks)*

(b) Describe the technique known as Differential GPS (DGPS). *(5 marks)*

(c) Define magnetic susceptibility. How can magnetic susceptibility data be used to determine bedding or foliation directions in rock samples? *(5 marks)*

(d) What do you mean by diagmagnetic, paramagnetic, and ferromagnetic properties in magnetic geophysical method? Give examples for minerals belonging to each category. *(10 marks)*

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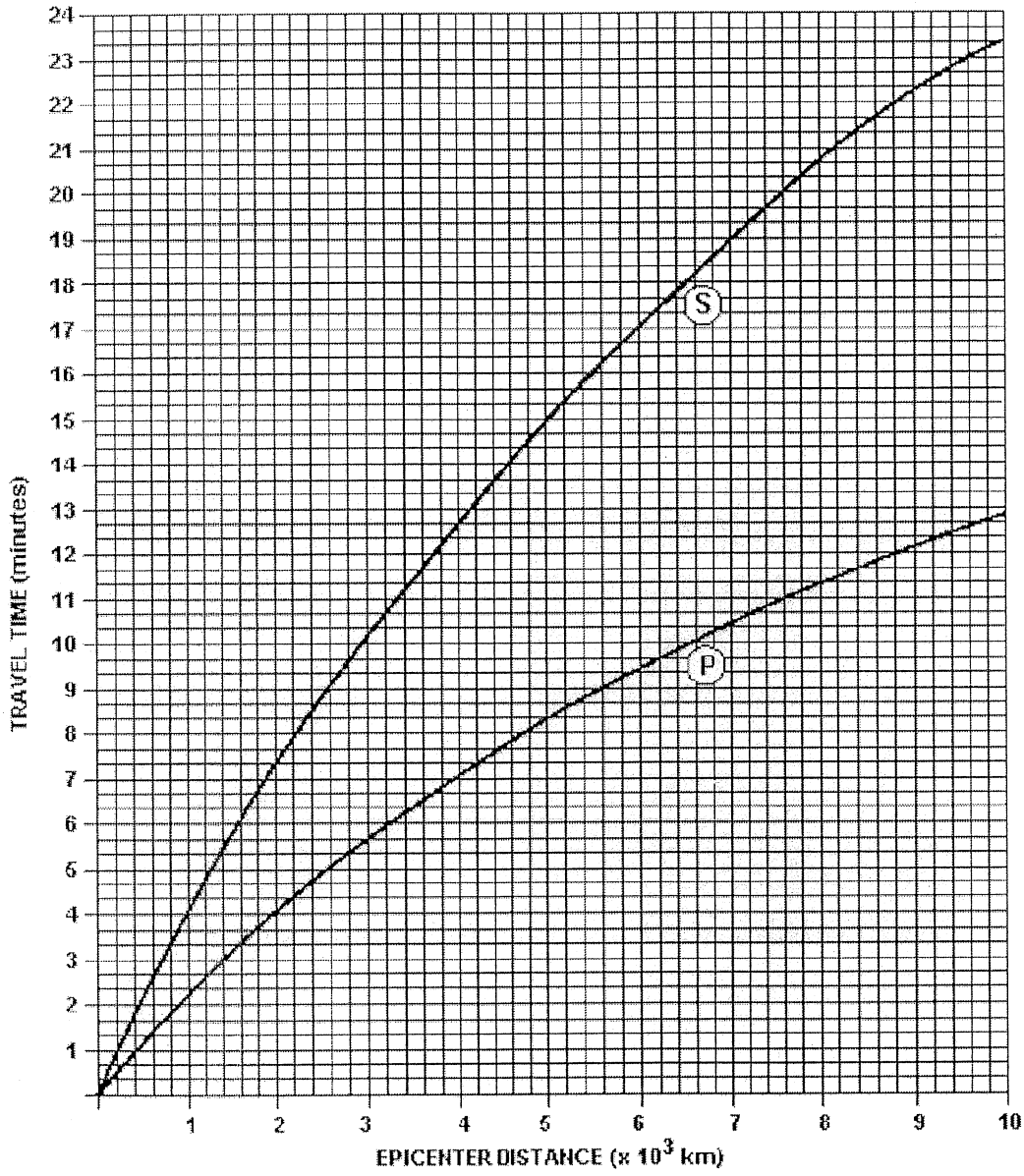
Supplementary page for question 4



Seismograph Location	S-P Time Difference (min)	Distance to Epicenter (km)
1. Balboa Heights		
2. Boulder Colorado		
3. Mexico City		

Location	Distance (km)
1. Balboa Heights	
2. Boulder Colorado	
3. Mexico City	