## MEG4543: Seismic Refraction Homework

1. Construct a travel time curve to a distance of 120 m for a structure with an 10 m thick soil layer with P-wave velocity 500 m/s over a saturated layer 20 m thick with P-wave velocity 1500 m/s over bedrock with velocity 3000 m/s. From the graph, what are the 2 crossover distances? Does the first crossover distance value agree with what you calculate using the following equation? (6 points)

$$X_{co} = \frac{2h_1\sqrt{V_2 + V_1}}{\sqrt{V_2 - V_1}}$$

2. A geophysics student on a project at CSIR did a seismic survey profile on the CSIR premises. He did both forward and reverse shooting and the data for this experiment is in the tabulated below. Construct a travel time curve for the following data for both the forward and reverse profiles. Evaluate slopes and intercept times, and use those values to determine the subsurface structure for the first 2 layers, and then estimate (do not try to calculate!) the properties of the bottom layer. Offsets are in meters and times are in milliseconds. (8 points)

| Offset X | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Forward | 8.3 | 16.7 | 25.0 | 33.3 | 41.7 | 50.0 | 58.3 | 66.7 | 72.5 | 75.1 | 77.1 | 80.3 |
| Reverse | 8.3 | 16.7 | 25.0 | 33.3 | 40.7 | 44.3 | 48.0 | 51.6 | 55.3 | 58.9 | 62.9 | 66.3 |
| | | | | | | | | | | | | |
| Offset X | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 | 105 | 110 | 115 | 120 |
| Forward | 82.8 | 85.4 | 86.5 | 87.4 | 88.3 | 89.2 | 90.0 | 90.9 | 91.8 | 92.7 | 93.6 | 94.5 |
| Reverse | 69.9 | 73.6 | 77.2 | 80.9 | 84.5 | 86.1 | 87.4 | 88.7 | 90.0 | 91.4 | 92.7 | 94.0 |

3. The following data are from a profile over a buried steep fault scarp underlying alluvium. Use the data to determine velocities for the alluvium and bedrock and the throw and approximate position of the buried fault step. Offsets are in meters and times are in milliseconds. (8 points)

| Offset X | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Forward | 3.6 | 7.1 | 10.7 | 14.3 | 17.9 | 21.4 | 23.0 | 24.0 | 24.9 | 25.8 | 26.7 | 27.7 |
| Reverse | 3.6 | 7.1 | 10.7 | 14.3 | 17.9 | 21.4 | 25.0 | 28.6 | 30.4 | 25.8 | 26.7 | 27.7 |
| | | | | | | | | | | | | |
| Offset X | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 | 105 | 110 | 115 | 120 |
| Forward | 28.6 | 29.5 | 30.4 | 31.4 | 35.8 | 36.7 | 37.7 | 38.6 | 39.5 | 40.4 | 41.4 | 42.3 |
| Reverse | 28.6 | 29.5 | 30.4 | 31.4 | 32.3 | 33.2 | 34.1 | 35.1 | 36.0 | 36.9 | 37.9 | 38.8 |

4. Apply the 'plus-minus' method to the set of data below. Offsets are in meters and times are in milliseconds. On graph paper, plot the travel time curves (forward and reverse), identify the paired refractions, and then apply the formulas in the text to determine ΔTD and hD, given the information V1 = 1500 m/s, V2 = 4000 m/s, and reciprocal time Tt = 25.8 milliseconds.

| Offset X | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| tSD(ms) | 3.3 | 6.7 | 10.0 | 13.3 | 16.7 | 19.4 | 20.3 | 21.2 | 22.1 | 23.0 | 24.0 | 24.9 |
| tS'D (ms) | 3.3 | 6.7 | 10.0 | 11.7 | 13.3 | 14.8 | 16.4 | 18.0 | 19.5 | 21.1 | 22.7 | 24.2 |
| | | | | | | | | | | | | |

Finally, make a plot of tSD – tS'D versus offset x and use the value of the slope to confirm the value of V2. (8 points).