



UNIVERSITI
TEKNOLOGI
PETRONAS

FINAL EXAMINATION SEPTEMBER 2022 SEMESTER

COURSE : QCB2063 - SEISMIC METHODS
DATE : 8 DECEMBER 2022 (THURSDAY)
TIME : 2:30 PM - 5:30 PM (3 HOURS)

INSTRUCTIONS TO CANDIDATES

1. Answer **ALL** questions in the Answer Booklet.
2. Begin **EACH** answer on a new page in the Answer Booklet.
3. Indicate clearly answers that are cancelled, if any.
4. Where applicable, show clearly steps taken in arriving at the solutions and indicate **ALL** assumptions, if any.
5. **DO NOT** open this Question Booklet until instructed.

Note :

- i. There are **ELEVEN (11)** printed pages in this Question Booklet including the cover page .
- ii. **DOUBLE-SIDED** Question Booklet.
- iii. Attach all the appendices and graph together with the Answer Booklet.

1. a. Discuss each of the following terms with the aid of diagrams
- i. Stress. [2 marks]
 - ii. Head wave. [2 marks]
 - iii. Fermat's Principle. [2 marks]
- b. Compare the following concepts with aid of diagrams.
- i. Elasticity vs Plasticity [4 marks]
 - ii. Young Modulus vs Poisson's Ratio [4 marks]
- c. A fresh marble core sample has a density of 2.81 g/cm^3 . The sample is tested to determine its elastic properties. The result shows that the sample has a compressional velocity of 5400 m/s and a shear velocity of 2700 m/s . From the information above:
- i. Calculate the Bulk Modulus, K of the marble sample. [3 marks]
 - ii. Calculate the Shear Modulus, G of the marble sample. [3 marks]

2. a. **FIGURE Q2a** shows the wave propagations in the subsurface. The dotted and continuous arrows indicate the ray paths of the wave through the medium of V_1 and V_2 .

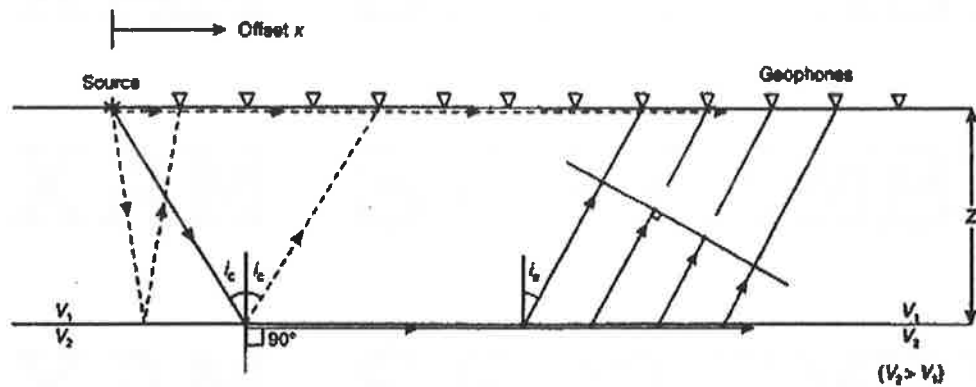


FIGURE Q2a: wave propagation in the subsurface

- i. Identify **THREE (3)** types of waves shown in **FIGURE Q2a**.
[3 marks]
- ii. Based on your answer in **part 2a(i)**, characterize each wave briefly.
[3 marks]
- iii. Sketch a simple time versus distance (T-X) graph based on the **FIGURE Q2a**.
[3 marks]

- b. **TABLE Q2b** shows the velocity of P-wave and S-wave velocities of a similar lithology but different in physical conditions.

TABLE Q2b: Velocities of the samples

	P-Wave Velocity (m/s)	S-Wave Velocity(m/s)
Weathered granite	2500	1500
Fresh granite	5500	2750

If the angle of incident of P-wave that strikes the interface between weather granite and fresh granite is 30° .

- i. Calculate all possible angles of reflection and angles of refraction for P-wave and S-wave.

[4 marks]

- ii. Based on your answer in **part 2b(ii)**, sketch all the angles of reflection and angles of refractions for P-wave and S-wave by using the answer sheet in **APPENDIX I**.

[4 marks]

- iii. Given the densities of weathered granite and fresh granite are 1100 kgm^{-3} and 1500 kgm^{-3} , respectively. Calculate the reflectivity of the interface.

[3 marks]

3. a. **TABLE Q3a** shows a raw data obtained from a seismic survey in Tambun, Perak. A total of 24 geophones with 5 meter spacing are used to investigate the subsurface conditions.

TABLE Q3a: Raw data of Seismic Refraction

Offset (m)	First Arrival (s)
50	0.03
100	0.06
150	0.09
200	0.12
250	0.15
300	0.18
350	0.20
400	0.22
450	0.24
500	0.26
550	0.28
600	0.30
650	0.32
700	0.34
750	0.35
800	0.36
850	0.37
900	0.38
950	0.39
1000	0.40

- i. Based on the data from **FIGURE Q3a**, construct a time-distance curve by using a provided graph paper.
[5 marks]
- ii. Based on your answer in **part 3a(i)**, calculate the velocity of each possible layers.
[3 marks]
- iii. By using intercept time technique, estimate the thickness of each layer.
[6 marks]

- b. **FIGURE Q3b** shows the geometry of a seismic refraction survey. A forward shot (Sf) and a reverse shot (Sr) were fired on the survey line which consists of several receivers.

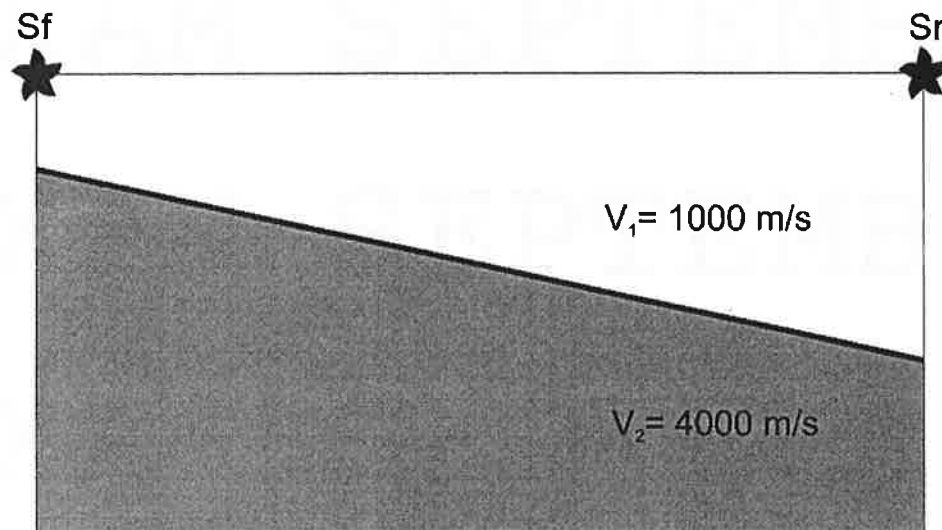


FIGURE Q3b

Construct a simple time versus distance (T-X) graph to represent the subsurface shown in **FIGURE Q3b**.

[3 marks]

- c. Propose a suitable seismic source to be conducted in a desert area with reasonable justifications.

[3 marks]

- 4 a. A seismic reflection survey has been carried out and the first reflector signal was plotted as shown in **FIGURE Q4a**.

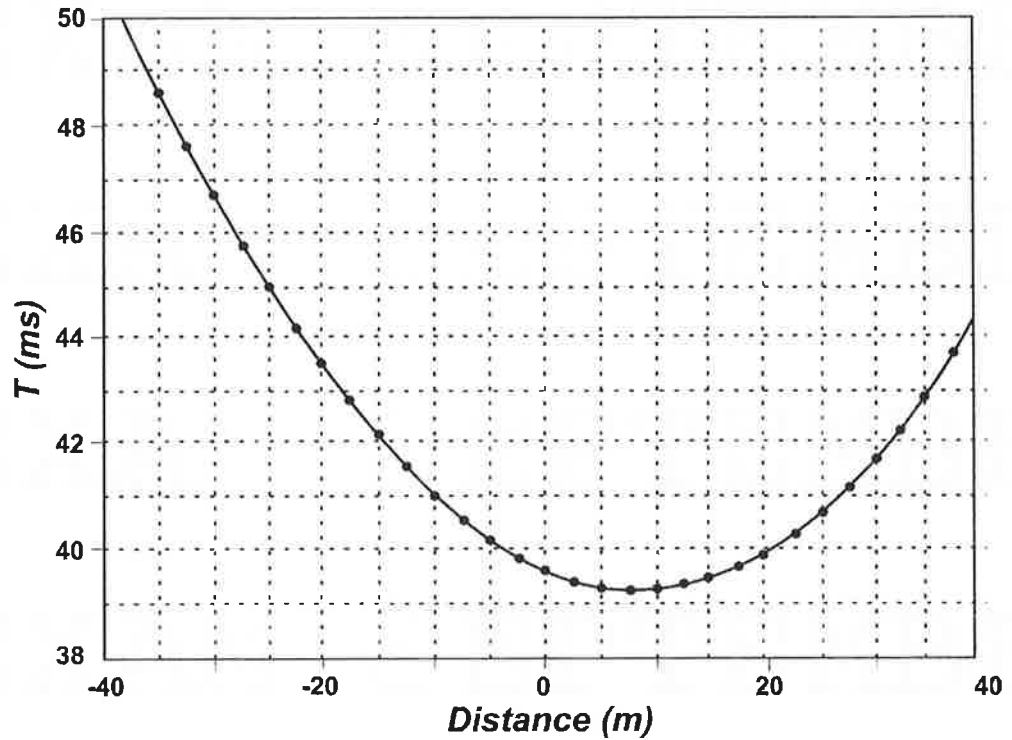


FIGURE Q4a: T-X plot of seismic reflection.

Based on the **FIGURE Q4a**:

- i. Plot T_{min} , X_{min} , T_0 , and X_0 by using **APPENDIX II**. [4 marks]
- ii. Estimate the dipping angle of the layer. [3 marks]
- iii. Calculate the depth of layer under the shot. [3 marks]

- b. **FIGURE Q4b** shows an X^2-T^2 plot of time–distance values of two reflection events.

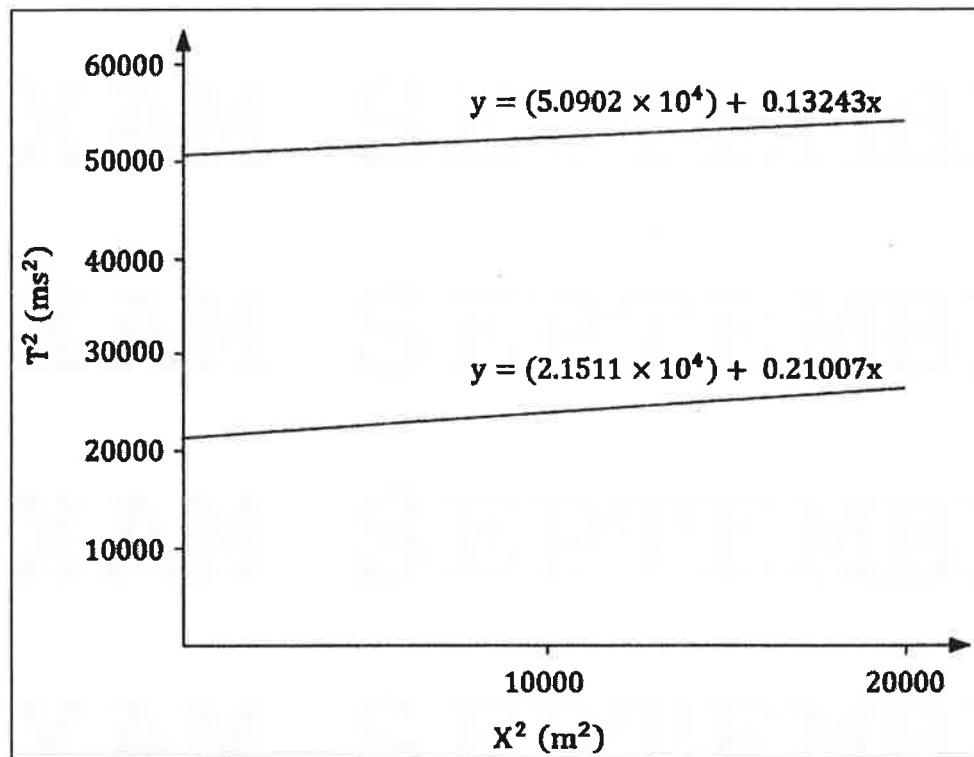


FIGURE Q4b

By using Dix method,

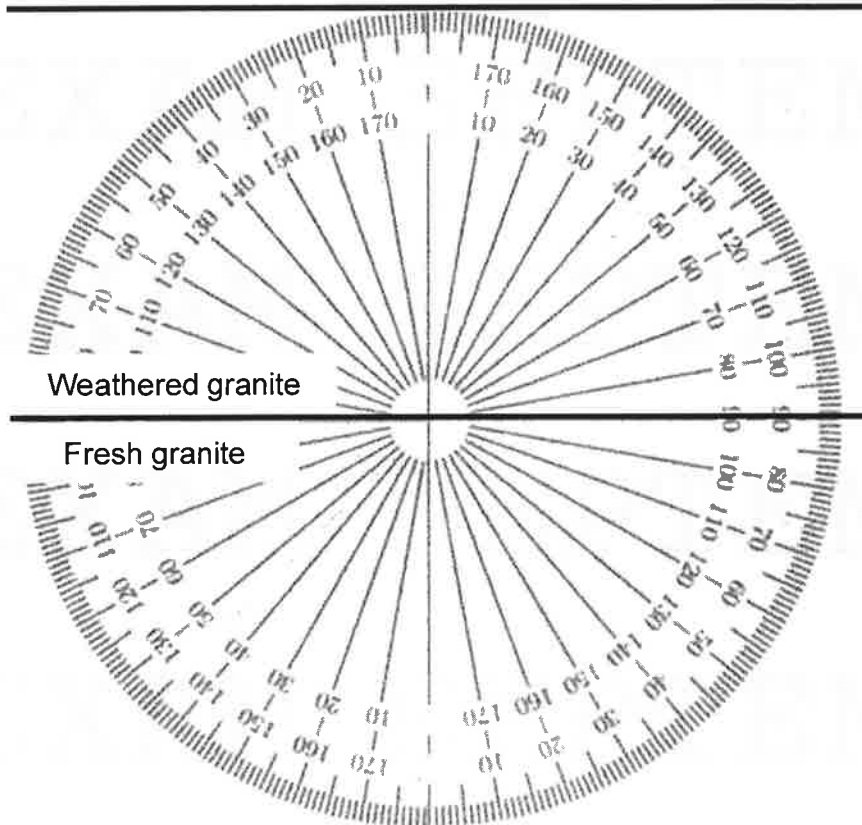
- i. Determine the RMS velocity for each of the reflectors. [3 marks]
- ii. Calculate the interval velocity for each of the reflectors. [4 marks]
- iii. Calculate the vertical thickness for each of the reflectors. [3 marks]

5. a. With the aid of diagrams, differentiate **FOUR (4)** types of common gathers.
[8 marks]
- b. Construct a convolution model from seismic wavelet (1, -0.5, 0.5) and reflectivity series (1, 0.5, 0.5).
[6 marks]
- c. Calculate the following:
- i. Nyquist frequency and fold-back frequency, if high-frequency signal of 120 Hz is sampled at 6 ms sampling interval.
[3 marks]
 - ii. Typical wavelength and resolution, if shale velocity is 3 km/s and dominant frequency on seismic at shale is 60 Hz.
[3 marks]

**APPENDIX I
ANSWER SHEET FOR QUESTION 2b(ii)**

EXAM ID:

Table No.:



[4 marks]

APPENDIX II
ANSWER SHEET FOR QUESTION 4a(i)

EXAM ID:

Table No.:

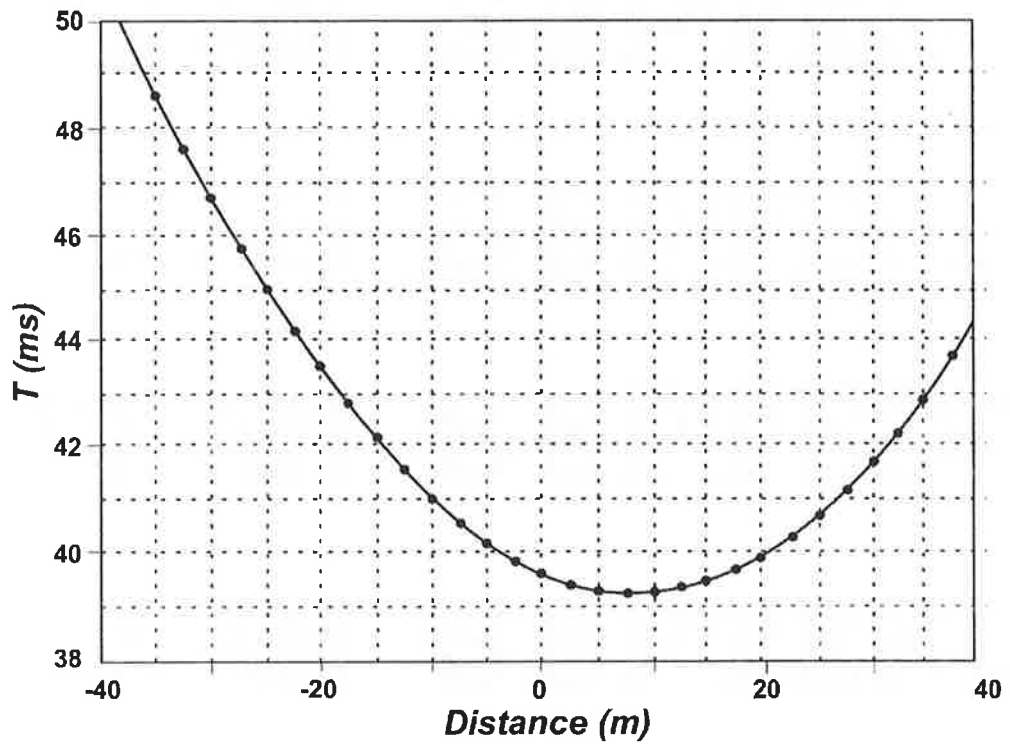


FIGURE Q4a: T-X plot of seismic reflection.

