UNIVERSITI TEKNOLOGI PETRONAS

FINAL EXAMINATION
SEPTEMBER 2023 SEMESTER

COURSE : QCB1043/QDB1043 - STRUCTURAL GEOLOGY

DATE : 11 DECEMBER 2023 (MONDAY)

TIME : 9:00 AM - 12:00 NOON (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.
6. **Students must submit the answer written in APPENDIX 1 for QUESTION 5 with the answer booklet.**

Note :

i. There are **NINE (9)** pages in this Question Booklet including the cover page and the Appendix.

ii. **DOUBLE-SIDED** Question Booklet.

1. a. Define the terms below:

i. Mohr Circle.

[2 marks]

ii. Reverse fault.

[2 marks]

iii. Half-graben.

[2 marks]

iv. Axial plane.

[2 marks]

v. Tectonic.

[2 marks]

b. Differentiate cylindrical and non-cylindrical folds.

[4 marks]

c. Compare homogeneous and heterogeneous deformations.

[6 marks]

2. Non-circular fossils including trilobite as shown in **FIGURE Q2** are useful for strain analysis through Wellman's Method.

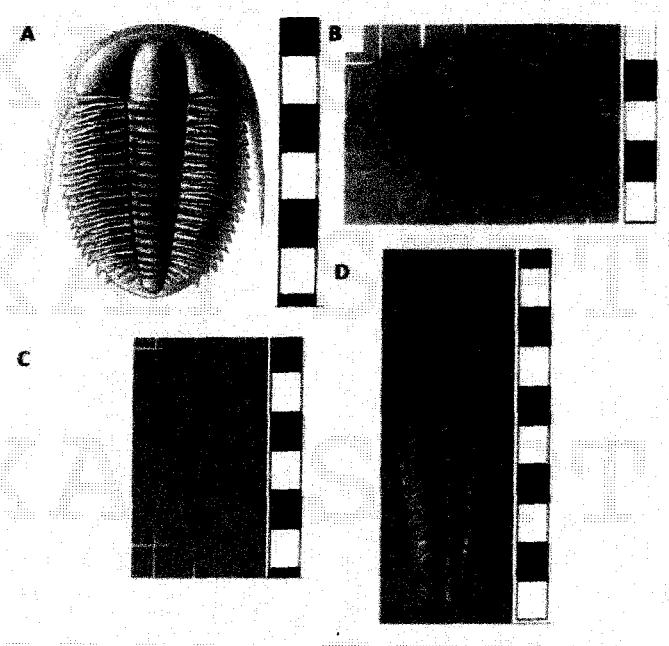

FIGURE Q2: Top view of a trilobite fossil. A) Original undeformed shape of a trilobite; B-D) Various deformed shapes of a trilobite with B being streched, C being squeeze and rotated and D being elongated.

a. List **TWO(2)** conditions required in performing the Wellman's Method for strain analysis.

[4 marks]

b. The outcome of strain measurement through Wellman's Method is a strain ellipsoid. Draw an example of a strain ellipsoid with the strain values of S1=4.8 and S3=1.2. Label the strain ellipsoid with S1 and S3 values.

[6 marks]

c. Calculate the strain ratio of the ellipsiod drawn in **Q2b** with strain values of S1=4.8 and S3=1.2.

[4 marks]

d. Discuss the concept of Wellman's Method in measuring the strain for non-circular object as shown in **FIGURE Q2**.

[6 marks]

3. Folds form when compression forces are applied on the rocks. Answer the following questions based on **FIGURE Q3**.

FIGURE Q3: Gneiss with folded light colour strata (Layer A) and folded dark colour stratas (Layers B1 and B2). Coin as scale.

a. Identify the competent and incompetent layers in gneiss as shown in **FIGURE Q3**.

[4 marks]

b. State the mechanism in the formation of folds as shown in **FIGURE Q3**.

[2 marks]

c. Describe **FIVE (5)** characteristics for folds of Layer A based on your observation in **FIGURE Q3**.

[10 marks]

d. Fold can be an antiform or synform, depending on the curvature directions. Explain the definition of inflection points on an antiform fold with the aid of a diagram.

[4 marks]

4. a. Answer the following questions based on **FIGURE Q4**.

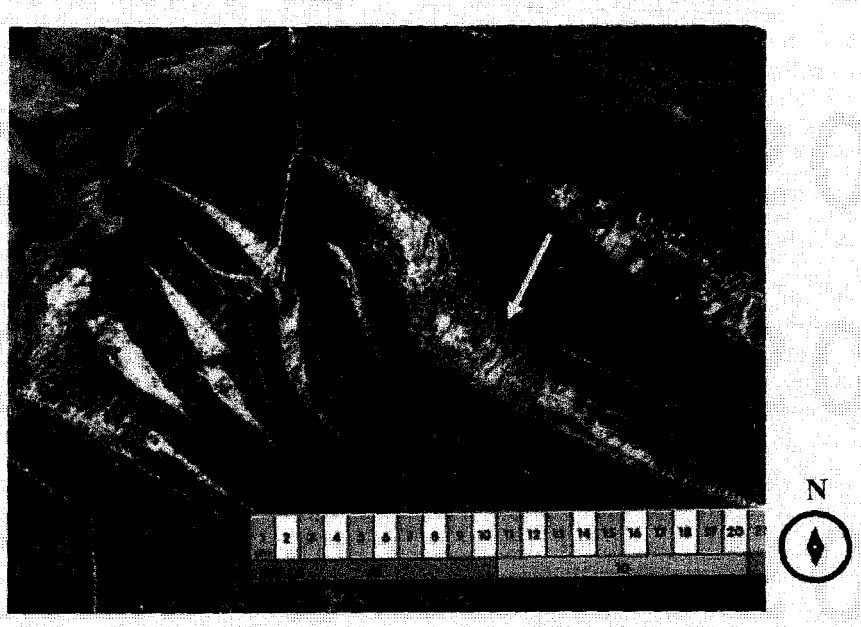

FIGURE Q4: Top view of the structure (pointed by white arrow) form in a limestone. N indicate the north direction.

i. Name the structure that form in this limestone (pointed by the arrow).

[2 marks]

ii. Classify the type of fracture mode for the structure identified in **QUESTION 4a(i)**.

[2 marks]

iii. Determine the shear movement of the structure classify in **QUESTION 4a(ii)**.

[2 marks]

iv. Interpret the maximum principal stress direction (σ_1) that resulted from the shear movement determine in **QUESTION 4a(iii)**.

[2 marks]

b. Illustrate synthetic and antithetic faults. Accompany your illustrations with proper labelling.

[6 marks]

c. The visualization of high-angle normal faults appears steeply dipping in the shallow subsurface data. In reality, the high-angle normal faults change its' dipping angle as it goes deeper and terminate on detachment layers. Analyse **THREE(3)** characteristics of listric-detachment faults.

[6 marks]

5. Fractures are a common geological structures found in rocks. Answer the following questions based on **FIGURE Q5**. An enlarge image of **FIGURE Q5** is provided in **APPENDIX 1**.

FIGURE Q5: Fractured basalt outcrop with an adult women as a scale.

a. As a structural geologist, you are tasked to conduct fracture analysis on the outcrop shown in **FIGURE Q5**. Suggest **FIVE(5)** important steps required in collecting the fracture data from this outcrop.

[10 marks]

b. Propose **ONE(1)** efficient fracture sampling method for this outcrop by sketching the sampling method on **APPENDIX 1**. Submit the answer on **APPENDIX 1** together with your answer booklet.

[4 marks]

c. Justify the fracture sampling method selected in **QUESTION 5b**.

[6 marks]

- END OF PAPER-

APPENDIX 1: FIGURE Q5

TABLE NO:

EXAM ID: