UNIVERSITY OF NAMIBIA
EXAMINATIONS

FACULTY	AGRICULTURE, ENGINEERING AND NATURAL SCIENCES
DEPARTMENT	CIVIL AND MINING ENGINEERING
SUBJECT	ENGINEERING AND STRUCTURAL GEOLOGY
SUBJECT CODE	I3611 MG
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DURATION	3 HOURS
MARKS	100

FIRST OPPORTUNITY EXAMINATIONS 2023

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This question paper consists of ...3.... pages excluding this front page.

Instructions

1. Closed book examination.

2. Read the questions carefully.

3. Answer FIVE **QUESTIONS** and show your work.

   Answer Question 1 and any other four questions. All questions carry equal marks

4. Marks for each question are indicated.

5. Start each question on a fresh page.

Constants:

The speed of light, $c = 3 \times 10^8$ m/s

Newton's gravitational law of attraction: $F = G * [m1\ m2]/r^2$

Where $G = 6.67 \times 10^{-11}$ N m^{-2}kg^{-2}

Mass of the Earth = 5.9722×10^{24} kg

Mean Distance to the Sun from Earth: 1 A.U = 150 000 000 km (at perihelion, 148 000 000; at aphelion 152 000 000 km)

Distance from the Earth to the Moon is approximately 405 000 km.

Formulas:

$$\sigma_n = (½)\,[\sigma_1 + \sigma_3] + (½)\,[\sigma_1 - \sigma_3]\,\text{Cos } 2\theta$$

$$\tau = (½)\,[\sigma_1 - \sigma_3]\,\text{Sin } 2\theta$$

$$C = \tau - \mu\sigma_n.$$

$$\frac{1}{\lambda f} = \frac{1}{2}\left(\frac{1}{\lambda_3} + \frac{1}{\lambda_1}\right) - \frac{1}{2}\left(\frac{1}{\lambda_3} - \frac{1}{\lambda_1}\right)Cos2\theta$$

$$\frac{\gamma}{\lambda f} = \frac{1}{2}\left(\frac{1}{\lambda_3} - \frac{1}{\lambda_1}\right)Sin2\theta$$

Question 1 is compulsory.

1. Answer the following questions as concisely as possible:
   (a) Draw a sketch of the internal structure of the earth, and label each section accurately, and mention its composition. [5]
   (b) Why does the Earth's magnetic field exist? If there was no magnetic field, explain what would happen on earth. [3]
   (c) What needs to happen in the internal structure of the earth in order for the magnetic field to disappear? [3]
   (d) Name three plate boundaries and state the rocks that are formed or associated with each of the three plate boundaries. Why is Plate tectonics possible? [3, 3, 3]

2. (i) If a space craft from Earth were to travel to Proxima Centauri (at about 4.2465 light years), at an average velocity of 120 800 km/hr, how long would it take (in years) to reach Proxima Centauri? Based on this answer, postulate on the ease of interstellar travel.
   [3, 2]
   (ii) Discus the architecture of the solar system, including the basic compositions of the planets and their phases. [15]

3. (a) The roads authority plans to rehabilitate the road from Nkurenkuru to Okongo in northern Namibia, where annual rainfall is about 700 mm/a and also to tar the road from Keetmanshoop to Karasburg in the South, where rainfall is about 150 mm/a and in some years it doesn't rain at all. Discuss what kind of rock types would be ideal for use as aggregate for both roads. Explain the reasons for your choices. [5, 5, 5]
   (b) Discuss the magnitude 4, 5, 6 of earthquakes on the Richter scale and the damage likely to occur for each magnitude? What is the effect of earthquakes on engineering structures? [5]

4. In the town of Shanakulya Oshanakulonga, for the 10 year average up to 2021-2022 season received $300 \frac{m^3}{annum}$ rain. Evaporation is given at 250 mm/year. The village council abstracts an average of $650\ m^3$ from their aquifer per year. An ephemeral stream passes through the settlement contributing an estimated $380 m^3/annum$. A vegetable farmer is allowed $100\ m^3/year$ for irrigation by boreholes from the ephemeral river. Calculate the water budget for the town of Shanakulya Oshanakulonga and show whether the settlement has a water budget issue or not. What would be your advice to the town council regarding water savings and management? [10, 5, 5]

5. Calculate:

(a) The Normal stress in the Tsumeb T4 unit is given as: (i) the maximum principal stress σ_1, is given as 500 MPa, and the minimum Principal Stress, σ_3 is given as 100 MPa. (ii) You are also told that the angle between σ_1 and the fracture is 30°. What is the differential stress and shear stress, τ in this rock?

[3, 3, 4]

(b) An Oncolith in the Arandis Marble Formation was found to have an ellipsoidal shape. The Long axis of the oncolith was measured at 6.0 cm, whereas the shortest axis was measured at 4.0 cm. The oncolith has been displaced from the main foliation by an angle, θ, of 30°.

(i) Calculate the quadratic elongation and shear strain in the Arandis Marble Formation. [4, 2]

(ii) Calculate the angular shear in the Arandis Marble and discuss whether or not it is likely to be porous. [2, 2]

6. (a) Calculate the lithostatic and hydrostatic stress in a rock at a depth 0f 8 km, given that the average density of the rocks is 2.5 g/cm^3 and that of water is 1 g/cm^3. Discuss why springs occur on the surface. [4, 4]

(b) Discuss how sedimentary rocks of sandstone and mudstone affiliation are formed (state the environment necessary for their formation)? What are the uses of sedimentary rocks? [4, 2]

(c) Granitic and basaltic igneous rocks are quite common on the earth. What conditions are necessary for the formation of intrusive and extrusive igneous rocks? Give one example of a volcanic and plutonic igneous rock. What are the main uses of igneous rocks? [3, 3]