KISII UNIVERSITY

UNIVERSITY EXAMINATIONS

SPECIAL EXAMINATION

THIRD YEAR EXAMINATION FOR THE AWARD OF THE DEGREE OF BACHELOR OF SCIENCE GEOPHYSICS & MINERALOGY

FIRST SEMESTER 2021/2022

(JULY, 2022)

BSMN 314: APPLIED GEOPHYSICS II

STREAM: Y3 S1 **TIME: 2 HOURS**

DAY: WEDNESDAY, 11:30 AM – 10:30 PM **DATE: 20/07/2022**

INSTRUCTIONS:

1. ***Do not write anything on this question paper.***
2. ***Answer Question ONE (Compulsory) and any other TWO questions.***
3. **The following formula may be useful:**

$$g_{\phi} = 978.01385[1 + 0.0053024sin^2\phi - 0.0000059sin^2 2\phi]mgal$$

Free Air Correction = 0.3081mgal/m

Bouguer Correction = 0.112mgal/m

QUESTION ONE:

a) i) What is a seismic wave? (2 marks)

ii) Explain three sources of seismic waves used in land surveys. (3 marks)

b) Explain the term earthquake seismology. (2 marks)

c) i) Differentiate between stress and strain in the internal structure of the Earth. (2 marks)

ii) Using a graph, show how stress and strain depend on one another until fracture point. (4 marks)

d) With aid of diagrams, explain the following elastic constants.

i) Young's modulus (E) (2 marks)

ii) Bulk modulus (K) (2 marks)

iii) Shear modulus (μ) (2 marks)

iv) Poisson's ratio (σ) (2 marks)

e) Using a diagram, explain the following terms as used in seismic waves.

i) Wavefront (2 marks)

ii) Ray path (2 marks)

iii) Propagation velocity (2 marks)

f) I) What is attenuation of seismic waves. (1 mark)

ii) Explain two causes of attenuation of seismic waves. (2 marks)

QUESTION TWO

a) Explain the following terms: (5 marks)

-Magnetic potential
-Magnetic moment
-Secular variation
-Magnetic storm
-Paleomagnetism

b) Outline the causes for the following;

-Main field
-Diurnal variations
-Magnetic anomalies (6 marks)

c) With the aid of a diagram, define the elements of the geomagnetic field. (3 marks)

d) i) Explain the working principle of a proton precession magnetometer.

(3 marks)

ii) Describe Peter's half-slope method used in estimating depth to magnetic sources. (3 marks)

QUESTION THREE

a. Considering that the detected signal in electromagnetic is a combination of primary and secondary signal given by;

$H_P = ASin\omega t$ and $H_S = BCos(\omega t - \emptyset)$ where A and B are functions of geometry of transmitter, conductor and detector.

i. Derive the equation of the polarization ellipse.

ii. Determine expressions for the ellipse for:

- Good conductor
- Poor conductor (10 marks)

b. (i) From Maxwell's laws and in a region of finite conductivity, show that,

$$\Delta^2 E = \mu\sigma \frac{\partial E}{\partial t} + \mu\varepsilon \frac{\partial^2 E}{\partial t^2} \text{ and } \Delta^2 H = \mu\sigma \frac{\partial H}{\partial t} + \mu\varepsilon \frac{\partial^2 H}{\partial t^2}$$

(ii) Assuming the solutions of equations in a (i) for magnetotellurics is given by

$$E(t) = E_0 e^{jwt} \text{ and } H(t) = H_0 e^{jwt}$$

Show that for air or poorly conducting rocks $\nabla^2 E = 0$ and $\nabla^2 H = 0$ while in good conductors $\nabla^2 E = j\omega\mu\sigma E$ and $\nabla^2 H = j\omega\mu\sigma H$ (10 marks)

QUESTION FOUR

a) i. State and explain two types of body seismic waves. (2 marks)

ii. State and explain two types of surface seismic waves. (2 marks)

b) i.State two physical properties that cause an incident ray to change direction at an interface. (2 marks)

ii. Write the expression for acoustic impedance. (2 marks)

iii. What is the effect on the proportion of energy transmitted across the interface when the contrast in acoustic impedance$Z$ is smaller. (1 mark)

c) Define 'Reflection' and 'Transmission' coefficients using Zoeppritz equations explaining all the terms used. (4 marks)

d) Taking,

I_P → Incident angle of P-wave

R_S → Reflected angle of S-wave

R_P → Reflected angle of P- wave

r_S → Refracted angle of S- wave

r_P → Refracted angle of P- wave

V_{P1} → Velocity of P- wave in medium 1

V_{S1} → Velocity of S-wave in medium 1

ρ_1 → Density of medium 1

V_{P2} → Velocity of P-wave in medium 2

V_{S2} → Velocity of S-wave in medium 2

ρ_2 → Density of medium 2

State Snell's Law and illustrate it in a diagram. (4 marks)

e) Define critical refraction and derive an expression for critical angle in terms of velocities at an interface. (3 marks)

QUESTION FIVE

a) i) With the aid of a sketch, explain the working principle of a gravimeter (4 marks)

ii) Show that at a height h a metre above the surface of the reference ellipsoid is given by:

$$g_h = g_o\left(1-\frac{2h}{R}\right)$$

Where g_h and g_o represent gravity at a height h and at the reference ellipsoid respectively. (3 marks)

iii) The data below was collected using a galvanometer with a dial constant of 0.0869mGal/dial division. Plot a drift curve and make drift correction for the four stations milli-Gals. (4 marks)

Station	Time	Reading in Dial Division
Base	11.20	762.71
ST. 1	11.42	774.16
ST. 2	12.14	759.72
ST. 3	12.37	768.95
ST. 4	12.59	771.02
Base	13.10	761.18

b) i) Outline the necessary gravity reductions applied to raw gravity data resulting to complete Bouguer anomaly (6 marks)

ii) At a point whose latitude $\varphi = 30^0$ N, elevation h = 600 metres above sea level, the value of observed gravity is 979592 milligals. Calculate the simple Bouguer anomaly in milligals. (3 marks)