भू-विज्ञान परीक्षा
Geo-Physics Examination 2014

A–FDN/RB–N–QZC

GEO-PHYSICS

Paper—III

Time Allowed : Three Hours | *Maximum Marks : 200*

INSTRUCTIONS

Please read each of the following instructions carefully before attempting questions :

*There are **ELEVEN** questions divided under **THREE** sections.*

*Candidate has to attempt **NINE** questions in all.*

*The **only** question in **Section A** is compulsory.*

*In **Section B**, **FOUR** questions out of **FIVE** are to be attempted.*

*In **Section C**, **FOUR** questions out of **FIVE** are to be attempted.*

The number of marks carried by a question / part is indicated against it.

All parts and sub-parts of a question are to be attempted together in the answer book.

Attempts of questions shall be counted in chronological order. Unless struck off, attempt of a question shall be counted even if attempted partly.

Any page or portion of the page left blank in the answer book must be clearly struck off.

*Answers must be written in **ENGLISH** only.*

Neat sketches are to be drawn to illustrate answers, wherever required.

Unless other-wise mentioned, symbols and notations have their usual standard meanings.

Assume suitable data, if necessary and indicate the same clearly.

Constants which may be needed :

Kepler's Constant	$3.986004418 \times 10^5\ km^3\ s^{-2}$
Mean radius of Earth	*6378 km*
Mass of electron (m_e)	$9.11 \times 10^{-31}\ kg$
Charge of electron (e)	$1.602 \times 10^{-19}\ C$

SECTION—A

1. Answer **ALL** of the following : 5×8=40

(a) State the reason for recommended slow speeds of Natural Gamma Ray (GR) and Gamma Ray Spectrometry (NGS) logging tools. 5

(b) (i) Explain horizontal and vertical resolutions of seismic reflection data. 3

(ii) A seismic reflection survey is conducted to map sedimentary horizons having P-wave seismic velocity of 3000 m/s and employing an airgun seismic source with a dominant frequency of 150 Hz. Find out vertical resolution of seismic data. 2

(c) Consider the finite-impulse response (FIR) filter with impulse-response $h(n) = \frac{1}{M+1}, 0 \le n \le M$.

Give one non-recursive realization of this system. 5

(d) What do you understand by scale of a map ? Comment briefly on Geographic Information System (GIS). 1+4=5

(Contd.)

(e) The primitive translation vectors of the hexagonal lattice may be taken as :

$$\vec{a} = \frac{\sqrt{3}}{2} a \hat{i} + \frac{a}{2} \hat{j}$$

$$\vec{b} = \frac{-\sqrt{3}}{2} a \hat{i} + \frac{a}{2} \hat{j}$$

$$\vec{c} = c \hat{k}$$

Determine (i) volume of the primitive cell, (ii) primitive translation vectors of the reciprocal lattice. 5

(f) The earth rotates once per side real day of 23 hours 56 minutes 4.09 seconds. Find the radius of the geostationary earth orbit satellite. 5

(g) Simplify the logical expression

$$\overline{(A + \overline{B})} B (A + \overline{C})$$

and draw the logical circuit to implement it. 5

(h) Use the uncertainty principle to estimate the ground state energy of a linear harmonic oscillator. 5

SECTION—B

(Attempt any **FOUR** questions)

2. (a) Briefly discuss the primary calibration of a natural gamma ray (GR) logging tool with the help of a neat schematic diagram. 8+2=10

(b) Explain as to how diurnal variations of geomagnetic field are taken care of in airborne magnetic survey data. Draw schematic diagrams, to illustrate your answer. 8+2=10

3. (a) Differentiate between transform fault and fracture zone. 5

(b) Briefly discuss "Eötvös correction" applied to marine gravity data. 5

(c) Draw a labelled schematic diagram showing morphology of ocean floor from coast to deep ocean. Explain its bearing on mineral and hydrocarbon resources. 4+6=10

4. (a) What is the Nyquist rate for the analog signal :

$$x_a(t) = 3 \cos 2000 \pi t + 5 \sin 6000 \pi t + 10 \cos 12000 \pi t \ ?$$

What is the discrete-time signal obtained after sampling it uniformly at a sampling rate $F_s = 5000$ samples/second ? What is the analog signal $y_a(t)$ we can reconstruct from the samples if we use ideal interpolation ? 10

(b) Using the discrete Fourier transform (DFT) and inverse discrete Fourier transform (IDFT)

properties, determine the response of the finite-impulse response (FIR) filter with impulse response

$$h(n) = \{\underset{\uparrow}{1}, 2, 3\}$$

to the input sequence :

$$x(n) = \{\underset{\uparrow}{1}, 2, 2, 1\}.$$ 10

5. (a) What is meant by 'Atmospheric Window' ? What do you understand by 'signature' in Remote Sensing ? Comment briefly on the different characteristics of the targets which facilitate their discrimination. 4+3+3=10

(b) What is a sensor in Remote Sensing ? What are the different kinds of Remote Sensors ? Discuss critically on the parameters considered most important for the performance of a sensor. 2+3+5=10

6. (a) Consider the following statement and critically discuss the same :

"Airborne radiometric surveys can isolate radioactive mineral abundance at shallow depth in the subsurface." 5

(b) Briefly discuss the principle of Global Positioning System (GPS) for position location in offshore region. 5

(Contd.)

(c) Given the following two discrete wavelets in time domain :

$f_1 = [0\ 1\ 1]$ and

$f_2 = [1\ 1]$

compute :

(i) Auto-correlation of wavelet f_1.

(ii) Cross-correlation of wavelets f_1 and f_2 and tabulate the outputs in each case for different time lags. 2+3=5

(d) Write briefly on Different Remote Sensing Platforms. 5

SECTION—C

(Attempt any **FOUR** questions)

7. (a) Derive an expression for the specific heat of a solid based on Debye's theory. 12

(b) Obtain the limiting forms of the specific heat at very high and very low temperatures. 8

8. (a) The total efficiency of an injection LASER with a GaAs active region is 18%. The voltage applied to the device is 2.5 V and the band gap energy for GaAs is 1.43 eV.

Calculate the external power efficiency of the device. 10

(b) List three advantages and three disadvantages of a Nd : YAG Laser.

Also give its schematic diagram. 6+4

9. (a) Draw the common-emitter amplifier circuit, using a p-n-p transistor and briefly discuss its working. 16

(b) Let α and β denote the current gains for the common-base and common-emitter configurations, respectively. What is the relation between α and β ? Calculate β if $\alpha = 0.98$. 4

10. A low earth orbit satellite is in a circular polar orbit with an altitude, h, of 1000 km. A transmitter on the satellite has a frequency of 2.65 GHz.

(i) Find the velocity of the satellite in orbit.

(ii) Find the component of velocity toward an observer at an earth station as the satellite appears over the horizon, for an observer who is in the plane of the satellite orbit.

(iii) Also find the Doppler shift of the received signal at the earth station. Use mean radius of the earth as 6378 km. 5+10+5=20

(Contd.)

11. (a) Solve the Schrödinger equation for a particle of mass m in a one-dimensional potential well of the form :

$$V(x) = 0, \quad 0 \leq x \leq L$$
$$= \infty, \quad x < 0, x > L.$$

Obtain the normalized eigenfunctions and the corresponding eigenvalues. 15

(b) Determine the probability of finding the particle between $x = 0$ and $x = \frac{L}{9}$ if it is in the state $n = 3$ in the potential well. 5