वियोज्य *DETACHABLE*

GEO-PHYSICS

Paper I

Time Allowed : Three Hours

Maximum Marks : 200

QUESTION PAPER SPECIFIC INSTRUCTIONS

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

There are **TEN** questions divided under **TWO** Sections.

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

Questions No. 1 and 6 are ***compulsory***.

Out of the remaining **EIGHT** questions, **FOUR** questions are to be attempted choosing **TWO** from each Section.

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

Attempts of questions shall be counted in sequential 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 may be drawn to illustrate answers, wherever required.

Unless otherwise mentioned, symbols and notations have their usual standard meanings.

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

SECTION 'A'

1. (a) Give brief account of characteristics of planets which must be satisfied by the theories propounded for the origin of solar system. 10

1. (b) Define "magnitude" of an earthquake and its various scales of measurements. Write an empirical relation between magnitude and intensity. 10

1. (c) Derive the expression for the generalized least squares solution. 10

1. (d) Write the Maxwell's equations for free space in differential and integral form. 10

2. (a) Discuss the principle of radioactive methods of determining age of the earth by defining decay constant (λ) and half life. 10

2. (b) Explain P-shadow zone in a standard earth model. List any three seismic phases which are observed in the P-shadow zone. Draw the travel path of the listed seismic phases. 10

2. (c) Explain Free-Air and Bouguer. Discuss with schematic sketches, the Free-Air and Bouguer anomalies observed over mountain ranges which are isostatically compensated and uncompensated respectively. 10

3. (a) Write short note on Receiver Functions. 10

3. (b) Define 'hypocenter' and 'epicenter' of an earthquake and classify earthquakes on the basis of focal depths. Explain the Benioff-Wadati zone with a figure. 10

3. (c) Explain underdetermined, overdetermined, mixed determined and even determined problems with an example for each. 10

4. (a) Define magnetic susceptibility. Discuss the secular and diurnal variations of the earth's magnetic field. Explain geomagnetic storms and their effects. 10

4. (b) Explain the differences between seismometer, accelerometer and displacementmeter. Write short note on 'Broadband seismograph'. 10

4. (c) Explain using travel time versus epicentral distance plots, how a high velocity zone and a low velocity zone in the earth are identified. 10

5. (a) Explain the iterative method of estimating the hypocentral parameters of an earthquake. Explain the factors leading to uncertainties in the location of hypocenters. 10

5. (b) List in a tabular form the geophysical and geological characteristics of a typical oceanic and a stable continental crust. 10

5. (c) Define the condition number for a normal matrix. Explain a well-conditioned and an ill-conditioned matrix. Explain the trade off of resolution and variance with a figure. 10

SECTION 'B'

6. (a) Evaluate the integral $I = \int_0^\infty \frac{dx}{1+x^2}$ using the method of contour integration and verify the result by using the conventional method of integration. 8+2=10

6. (b) Use the relation $\left(\frac{\partial U}{\partial V}\right)_{T,N} = T\left(\frac{\partial P}{\partial T}\right)_{V,N} - P$ to show that the internal energy of an ideal gas is a function of temperature alone. Calculate change in entropy of an ideal gas and the universe when this gas undergoes a reversible isothermal expansion from volume V_0 to $2V_0$. 3+7=10

6. (c) Explain Ampere's circuital law in magnetostatics. Elaborate the steps adopted by Maxwell in modifying this equation for time-dependent fields. 10

6. (d) Explain the interaction of solar radiation with the neutral atmosphere. Which portion of the solar radiation is responsible for formation of ionosphere. 10

7. (a) Evaluate $\vec{\nabla} f(r)$ and show that $\vec{\nabla}\times\left(\vec{r}\, f(r)\right) = 0$, where $f(r)$ is any arbitrary function of $|\vec{r}|$. 5+5=10

7. (b) Show that $\vec{\nabla}\cdot\left(\vec{r}\, f(r)\right) = 0$ only if $f(r) = Cr^{n-1}$ with $n = -2$. Here C is a constant. 10

7. (c) Find eigenvalues and eigenvectors of the matrix :

$$\sigma_y = \begin{pmatrix} 0 & i \\ -i & 0 \end{pmatrix}.$$ 10

8. (a) Derive an expression for the Bose distribution function and discuss that the chemical potential of an ideal Bose gas is always negative. 10+5=15

8. (b) Show that an ideal Bose gas undergoes Bose-Einstein Condensation at a finite temperature ($T = T_c$) when cooled from high temperature ($T > T_c$) keeping number density fixed. 15

9. (a) Explain the phenomenon of the Debye shielding in plasma and derive the expression for the Debye length.
Find the Debye length for a distant galaxy containing a cloud of protons and anti-protons, each with density $n = 10^6 m^{-3}$ and temperature 100 K. 7+3=10

9. (b) Derive the equations satisfied by the vector potential $\vec{A}(\vec{r}, t)$ and the scalar potential $\phi(\vec{r}, t)$ if one uses the Lorentz gauge condition. 10

9. (c) A uniform plane wave propagating in a material medium has the electric field

$E_y(z, t) = 2e^{-\alpha z}\sin(10^8 t - \beta z)$ V/m

Find attenuation and propagation constants α and β if the medium is characterized by $\in_r = 1$, $\mu_r = 20$ and $\sigma = 3$ mho/m. 10

10.(a) Describe height profile of thermal structure of the atmosphere indicating the cause of variation in different layers of atmosphere. 10

10.(b) Define ionospheric irregularities and differentiate between Sporadic-E and Spread-F irregularities. 10

10.(c) Explain different types of errors in GPS measurements. Calculate range error in L_1 signal due to presence of ionosphere having total electron contents (TEC) of 5 TECU. 5+5=10
