Junior Research Fellowship in Geology

(Test Codes: GEA and GEB)

The candidates for Junior Research Fellowship in Geology will have to take two tests: Test GEA (forenoon session) and Test GEB (afternoon session).

Syllabus

Test GEA

Part - 1

Algebra: Properties of real numbers. Geometry of complex variables. DeMoiver's theorem. Algebra of matrices. Rank & inverse of a matrix. Determinants. Solution of linear equations. Orthogonal & unitiary matrices. Eigenvalues & eigenvectors of a matrix.

Calculus: Sequence & series. Taylor series. Limit & continuity. Derivatives. Integration of functions of one variable. Definite integrals. Functions of several variables. Partial derivatives. Maxima & minima. Ordinary linear differential equations. Elementary linear partial differential equations. Heat conduction equations.

Co-ordinate Geometry: Straight line. Conic sections. Elementary 3-D co-ordinate geometry.

Part - II

Geomathematics and Geostatistics: Analysis of orientation and time-series data, Mohr's Circle of stress and strain, Geological Strain Analysis, Rheology of materials, Heat flow within the Earth, Flow through porous media, Thermodynamic Principles, Stereographic Projection of geological data.

Applications of elementary probability theory, Measures of central tendency, Dispersion, Binomial-Poisson-Normal distributions, Student's T test, ANOVA models, Snedecor's F test, Correlation & regression.

Test GEB

Structural Geology and tectonics

Interpretation of geological maps. Concepts of stress and strain, plastic and viscous flow; theory of brittle fracture. Fold and fault – their geometry, classification and mechanics. Superposed folds and their recognition. Classification and genesis of foliation, lineation and joints. Outline of the structure of the Himalayas. Isostasy and gravity anomalies.

Plate tectonics and mobile belts, seismisity and seismic zones. Ophiolites and their tectonic significance, Epirogeny, Rifts, Mantle Plumes.

Mineralogy
Principles of mineral optics, methods of mineral identification and properties of common rock forming minerals.

Petrology
Phase equilibria studies of various silicate systems with reference to petrogenesis. Various types of magmas, magmatic differentiation and assimilation. Petrogenetic study of important igneous or groups of igneous rocks – granites, alkaline rocks, andesite, basalt. Processes of generation of magmas in the crust and upper mantle – correlation with plate tectonics. Controls of metamorphism, nature of metamorphic reactions, chemical equilibrium. Metamorphic facies concept: mineral assembalges and important reactions in different metamorphic facies. Relationship between metamorphism, ultrametamorphism and granitization. Petrogenetic problems of Khondalite, Charnockite and other metamorphic rocks of India.

Geochemistry and Geochronology
Radioactivity : Radioactive decay, age and event dating, nuclear clocks. Geochemical classification and distribution of elements in the earth. Law of ionic substitution, concept of solid solution and controlling factors.

Sedimentology
Classification of sedimentary rocks. Transport of sediments by fluids. Sedimentary structures. Texture of sedimentary rocks. Environments of deposition and resulting succession of sedimentary structures and lithologies. Processes and products of continental, transitional to marine and marine depositional environments. Sedimentary facies analysis. Lithification and diagenesis of sediments. Statistical analysis of grain size and shape. Palaeocurrents and basin analysis. Major controls of sedimentation.

Economic geology
Principles of classification of mineral deposits. Characters of common ore forming minerals. Processes of formation of economic mineral deposits. Strategic, critical and essential minerals of India.

Palaeontology
Evolution of life. Fossils, their nature, modes of preservation and uses. Migration, dispersal and extinction of animals and plants. Morphology, classification and evolution of important invertebrate and vertebrate fossil groups. Microfossils – techniques of their study and importance in geology. Fundamentals of palaeoecology. Brief study of the important Gondwana flora and fauna of India.

Stratigraphy
Principles of stratigraphy. Stratigraphic Units. Standard geological time scale. Principles of palaeogeographic reconstruction. Principles of stratigraphic correlation. Outline of

sequence stratigraphy. Study of the important geological formations of India. Age and correlation problem in Indian stratigraphy.

GIS and Remote Sensing

Elementary concepts and definitions of Geographical Information System, Remote Sensing, and Global Positioning System. Spatial coordinate systems, map projections and basics of coordinate transformation. Methods of storing vector map data (geometric and non-geometric attributes) in digital formats. Methods of storing remotely sensed image information in digital formats. Sensors, energy sources, and characteristics of satellite images. Elementary techniques of analyzing vector and raster geospatial data.

Sample Question

BOOKLET NO. TEST CODE: **GEA**

Forenoon

No of Questions:	Time: 2 hours
PART I- ten questions	10X3=30 marks
PART II-seven questions	7X10=70 marks

Give your answers in the answer booklet only.
Write your Name, Registration Number, Test Centre, Test Code and the Number of this booklet in the appropriate places on the answer sheet.

STAPLE/ATTACH QUESTION BOOKLET WITH THE ANSWER BOOKLET FOR QUESTION 7. ROUGH WORK MUST BE DONE ON THE QUESTION BOOKLET AND OR ON THE ANSWER BOOKLET. YOU ARE NOT ALLOWED TO USE CALCULATOR.

Final answers to some of the problems may involve computing long arithmetic expressions. Candidates need not spend time in numerically simplifying these expressions.

STOP! WAIT FOR THE SIGNAL TO START

PART – I

Select the right answer from the given alternatives for each of the following questions. *10X3=30*

1. The equation of the tangent to the circle

$$x^2 + y^2 + 2gx + 2fy = 0$$

at the origin is

(a) $fx + gy = 0$
(b) $gx + fy = 0$
(c) $x = 0$
(d) $y = 0$

2. $\int_0^{\frac{\pi}{2}} \frac{\sin x}{\sin x + \cos x} dx$ has the value

(a) $\frac{\pi}{4}$
(b) $\frac{\pi}{2}$
(c) π
(d) None of these

3. For n=100 , $x^n \frac{d^n}{dx^n} \log_e x + 99!$ is

(a) 99 !
(b) $x + 99!$
(c) 0
(d) None of these

4. The area of the region bounded by the curves $y^2 = 4ax$ and $x^2 = 4ay$ is

(a) $\frac{8a^2}{3}$

(b) $\frac{16a^2}{3}$

(c) $\frac{32a^2}{3}$

(d) $\frac{64a^2}{3}$

5. If $x^p y^q = (x+y)^{p+q}$, then $\frac{dy}{dx}$ equals

(a) $\frac{x}{y}$

(b) $\frac{y}{x}$

(c) $\frac{y}{x^2}$

(d) $\frac{x}{y^2}$

6. If $f(x) = \frac{1}{1+e^{\frac{1}{x}}}$ and $f(0) = 0$, then $f(x)$ is

(a) continuous at $x = 0$
(b) differentiable at $x = 0$
(c) discontinuous at $x = 0$
(d) None of these

7. If $x_r = \cos\frac{\pi}{2^r} + i\sin\frac{\pi}{2^r}$, then $x_1 x_2 \ldots$ to infinity is

(a) 1
(b) i
(c) –1
(d) – i

8. $\lim_{x\to 0}(\cos x)^{1/x}$ is given by

(a) 0
(b) -1
(c) 1
(d) None of these

9. If $f(x) = x^2 - 1$ and $g(x) = x + 2$ then the value of the composite function $(ffg)(x)$ at x=1 is given by

(a) 63
(b) 8
(c) -63
(d) 0

10. The eigenvalues of the matrix A = $\begin{bmatrix} 2 & 1 & 1 \\ 1 & 2 & 1 \\ 1 & 1 & 2 \end{bmatrix}$ are

(a) 1,1,4
(b) 1,2,3
(c) 2,3,4
(d) 2,2,4

PART – II

Answer all the questions *7X10*

1. The seismometer A is situated 100km east of B. Another seismometer C is situated 100km away from A. The bearing from A to C is 330°. If all the three seismometers have recorded an earthquake at the same time then where is the epicenter located?

2. The rate of migration of individual ripples in a ripple train is x cm/unit time. If the rate of net deposition is y cm/ unit time what would be the angle of climb? Explain with schematic diagram.

3. "Focal Mean and focal Majority functions applied on a raster band of satellite imagery produce different results" –Justify the statement with an appropriate example.

4. A limestone formation is exposed along an east facing slope. Its attitude is N25°W, 36°SW. The traverse length from the lower contact to the upper contact along a bearing of N80°W was 623 meters. The slope angle measured perpendicular to strike was 15°. Determine the true thickness of the limestone. SCALE: 1" = 400 meters.

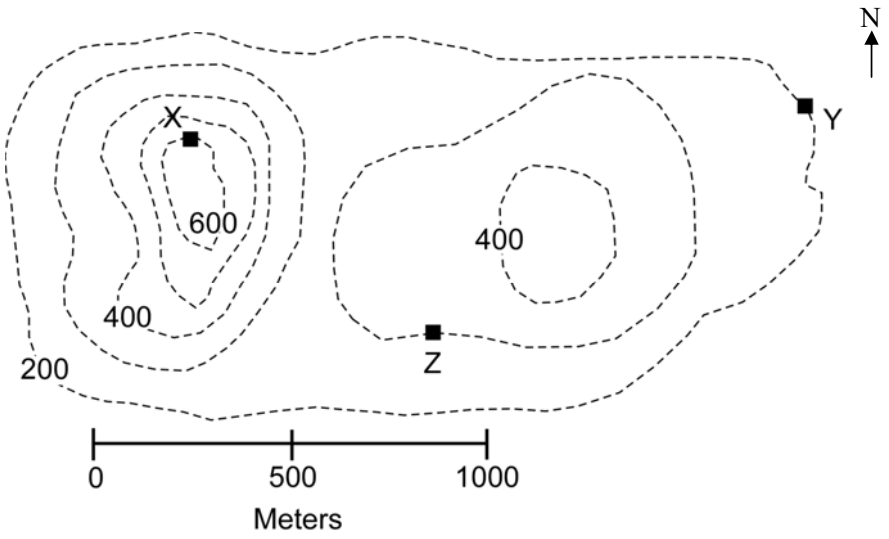
5. The angle between a mineral elongation lineation and fold axis is 30° as measured on axial plane schistosity. If the fold limbs are vertical show that the locus of the lineation is a small circle on stereographic projection. If the strike of schistosity is N-S, find the plunge of mineral elongation lineation. Mark on a sketch stereographic projection a plane perpendicular to fold axis.

6. Lengths and widths of shells of a brachiopod genus are given below.

Length (mm)	Width (mm)
18	15
17	14
14	11
11	10
9	7
6	5

Find out the correlation coefficient of the length and width of brachiopod shells.

7. A synthetic map showing contour pattern is given below. Contour height in meters. Find the strike and dip of the thin coal seam that outcrops at three locations namely X, Y and Z. Important relation that you may need: $\tan(\theta) = h / L$



Sample Question

BOOKLET NO. TEST CODE: **GEB**

Afternoon

No of Questions: 28	Time: 2 hours
PART I- interpretation of geological map	25 marks
PART II-six questions	6X7=42 marks
PART III-six questions	6X3=18 marks
PART IV-fifteen questions	15X1=15 marks

Give your answers in the answer booklet only.
Write your Name, Registration Number, Test Centre, Test Code and the Number of this booklet in the appropriate places on the answer sheet.

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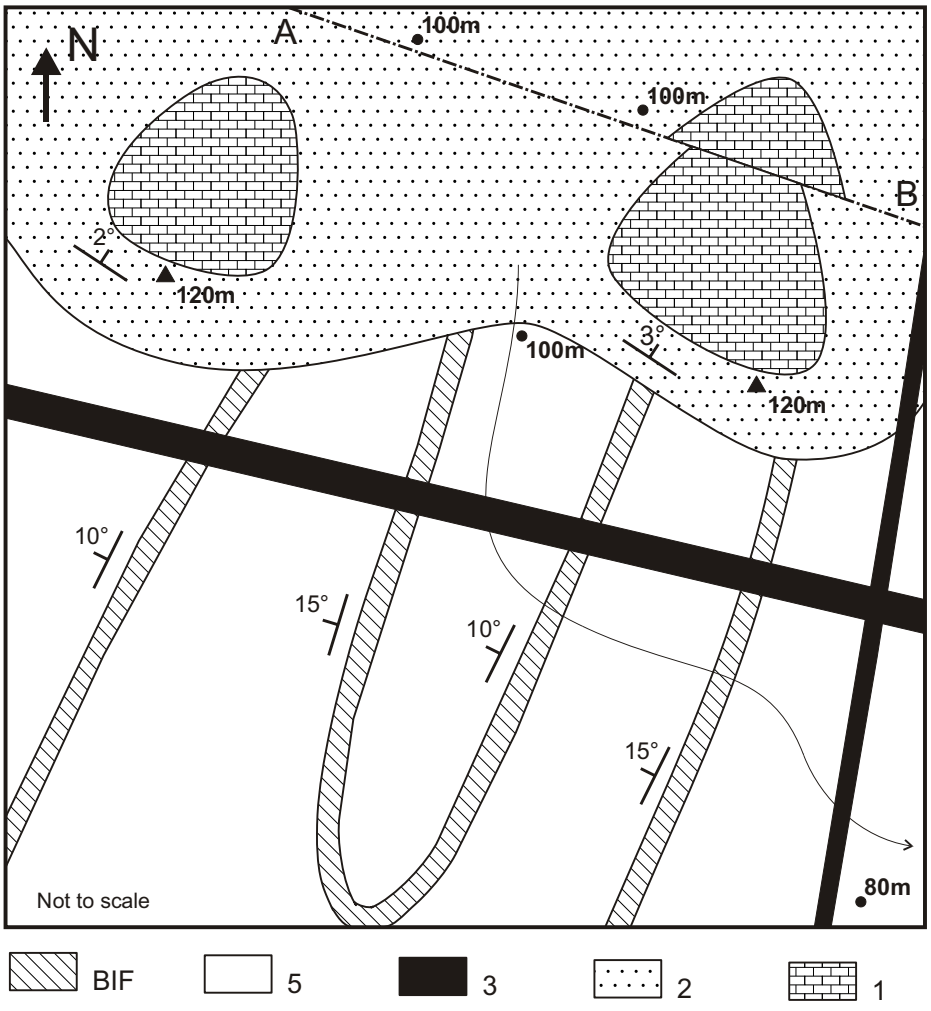
STOP! WAIT FOR THE SIGNAL TO START

PART I



Q1. Interpretation of Geological map

a. Name the rock units which are folded. Draw the recognizable fold axial traces marking antiform and synform on the map. What is the approximate orientation of the axial plane, and hinge of the folds? 1+2+2

b. Indicate how many rock units are there with the pattern marked '5' in the index giving reasons. 1+2

c. Draw a sketch cross section illustrating the folded structure, indicating on the map appropriate line of section. 5

d. Indicate the nature of contact between the folded units and units marked '2', giving reasons. Give an estimate of the upper limit of the thickness of the unit marked '2'. 2+2

e. How would you explain the offset of the contact between units '1' and '2', across the line AB? 3

f. Indicate the relationship between unit(s) marked '3' and the remaining rock units giving reasons. 2

g. Arrange the rock units in their true stratigraphic order. 3

PART II

Write brief and to the point answer to each questions 6X7=42

Q2. Define the following four terms: progradation, regression, retrogradation, transgression. Are these terms related in any way? Briefly justify your answer.

Q3. Define the following terms (in context of texture of sandstone): cement, matrix and framework. Draw sketch to show how these three elements will appear if a thin section of a sandstone sample is examined under microscope.

Q4. "Of several mass extinction events of the world, the P-T extinction event has been considered as the most severe in the history of the Earth." Why?

Q5. Explain with the help of suitable diagrams: syn-tectonic, post tectonic and pre-tectonic porphyroblasts.

Q6. What is abundance biozone? Discuss why abundance biozone, which may be used for biostratigraphic correlation, do not provide reliable means of time stratigraphic correlation.

Q7. Illustrate with a suitable sketch the course of crystallization of the parent melt of a plagioclase-phyric basalt with intergranular texture in groundmass.

PART III

Select the right answer from the given alternatives for the questions 8-13, giving justification for your answer. Justification need not be more than 3-4 sentences. 6X3=18

Q8. High diversity of the Siwalik vertebrates is related to favourable

a. geomorphologic condition only
b. paleoposition of India during the Siwalik time
c. climatic condition only
d. combinations of a, b, c.

Q9. Partial melting is often associated with some form of reaction. Which of the following mineral reactions is likely to be associated with partial melting?

a. Chlorite+ Qtz. $\longrightarrow$ Gt. + Bt.
b. Olivine + Water $\longrightarrow$ Serpentine
c. Illite $\longrightarrow$ Chlorite + Water
d. Muscovite $\longrightarrow$ K-Feldspar +Sillimanite + Water

Q10. Penta-radiate symmetry superposed on bilateral symmetry is common among the

a. echinoids
b. ammonoids
c. all cnidarians
d. bivalves.

Q11. Biological mass extinction events through the geologic past

a. always led to the advent of new biota
b. never led to the advent of new biota
c. always occurred only in the marine realm
d. always occurred only in the terrestrial realm.

Q12. The graphical representations (beach ball plots) of three fault plane solutions are given below. Which of the following represents strike-slip solution?

a)  b)  c) 

Q13. Palaeocurrent direction associated with the formation of trough cross strata is more accurately denoted by:

a. axis of the curved foreset-traces exposed on the bedding plane
b. direction of dip of the foreset in a longitudinal section
c. direction of dip of the foreset measured in a flow transverse section.

Part IV

Select the right answer from the given alternatives for the questions 14-28, no justification for your answer is needed. 15X1=15

Q14. If a region of metamorphic rocks has an abundance of andalusite in the rocks, what would it indicate about the nature of metamorphism?

a. pressure was usually high relative to temperature
b. pressure was usually low relative to temperature
c. pressure was typical of most common type of regional metamorphism
d. none of the above.

Q15. Abundance of following clay mineral is inferred to be typical of arid climatic setting

a. kaolinite
b. smectite
c. vermiculite
d. chlorite.

Q16. One of the easiest ways of deciphering neotectonic activity of an area is:

a. examining the gravity survey data of the area
b. examining the structural map of the area
c. examining the geomorphic features of the area
d. examining the geological map of the area.

Q17. The tectonic plates

a. are the outermost shell of the solid Earth.

b. include a rigid, solid layer about 100 km thick

c. include the crust and the uppermost mantle

d. all of the above.

Q18. Which of the following minerals is likely to crystallize first from a cooling mafic magma?

a. biotite

b. quartz

c. olivine

d. muscovite.

Q19. What makes a good index fossil?

a. big and easy to see in the field

b. with a hard shell that can be easily preserved

c. spans over a long geological time period

d. widespread geographically and limited to a short span of geological time

Q20. Para-amphibolites could be distinguished from ortho-amphibolites by

a. presence or absence of garnet

b. presence or absence of alluminosilicate

c. presence or absence of amphibole

d. presence or absence of biotite.

Q21. Besides Earth, what other planets show evidence of stream erosion?

a. Venus
b. Mercury
c. Jupiter
d. Mars.

Q22. Which mineral pairs possess the following properties: two sets of cleavage and colourless to pale colour in plane polarized light?

a. quartz and tremolite
b. calcite and orthoclase
c. hypersthene and orthoclase
d. hypersthene and hornblende

Q23. The correct order of increasing regional metamorphic grade is given by which of the following sequence of index minerals?

a. quartz-calcite-wollastonite-fibrolite
b. chlorite-biotite-almandine-sillimanite
c. muscovite-chlorite-staurolite-andalusite
d. olivine-pyroxene-hornblende-biotite.

Q24. Trilobite eyes are compound in nature and each lens is

a. biaxial dolomite crystal
b. biaxial calcite crystal
c. uniaxial calcite crystal
b. uniaxial dolomite crystal.

Q25. The paleocurrent pattern of a tide-dominated marine deposit is likely to be:

a. polymodal
b. bipolar
c. bimodal
d. bipolar-bimodal.

Q26. Species defined only from fossilized hard part are

a. morphospecies
b. endemic species
c. index species
d. none of the above.

Q27. In India, largest number of fossil vertebrate taxa are known from the

a. Chattisgarh basin
b. PG basin
c. Siwalik basin
d. Damodar basin.

Q28. Phylogenetic systematics (cladistics) is based on

a. numerical character states only
b. shared derived characters.
c. skull characters only
d. primitive characters.