Syllabus

(GM 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.

(GM Part II)

Geomathematics and statistics: Paleo-vector determinations, Analysis of 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.

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

Sample Questions

NAME : ---------- TEST BOOKLET NO

CENTRE: ----------

On the test booklet and the answer booklet write your Name, Registration No., Test Code. Write the question booklet number on the answer booklet

ATTENTION

Read the following carefully before answering the test.

There are two parts

Part I 10 questions 30 marks

Part II 5 questions 70 marks

ALL ROUGH WORK MUST BE DONE ON THE TEST BOOKLET AND/OR ANSWER BOOKLET. YOU ARE NOT ALLOWED TO USE CALCULATORS

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 SIGNAL TO START

TEST CODE GM

Sample Questions
PART – I
Compulsory for candidates of geology

Select and justify the correct answer from the given alternatives:

1. The equation of the circle whose diameter is the line segment joining the origin and the point $\left(a^3, \frac{1}{a^3}\right)$ is

   i) $a^3x^2 + \frac{y^2}{a^3} - x - y = 0$

   ii) $a^3x^2 + \frac{y^2}{a^3} + x - y = 0$

   iii) $x^2 + y^2 - a^3x - \frac{y}{a^3} = 0$

   iv) $x^2 + y^2 + a^3x - \frac{y}{a^3} = 0$

2. If $f(x) = \frac{1-x}{1+x}$, the value of $f\left(f\left(\frac{1}{x}\right)\right)$, $x \neq 0, -1, 1$ is

   i) $\frac{1}{x}$

   ii) $\frac{1}{1+x}$

   iii) $\frac{1}{1-x}$

   iv) $\frac{1}{1-x^2}$

3. The minimum value of $x^4 + 4x^3 + 8x^2 + 8$, where x is real , is

   i) 8

   ii) 3

   iii) 0

iv) 6

4. The value of $\lim_{x \to 0} \left(\cos x\right)^{\frac{1}{x}}$ is

i) 0

ii) 1

iii) 1

iv) 2

5. If $y = e^{\sin^{-1} x}$, then the value of

$$\left(1 - x^2\right)\frac{d^2y}{dx^2} - x\frac{dy}{dx} - y \text{ is}$$

i) 0

ii) 1

iii) –1

iv) 3

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

i) 1

ii) i

iii) –1

iv) $-i$

7. $\int_{-2}^{2} \left|1 - x^2\right| dx$ is equal to

i) 2

ii) 3

iii) 4

iv) 5

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

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

ii) $\frac{16a^2}{3}$

iii) $\frac{32a^2}{3}$

iv) $\frac{64a^2}{3}$

9. The values of λ and μ for which the equations

$$x + y + z = 6$$
$$x + 2y + 3z = 10$$
$$x + 2y + \lambda z = \mu$$

have an infinite number of solutions are

i) $\lambda = 3$ and

ii) $\lambda = 3$ and $\mu \neq 10$

iii) $\lambda \neq 3$ and μ may have any value

iv) $\lambda = 6$ and $\mu = 5$

10. If $A = \begin{bmatrix} 1 & 1 & -1 \\ 2 & -3 & 4 \\ 3 & -2 & 3 \end{bmatrix}$ and $B = \begin{bmatrix} -1 & -2 & -1 \\ 6 & 12 & 6 \\ 5 & 10 & 5 \end{bmatrix}$,
which of the following statements is true ?

i) AB = BA

ii) Rank(AB) = Rank(BA)

iii) Rank(AB) = 0 , Rank(BA) = 1

iv) Rank(BA) = 0 , Rank(AB) = 1

TEST CODE: GM

Sample Questions

PART – II
To be answered by geology stream candidates

11. A ship started its journey from an island lying at 30° N latitude and 120° E latitude. It travelled west along the same latitude for 1 degree of longitude and then turned north and followed that longitude to a location at 31° N and 119° E. Find out how many kilometers that ship travelled considering a spherical Earth of radius R kilometers.

12. Superposition of two strain increments can be modeled using matrix algebra. A rectangular section of a rock body undergoes pure shear whereby width of the section is halved. This is followed by right handed shear strain of √3 parallel to length of the rectangular section. Construct strain matrices for the two increments of strain assuming X-coordinate axis parallel to the length of the rectangular section. Find the total strain matrix.

13. In stereographic projection, the polar co-ordinates of the pole to a plane is given by (r, θ) where $\theta = \alpha + \pi/2$; α is the azimuth of the strike of the plane; $r = R \tan \beta/2$; R is the radius of the projection circle and β is the dip of the plane.
    i) Find the locus of the poles to planes with $\pi/4 \leq \alpha \leq 3\pi/4$ and $\beta = \pi/2$.

ii) Show that rate of decrease in r in the interval $\pi/6 \leq \beta \leq \pi/3$ *is lesser than that in the interval* $\pi/3 \leq \beta \leq \pi/2$. [cos $\pi/12$ =0.06698*;* cos $\pi/8$ = 0.25*;* cos $\pi/6$ = 0.5]

14. The sample data on salinity measurements (in parts per thousand) from two different water bodies are given below:

Water body 1 : 46,37, 62, 59, 40

Water body 2 : 35, 49, 48, 39, 36

Assuming that the population variability in the salinity level of the two water bodies are approximately the same, compute an approximate statistic to test whether the mean salinity level of water body 1 is larger than the Water body 2 at 5% level of significance.

(t_8 (0.05)) = 1.86, (t_9 (0.05)) = 1.83, (t_{10} (0.05)) = 1.81)

Test Code: RG (Short answer + Objective type)

Junior Research Fellowship in Geology

The candidates for Junior Research Fellowship in Geology will have to take two tests- Test GM in the forenoon session and Test RG in the afternoon session.

Syllabus

1. *Structural Geology*
   Concepts of stress and strain, plastic and viscous flow; theory of brittle fracture. Folding and faulting – 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.
   Interpretation of geological maps.

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

3. *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, ophiolites.
   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.

4. *Geochemistry*
   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.

5. *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.

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

7. *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 invertibrate and vertibrate 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.

8. *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.

9 *GIS and Remote Sensing*

Remote sensing—definition, concept, scope, history of development with special reference to India. Geographic Information Systems and Global Positioning system; Geoinformatics- Scope and applications. Photographic systems – terrestrial and aerial photographs, Stereovision, stereo photography and stereoscopy. Satellite images—platforms, sensors, energy sources and data products. Image interpretation – visual and digital techniques. Some applications of GIS-RS techniques in geological problems

Sample Questions

PART-I

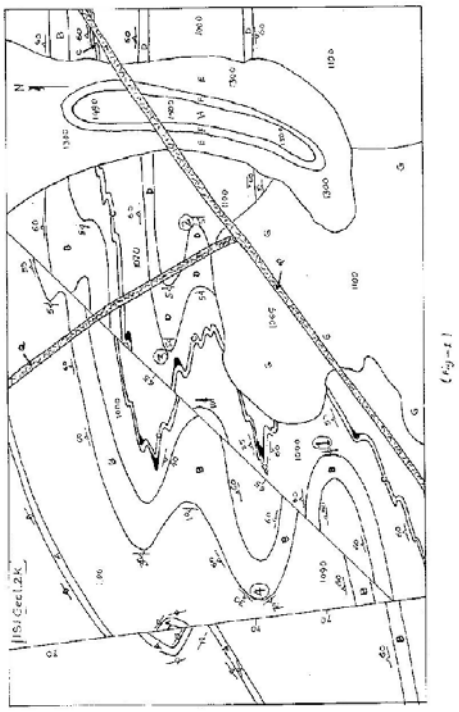

Figure 1

1. Work out the following from the geological map (ISI-GEOL-2K, Figure 1) given on page 1. Scale of the map is approximately 10 cm = 750m. Spot height in feet.

   (a) Describe the relation between rock sequences A-B-C-D and E-F-H.
   (b) Describe the relation between rock unit G and the other rock sequences in the area.
   (c) Which rock unit is the youngest in the area and what is its mode of occurrence? Justify your answer.
   (d) Is the NE trending fault a normal fault? Justify your answer.
   (e) Comment on the nature of displacement on the NNW trending fault.

(f) Change in attitude of foliation shown in different parts of the mapped area indicates that the foliation is folded. Are all the folds shown on the map of comparable style? Cite orientations of fold axes and axial planes at locations 1 through 4 (circled spots) in support of your answer.

PART-II

Note : Write short answer to each of the following questions.

2. Describe briefly the history of differentiation of the earth.
3. "Granitic rocks have mineralogical compositions close to eutectics." – explain.
4. Give an account of the textural features suggestive of chemical equilibrium in metamorphic rocks.
5. Give an account of the climatic and tectonic significance of arkosic sandstones.
6. (a) Could *Archaeopteryix* fly? Justify your answer. (b) Why are fossil brachiopods mostly found with their valves closed?
7. How do you explain the origin of crustal stresses?
8. Give a detailed account of the important aerial photo-interpretation elements usually used for photo-geological mapping. Illustrate your answers with suitable examples and sketches
9. Name three spatial objects that are mainly used to represent the real world phenomena. Give examples of their usage with respect to geological mapping.

PART-III

Questions 9-12 are multiple choice type. Select the correct answer for each and justify it.

10. The primitive crust of the earth was
    (a) granitic (b) basaltic (c) komatiitic (d) andesitic.

11. The major source of heat in the primordial earth was
    (a) decay of short-lived radioactive isotopes
    (b) decay of long-lived radioactive isotopes
    (c) impact of planetesimals
    (d) all of the above.

12. Bedforms with the crest trending roughly parallel to the net sediment transport direction are called
    (a) linear dune (b) longitudinal dune (c) seif dune (d) parabolic dune.

13. Transgression is cause by
    (a) rise in eustatic sea level

(b) rise in relative sea level
(c) increased rate of subsidence
(d) decreased rate of sedimentation.

14. Boudins are products of
(a) homogeneous deformation
(b) inhomogeneous, brittle deformation
(c) inhomogeneous, ductile deformation
(d) none of the above.

PART-IV

Select the correct answer from the multiple choices. No justification is needed.

15. Temperature at the crust-mantle boundary is of the order of
(a) 600°C (b) 900°C (c) 1700°C (d) 1300°C.

16. Diphyodonty does not take place in
(a) incisors (b) pre-molars (c) molars (d) canines

17. Epsilon cross-stratification is common in
(a) marine environment
(b) fluvial environment
(c) lacustrine environment
(d) aeolian environment.

18. S- or Z-shaped inclusion trails in garnets indicate
(a) Syn-tectonic crystallization
(b) Pre-tectonic crystallization
(c) Post-tectonic crystallization
(d) None of the above.

19. Under high P-T conditions Al is favoured in a SiO_4 tetrahedra linkage in the
(a) 4 co-ordinated position
(b) 6 co-ordinated position
(c) 8 co-ordinated position
(d) 10 co-ordinated position.

20. *Barapasaurus tagorie*, a Jurassic dinosaur, was recovered from
(a) Jabalpur Formation
(b) Ariyalur Formation
(c) Kota Formation
(d) Bhuj Formation.

21. Paratype is formally designated when
    (a) used in the description of the species
    (b) a new specimen is used due to the destruction of the type specimen
    (c) it is not the part of the original type material
    (d) several type specimens are used.

22. Foreland basins are associated with
    (a) crustal extension
    (b) strike slip faults
    (c) thrust loading
    (d) thermal contraction.

23. Transform faults occur within
    (a) continental lithosphere
    (b) oceanic lithosphere
    (c) both continental and oceanic lithosphere
    (d) none of the above.

24. An area in isostatic equilibrium would show
    (a) no free air anomaly but may show Bouguer anomaly
    (b) no free air and Bouguer anomaly
    (c) free air anomaly but no Bouguer anomaly
    (d) none of the above.