PART I

(*Select the right answer from the given alternatives for each of the following questions. Ten questions, four marks each*)

1. If α, β are the roots of the quadratic equation $x^2 + ax + b = 0, (b \neq 0)$, then the equation whose roots are $\alpha - \frac{1}{\beta}, \beta - \frac{1}{\alpha}$ is

   a) $ax^2 + a(b-1)x + (a-1)^2 = 0$

   b) $bx^2 + a(b-1)x + (b-1)^2 = 0$

   c) $x^2 + ax + b = 0$

   d) $abx^2 + bx + a = 0$

2. The distance between the foci of an ellipse is equal to the length of the Latus Rectum then its eccentricity is

   a) $\frac{1}{4}(\sqrt{5} - 1)$

   b) $\frac{1}{2}(\sqrt{5} + 1)$

   c) $\frac{1}{2}(\sqrt{5} - 1)$

   d) $\frac{1}{4}(\sqrt{5} + 1)$

3. The value of $I = \int_0^{\frac{\pi}{4}} (tan^{n+1}x)dx + \frac{1}{2}\int_0^{\frac{\pi}{2}} \left(tan^{n-1}(\frac{x}{2})\right) dx$ is

a) $\frac{1}{n}$

b) $\frac{n+2}{2n+1}$

c) $\frac{2n-1}{n}$

d) $\frac{2n-3}{3n-2}$

4. If *log(a+c), log(a-c), log(a-2b+c)* are in Arithmetic Progression then

a) *a*, *b*, *c* are in Arithmetic Progression

b) *a*, *b*, *c* are in Harmonic Progression

c) a^2, b^2, c^2 are in Arithmetic Progression

d) *a*, *b*, *c* are in Geometric Progression

5. Let $f(x) = a|Sinx| + 2x, \forall x \in IR$. Assume that $f(x)$ is differentiable at $x = 0$. Then the value of a is

a) 0.5

b) 1

c) 0

d) -1

6. Sum to *n* terms of the series
$\frac{1}{(1+x)(1+2x)} + \frac{1}{(1+2x)(1+3x)} + \frac{1}{(1+3x)(1+4x)} + \ldots\ldots$ is

a) $\frac{(n+1)}{(1+x)[1+(n+1)x]}$

b) $\frac{n}{(1+x)[1+nx]}$

c) $\frac{n(n+1)}{(1+x)[1+(n+1)x]}$

d) $\frac{n}{(1+x)[1+(n+1)x]}$

7. If $A = \begin{pmatrix} 1 & 2 & 2 \\ 1 & 2 & -1 \\ -1 & 1 & 4 \end{pmatrix}$ then

a) $A^3 - 7A^2 + 15A - 9I = 0$

b) $A^3 - 7A^2 - 15A - 9I = 0$

c) $A^3 - 7A^2 + 9A + 9I = 0$

d) $A^3 - 7A^2 - 9A - 9I = 0$

8. The limit of $\sum_{n=1}^{1000}(-1)^n(x)^n$ as $n \to \infty$

a) does not exist

b) exists and equal to *0*

c) exists and approaches $+\infty$

d) exists and approaches $-\infty$

9. The solution *y(t)* of the initial value problem $e^{y}\frac{dy}{dt} - (t + t^3) = 0, y(1) = 1$ is given by

a) $\log\left(e - \frac{1}{2} + \frac{t^2}{2} + \frac{t^4}{4}\right)$

b) $\log\left(e + \frac{3}{4} + \frac{t^2}{2} + \frac{t^4}{4}\right)$

c) $\log\left(e - \frac{3}{4} + \frac{t^2}{2} + \frac{t^4}{4}\right)$

d) $\log\left(e + \frac{1}{2} + t^2 + t^4\right)$

10. If $f(x) = e^{x}(x-2)^2$ then

a) *f(x)* is increasing in $(-\infty, 0)$ and $(2, \infty)$ and decreasing in $(0, 2)$

b) *f(x)* is increasing in $(-\infty, 0)$ and decreasing in $(0, \infty)$

c) *f(x)* is increasing in $(2, \infty)$ and decreasing in $(-\infty, 0)$

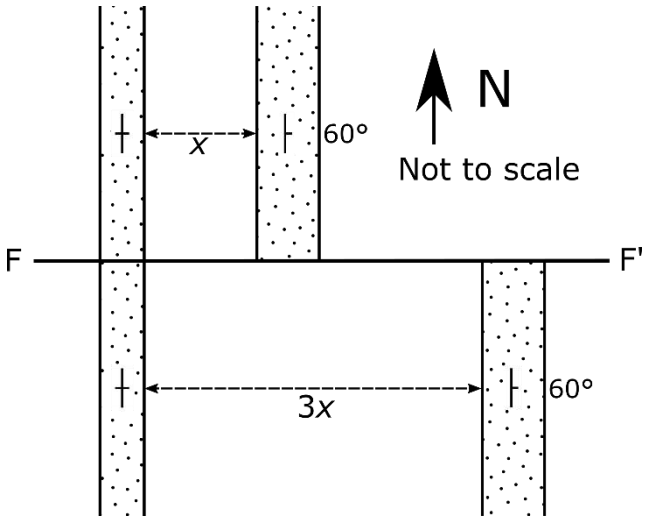
d) *f(x)* is increasing in $(0,2)$ and decreasing in $(-\infty, 0)$ and $(2, \infty)$

Part II

(*Ten questions, six marks each*)

1. The figure shows map view of north-south tending limbs of a folded quartzite bed exposed on a horizontal surface. The fold is non-plunging. The line FF' represents the trace of a fault plane. Calculate the amount of vertical displacement in terms of *x*.

[6]



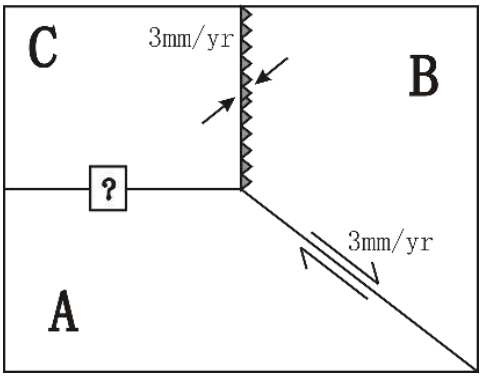
2. Magnetic measurements have been made on a basalt flow at present at 47°N, 20°E. The angle of inclination and declination of the remnant magnetization of this basalt are 30°, and 80° respectively. Write the latitude and longitude of the paleomagnetic pole.

[6]

3. A cylindrical specimen of rock, 50mm in Diameter and 100 mm long is subjected to an axial compressive force of 5Kn. Find the normal stress and shear stress on a plane inclined at 30° to the radial direction.

[6]

4. The boundary between B and C is a trench along which convergence is occurring obliquely at an angle 45° east of north.



i. Plot the motion of A, B and C in velocity space.

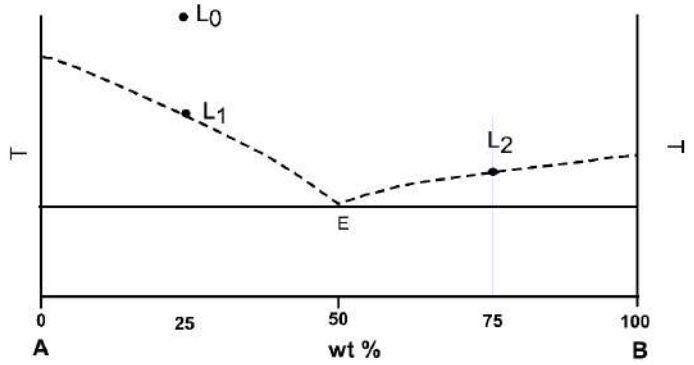
ii. Holding Plate A fixed, plot the vectors on plates B and C showing their velocities relative to plate A.

iii. Decide whether the boundary between plates A and C is a ridge, trench, or transform.

iv. Find $_AV_C$.

[2 + 2 + 1 + 1 = 6]

5. A two-component phase diagram at a constant pressure is shown below.



a) What will be the composition of the system at the points L_0, L_1 and L_2?

b) Calculate degrees of Freedom (F) of the system at the points L_0, L_1 and L_2.

[1+1+1+1+1+1 = 6]

6. Real fluids have dynamic viscosity ($\eta > 0$) and their motion is known as viscous flow. Now, consider the relationship,

$$\tau = \eta \frac{du}{dy}$$

where, τ = shear stress, u is velocity and y is depth.

From this determine the velocity - depth relationship in the water column. Note that velocity $u = u_y = 0$ at $y = 0$.

[6]

7. The diameter of a large number of clastic grains was measured from a geologically ancient fluvial channel-fill deposit. It has been observed from the frequency distribution that the mean diameter is 4mm and mode is 0.5mm. Write whether the sample represents the deposits of the proximal or the distal reach of the river. What will be the median grain diameter?

[3 + 3 = 6]

8. What is the equation used for converting grain-size measured in mm to the Krumbein's phi scale? Given that in the Udden-Wentworth scale, for sand-size grains, the class boundaries are at 2, 1, 1/2, 1/4, 1/8 and 1/16mm, justify the form of the equation adopted by Krumbein.

[2 + 4 = 6]

9. The stress tensor at the Earth's surface, referred to a North-East-Down coordinate system, is given by the following matrix:

$$\sigma_{ij} = \begin{matrix} 100 & 30 & 25 \\ 50 & 70 & 20 \\ 30 & 20 & 40 \end{matrix}$$

a) What are the normal and shear stresses on a plane that is parallel to the surface of the Earth?
b) What is the mean stress? Comment on this state of stress. Is it reasonable? Explain your answer.

[2 + 1 + 1 + 1 + 1 = 6]

10. Coded morphology of five hypothetical species (A-E) is given below.

	Characters					
Species		1	2	3	4	5
	A	-	-	-	+	-
	B	-	-	+	-	-
	C	-	+	-	+	+
	D	+	+	-	-	+
	E	+	+	-	+	-

If we divide these five species into two groups, which will be the best alternative supported by 60% characters. '+' means presence and '–' means absence of a character.

[6]