# GG: GEOLOGY AND GEOPHYSICS

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## General Aptitude - GA

*Q.1. - Q.5 Multiple Choice Question (MCQ), carry ONE mark each(for each wrong answer: -1/3).*

1) The people _____ were at the demonstration were from all sections of society. (GATE GG 2021)

a) whose b) which c) who d) whom

2) A transparent square sheet shown above is folded along the dotted line. The folded sheet will look like _____. (GATE GG 2021)

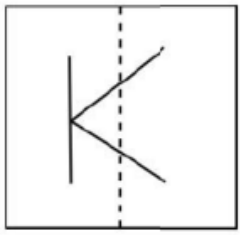
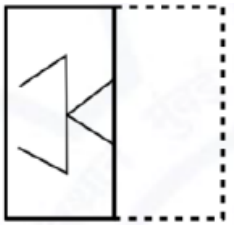
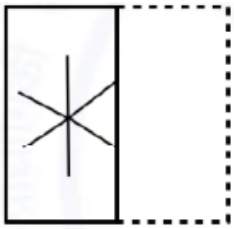


Fig. 1. Q.2.

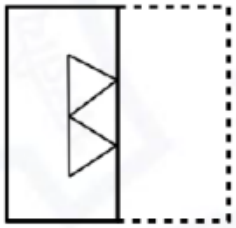
a)



b)



c)



d)

3) For a regular polygon having 10 sides, the interior angle between the sides of the polygon, in degrees, is: (GATE GG 2021)

a) 396 b) 324 c) 216 d) 144

4) Which one of the following numbers is exactly divisible by $\left(11^{13}+1\right)$? (GATE GG 2021)

a) $11^{26}+1$ b) $11^{33}+1$ c) $11^{39}-1$ d) $11^{52}-1$

5) Oasis is to sand as island is to _____ Which one of the following options maintains a similar logical relation in the above sentence? (GATE GG 2021)

a) Stone b) Land c) Water d) Mountain

*Q.6. - Q.10. Multiple Choice Question (MCQ), carry TWO marks each (for each wrong answer: -2/3).*

6) The importance of sleep is often overlooked by students when they are preparing for exams. Research has consistently shown that sleep deprivation greatly reduces the ability to recall the material learnt. Hence, cutting down on sleep to study longer hours can be counterproductive. Which one of the following statements is the CORRECT inference from the above passage? (GATE GG 2021)

a) Sleeping well alone is enough to prepare for an exam. Studying has lesser benefit.
b) Students are efficient and are not wrong in thinking that sleep is a waste of time.
c) If a student is extremely well prepared for an exam, he needs little or no sleep.
d) To do well in an exam, adequate sleep must be part of the preparation.

7) In the figure shown above, each inside square is formed by joining the midpoints of the sides of the next larger square. The area of the smallest square (shaded) as shown, in $cm^2$ is: (GATE GG 2021)

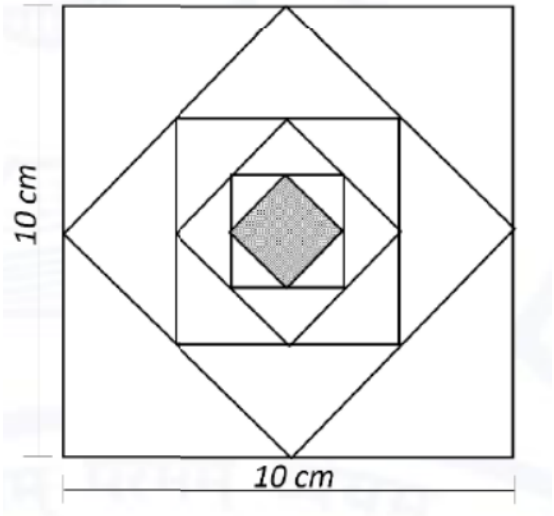



Fig. 2. Q.7.

a) 12.50 b) 6.25 c) 3.125 d) 1.5625

8) Let $X$ be a continuous random variable denoting the temperature measured. The range of temperature is [0, 100] degree Celsius and let the probability density function of $X$ be $f(x) = 0.01 \text{for} 0 \leq X \leq 100$. The mean of $X$ is _____ (GATE GG 2021)

a) 2.5 b) 5.0 c) 25.0 d) 50.0

9) The number of students passing or failing in an exam for a particular subject are presented in the bar chart above. Students who pass the exam cannot appear for the exam again. Students who fail the exam in the first attempt must appear for the exam in the following year. Students always pass the exam in their second attempt. The number of students who took the exam for the first time in the year 2 and the year 3 respectively, are _____. (GATE GG 2021)

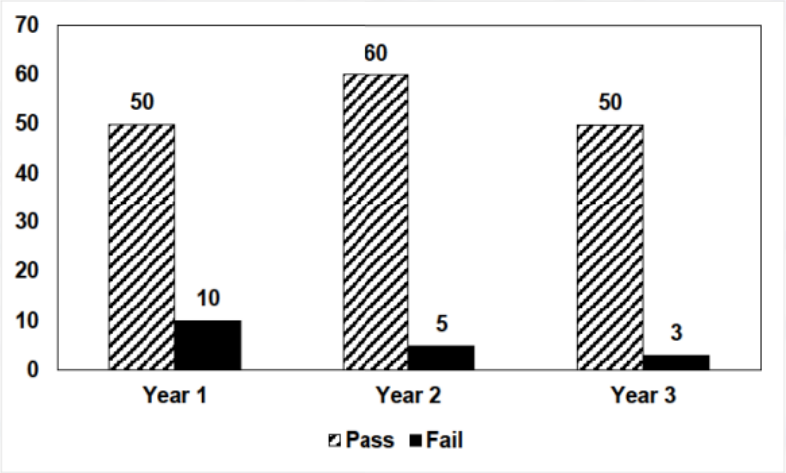



Fig. 3. Q.9.

a) 65 and 53 b) 60 and 50 c) 55 and 53 d) 55 and 48

10) Seven cars P, Q, R, S, T, U and V are parked in a row not necessarily in that order. The cars T and U should be parked next to each other. The cars S and V also should be parked next to each other, whereas P and Q cannot be parked next to each other. Q and S must be parked next to each other. R is parked to the immediate right of V. T is parked to the left of U. Based on the above statements, the only INCORRECT option given below is: (GATE GG 2021)

a) There are two cars parked in between Q and V.
b) Q and R are not parked together.
c) V is the only car parked in between S and R.
d) Car P is parked at the extreme end.

## GEOPHYSICS (GG)

*Q.1. - Q.15 Multiple Choice Question (MCQ), carry ONE mark each (for each wrong answer: -1/3).*

1) Which of the given planets has the highest average density? (GATE GG 2021)

a) Mercury b) Venus c) Earth d) Mars

2) In a multi-electrode resistivity tomography (ERT) survey, using equally spaced electrodes, which of the given configurations will provide the maximum number of data points? (GATE GG 2021)

a) Wenner array array ray
b) Axial Dipole-dipole c) Axial Pole-dipole ard d) Schlumberger array

3) In Electromagnetic methods of prospecting, which one of the given options is CORRECT about frequency and type of current source for the Primary field used? (GATE GG 2021)

a) High frequency A.C.
b) Low frequency A.C.
c) Both high frequency A.C. and D.C.
d) Low frequency D.C.

4) 'Group' is a unit of: (GATE GG 2021)

a) Lithostratigraphy b) Sequence stratigraphyc) Biostratigraphy d) Chronostratigraphy

5) Furongian is an Epoch of: (GATE GG 2021)

a) Cambrian b) Ordovician c) Triassic d) Cretaceous

6) The stage of textural maturity of a clay-rich sandstone containing poorly-sorted and angular framework grains is: (GATE GG 2021)

a) Mature b) Supermature c) Immature d) Submature

7) Which one of the following structures indicates Synsedimentary deformation? (GATE GG 2021)

a) Festoon bedding b) Flaser bedding c) Tabular bedding d) Convolute bedding

8) Low value in SP log as observed in dispersed shales is mainly due to the impeded movement of: (GATE GG 2021)

a) $Na^+$ b) $Cl^-$ ion c) $K^+$ d) $OH^-$ ion

9) In Radiometric survey, the $\gamma$-ray spectrometer count rate depends on: (GATE GG 2021)

a) Cracks present in the target rock volume
b) Solid angle of the target rock about the spectrometer
c) Temperature in the target rock
d) Pressure in the target rock

10) The dimension of radiant emittance of a blackbody as per Stefan-Boltzmann law is:(GATE GG 2021)

a) $M^0L^1T^{-1}$ b) $M^1L^{-1}T^{-2}$ c) $M^1L^2T^{-2}$ d) $M^1L^0T^{-3}$

11) A surface geological process that can create a landform called Cirque is: (GATE GG 2021)

a) aeolian deposition
b) fluvial deposition
c) glacial erosion
d) deposition of volcanic ash

12) If $\alpha$ and $\beta$ are P- and S-wave velocities, respectively, then $\alpha^2-(4/3)\beta^2$ is equal to: ($\kappa$ is the bulk modulus, $\mu$is sh (GATE GG 2021)

a) $\kappa/\rho$ b) $\mu/\rho$ c) $\kappa+\mu/\rho$ d) $\kappa-\mu/\rho$

13) Which one of the following phases is P-wave that converts to S-wave during passage through the solid inner core? (GATE GG 2021)

a) PKIKP b) PKJKP c) PKhKP d) PKPPcP

14) In reduction of gravity data, the latitude correction is maximum at: (GATE GG 2021)

a) 35° latitude b) 45° latitude c) 55° latitude d) 65° latitude

15) The most coaliferous unit of the Gondwana Supergroup is: (GATE GG 2021)

a) Talchir Formation
b) Barakar Formation
c) Karharbari Formation
d) Panchet Formation

*Q.16. - Q.25 Numerical Answer Type (NAT), carry ONE mark each (no negative marks).*

16) A vertical borehole encounters a shale bed of uniform thickness occurring at a depth of 5 m and dipping 60°. The borehole pierces through this shale bed for a length of 10 $m$ to reach a sandstone layer below. The true thickness of the shale bed is _____ $m$. [in integer] (GATE GG 2021)
17) The mass and volume of a fully dried soil sample are 2200 $gm$ and 1100 $cm^3$, respectively. If the specific gravity of the soil particles is 2.5 and water density is 1 $gm/cm^3$, the void ratio of the soil is _____. [round off to 2 decimal places] (GATE GG 2021)
18) A constant-head permeability test was performed on a vertical sand column of height 40 $cm$ and cross-sectional area of 25 $cm^2$. During the test, when the loss of head was 50 $cm$, the volume of water collected in 2 minutes was 300 $cm^3$. Applying Darcy's law, the calculated coefficient of permeability of the sand column is _____ $cm/sec$. [round off to 2 decimal places] (GATE GG 2021)
19) The radius ($r$) of the oblate spheroid at 45° latitude with ellipticity of polar flattening of 1/298.25 and equatorial radius of 6378140 $m$ is _____ $km$. [round off to 2 decimal places] (GATE GG 2021)
20) Light passes through two media with refractive indices of 1.75 and 1.55, respectively. The thickness of both the media is 30 $\mu m$. The resultant path difference of the yellow light component ($\lambda$ = 589 $nm$) is _____ $\mu m$. (GATE GG 2021)
21) The water table in an unconfined aquifer at a place near the coast is 1 $m$ above the Mean Sea Level. Given the densities of fresh and saline water as 1.001 and 1.025 $g/cc$ , respectively, the fresh-saline water interface at the same location should be at a depth of _____ $m$ from the water table. [round off to one decimal place] (GATE GG 2021)
22) The volume percentage of galena and quartz in an ore body of $Pb$ are 90 and 10, respectively. The densities of galena and quartz are 7.6 and 2.65 $g/cc$ , respectively. The grade of the ore body in terms of weight percent of $Pb$ is _____. (Atomic weights of $Pb$ = 206 and $S$ = 32) [round off to 2 decimal places] (GATE GG 2021)
23) Normal moveout (NMO) for reflected phase of seismic data is 2 milliseconds. Consider the diffraction source at the edge of the same reflector, where the shot point is now placed directly above diffraction source. In this case, the NMO due to diffraction is _____ milliseconds. [in integer] (GATE GG 2021)
24) In a 2$D$ seismic survey, first receiver location is at (1000 $m$, 4000 $m$), second receiver location is at (2000 $m$, 4000 $m$) and the source location is at (2000 $m$, 1000 $m$). Consider P-wave velocity as 5000 $m/sec$. The difference in first arrival time of P-wave phase for the two receivers is _____ seconds. [round off to 2 decimal places] (GATE GG 2021)
25) The potential difference measured between potential electrodes using Wenner array is 500 $mV$ when a current of 2 $A$ is passed through the subsurface between current electrodes. If the computed apparent resistivity is 100 $\Omega m$ then the distance between the current electrodes will be _____ $m$. [round off to 2 decimal places] [Use $\pi$ = 3.141] (GATE GG 2021)

*Q.26. - Q.42. Multiple Choice Question (MCQ), carry TWO marks each (for each wrong answer: -2/3).*

26) In a horizontally stratified cuboid rock sample (stratified in vertical z direction with various layers of different resistivity), bulk resistivity is measured in three perpendicular directions. If $\rho_1, \rho_2$ and $\rho_3$ are the bulk resistivities measured perpendicular to $xy$, $xz$ and $yz$ planes, respectively, then (GATE GG 2021)

a) $\rho_1 < \rho_2 = \rho_3$
b) $\rho_1 > \rho_2 = \rho_3$
c) $\rho_1 = \rho_2 \neq \rho_3$
d) $\rho_1 \neq \rho_2 \neq \rho_3$

27) Which one is the CORRECT sequence of electromagnetic methods in terms of depth of investigation?
P - AFMAG method
Q - VLF method
R - GPR method
S - Magnetotelluric method (GATE GG 2021)

a) P > Q > S > R
b) P > S > R > Q
c) S > P > Q > R
d) S > Q > R > P

28) Which Norm gives the maximum weight to the data points having maximum deviation/outlier from the smoothly fitted curve during linearized inversion? (GATE GG 2021)

a) L1-Norm b) L2-Norm c) Lp-Norm d) L∞-Norm

29) Which one of the following statements is CORRECT for the Quenching agent used in the tube of Geiger-Muller counter? (GATE GG 2021)
a) It enhances the emission of secondary electrons from the cathode.
b) It reduces the emission of secondary electrons from the cathode.
c) It enhances the emission of secondary electrons from the anode.
d) It reduces the emission of secondary electrons from the anode.

30) Which one of the following statements is CORRECT regarding the property of Laplacian operator for vector/scalar fields? (GATE GG 2021)
a) Laplacian of a vector field is zero if the Laplacian of each of its components are zero.
b) Laplacian of a vector field is zero if the Laplacian of any one of its component is zero.
c) If the Laplacian of a scalar field is zero then the scalar field is not harmonic.
d) If the Laplacian of a scalar field is finite (non-zero) then the scalar field is harmonic.

31) The most desirable interaction of $\gamma$-ray with matter for $\gamma$-ray spectroscopy is (GATE GG 2021)
a) Photoelectric effect only
b) Both Photoelectric effect and Compton scattering
c) Both Compton Scattering and Pair production
d) Photoelectric effect, Compton scattering and Pair production

32) Which one of the following is the CORRECT sequence for a $2D$ seismic reflection data processing prior to Time-depth conversion? (GATE GG 2021)
a) Migration → Deconvolution → Filtering → Equalization → Coherency
b) Deconvolution → Migration → Filtering → Coherency → Equalization
c) Filtering → Deconvolution → Migration → Equalization → Coherency
d) Deconvolution → Filtering → Equalization → Migration → Coherency

33) Choose the CORRECT procedure to avoid the area of cracked, altered formation in Sonic log. (GATE GG 2021)
a) Measure interval transit times using long-spacing sonic tools.
b) Use more number of sets of sources.
c) Measure interval transit times using short-spacing sonic tools.
d) Use more number of sets of detectors.

34) The factor that DOES NOT influence measurement of Nuclear Magnetic Resonance log is (GATE GG 2021)

a) mineral composition of the rock
b) bound water (irreducible water).
c) free water.
d) pore fluid pressure.

35) Consider a time-invariant geophysical filter with the given input as: $x(t) = e^{-\alpha t}$ when $t \geq 0$; $x(t) = 0$ when $t < 0$ and output $y(t) = e^{-\beta t}$ when $t \geq 0$; $y(t) = 0$ when $t < 0$. The transfer function for the given input and output of time-invariant filter will be: (GATE GG 2021)

a) $\frac{\alpha+i\omega}{\beta-i\omega}$ b) $\frac{\alpha+i\omega}{\beta+i\omega}$ c) $\frac{\alpha-i\omega}{\beta+i\omega}$ d) $\frac{\alpha-i\omega}{\beta-i\omega}$

36) Which of the given figures is the Hilbert transform of the Dirac delta function $\delta(\xi)$: (GATE GG 2021)

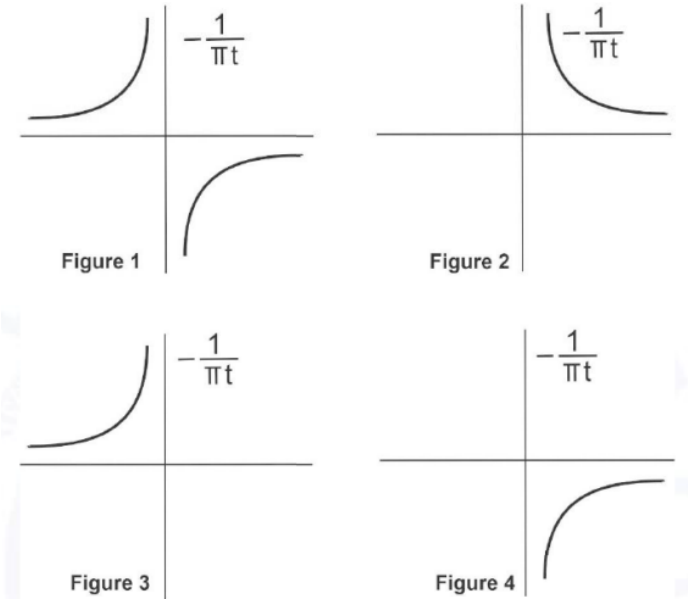



Fig. 4. Q.36.

a) Figure 1 b) Figure 2 c) Figure 3 d) Figure 4

37) If a mountain range is 100% isostatically compensated (Airy's type), what would be the expected nature of the Bouguer anomaly and free-air anomaly? (GATE GG 2021)
a) Bouguer anomaly is very large and negative; free air anomaly is small and positive.
b) Bouguer anomaly is very large and negative; free air anomaly is large and positive.
c) Bouguer anomaly is exactly zero; free air anomaly is very large and positive.
d) Bouguer anomaly is very large and negative; free air anomaly is large and negative.

38) Which of the following is INCORRECT for a recorded nuclear explosion event? (GATE GG 2021)
a) The first P-wave from an explosion source to arrive t any seismic station, irrespective of Azimuth, should be compressional.
b) Nuclear explosions are not as good as earthquakes at generating surface waves or S-waves.
c) In general, earthquakes have Mb values same those for nuclear explosions with same Ms values.
d) Nuclear explosions have all been shallower than 2 $km$ depth.

39) Focal depth can be determined from measurement of the difference in the travel time between: (GATE GG 2021)

a) pP and P b) PP and P c) PcP and P d) PPP and P

40) Of the following options, at which discontinuity both P-wave and S-wave have maximum velocity drop? (GATE GG 2021)

a) Conard b) Mohorovicic c) Gutenberg d) Lehman

41) In data enhancement techniques, what is the advantage of magnetic anomaly being 'Reduced to the pole'? (GATE GG 2021)

a) Enhances the signal to noise ratio.
b) Estimates the depth to the basement.
c) Takes care of variation of the magnetic anomaly with latitude.
d) Helps in pseudo-gravity transformation.

42) Match the source in Group - *I* with their half-width $(X_{1/2})/\delta g_{max}$ and depth ($d$) relation in Group - *II* (GATE GG 2021)

**Group *I***

p) Sphere
q) Horizontal Cylinder
r) Steeply dipping sheet
s) Irregular body

**Group *II***

a) $d = 0.7X_{1/2}$
b) $d \leq 0.86 \times \left( \frac{\delta g_{max}}{\left(\frac{dg}{dx}\right)_{max}} \right)$
c) $d = 1.3X_{1/2}$
d) $s = X_{1/2}$

a) P-1, Q-2, R-4, S-3
b) P-1, Q-4, R-3, S-2
c) P-3, Q-4, R-1, S-2
d) P-3, Q-1, R-4, S-2

*Q.43. - Q.55 Numerical Answer Type (NAT), carry TWO mark each (no negative marks).*

43) If a gravity determination is made at an elevation of $150\,m$ above mean sea level, the Bouguer correction required for a density contrast of $250\,kg/m^3$ with the surroundings is _____ *mgal*. [round off to 2 decimal places] (GATE GG 2021)

44) An infinite horizontal cylinder of radius $40\,km$ is buried at a depth of $100\,km$ and yields the same maximum gravity anomaly as that of an infinite horizontal cylinder of radius $1\,km$, buried at a depth of $1\,km$ having density contrast with the surroundings of $200\,kgm^{-3}$. The density contrast of the deeper cylinder with respect to the surrounding is _____ $kg/m^3$. [round off to one decimal place] (GATE GG 2021)

45) An earthquake causes an average of $25\,m$ strike slip displacement over a $50\,km$ long, $25\,km$ deep portion of a transform fault. Assuming that the rock rigidity is $3 \times 10^{10}\,Nm^{-2}$, the moment magnitude ($Mw$) of the earthquake is _____. [round off to 2 decimal places] (GATE GG 2021)

46) Lithological unit $X$ is sandwiched between $Y1$ above and $Y2$ below it. Now consider a log across lithology $X$, where Gamma ray (GR) reading is given by $100\,API$; $Y1$ lithology, where minimum GR reading is $10\,API$; and $Y2$ lithology of shale, where GR reading is $200\,API$. Then the shale-free fractional volume in the $X$ lithology will be _____. [round off to 2 decimal places] (GATE GG 2021)

47) In a $2D$ seismic survey, 25 receivers are placed in a group and 25 sources are placed in another group, where random noise is present. The signal to noise ratio for this arrangement will be _____. [in integer] (GATE GG 2021)

48) In a VSP survey, the tube wave passage through borehole causes cross-section area change from $0.79\,m^2$ to $1.13\,m^2$. The transmission coefficient will be _____. [round off to 2 decimal places] (GATE GG 2021)

49) In a cratonic region, radioactive heat generation decreases exponentially with depth. Assuming characteristic depth as $10\,km$ and surface heat generation as $3\,\mu Wm^{-3}$ and neglecting mantle heat flow, the heat production per unit volume for a $30\,km$ thick layer will be _____ $\mu Wm^{-3}$. [round off to 2 decimal places] (GATE GG 2021)

50) In an Induced Polarization survey, 50 milliseconds chargeability was measured for steady state voltage (full saturation reached) of $200\,V$ between potential electrodes. When the current was switched off, the voltage across potential electrodes drops instantaneously (time $t = 0\,s$) to a level Va and thereafter decays linearly with time and becomes zero in 10 seconds. The magnitude of instantaneous voltage Va (at time $t = 0\,s$) will be _____ $mV$. [in integer] (GATE GG 2021)

51) Apparent resistivity sounding data for Schlumberger array is theoretically generated by the teacher for the following 4-layer model as: $\rho_1 = 100\Omega\,m, \rho_2 = 20\Omega\,m, \rho_3 = 500\Omega\,m, \rho_4 = 10\Omega\,m$ and layer thicknesses $h_1 = 50\,m, h_2 = 20\,m and h_3 = 50\,m$. If the student interprets this theoretical sounding data for $\rho_3$ as $750\,\Omega m$, then according to the Principle of Equivalence, the thickness $h_3$ would be _____ $m$. [round off to 2 decimal places] (GATE GG 2021)

52) A $3D$ conducting body is located at a depth of $50\,m$ in a homogeneous medium of resistivity $500\,\Omega\,m$. A frequency of $f_1\,Hz$ is appropriate to detect this conducting body in a plane wave EM survey. When the same conducting body is located in a host medium of resistivity $100\,\Omega\,m$ at the same depth then a frequency of $f_2\,Hz$ is found to be appropriate. Then the value of $\frac{f_2}{f_1}$ will be _____. [round off to 2 decimal places] (GATE GG 2021)

53) The apparent resistivity and phase computed for MT measurement at $10^{-3}\,Hz$ frequency is $500\,\Omega\,m$ and $30°$, respectively. Ratio of Imaginary to Real component of the Impedance tensor is _____. [round off to 2 decimal places] (GATE GG 2021)

54) The diagonal elements of a covariance matrix computed for a linearized inverse problem having model parameters $m_1, m_2, m_3, m_4, m_5$are$49, 15, 3, 200, 40$, respectively. The standard deviation (uncertainty) in the estimation of model parameters $m_4$ is _____. [round off to 2 decimal places] (GATE GG 2021)

55) Electric current density incident at an angle $40°$ from vertical at the horizontal interface between two layers with resistivity $\rho_1 = 100\,\Omega\,m$and$\rho_2 = 500\,\Omega\,m$ (from layer 1 to layer 2). The current density will enter into the second layer at an angle _____ degrees from vertical. [round off to 2 decimal places] (GATE GG 2021)

*END OF THE QUESTION PAPER*