ASSIGNMENT 1: GATE 2007 MN:MINING ENGINEERING

AI25BTECH11010 - Dhanush Kumar

1) The line ran _____ the page, right through the centre, and divided the page into two.

(GATE MN 2023)

a) across
b) of
c) between
d) about

2) Kind : _____ :: Often : Seldom (By word meaning)

(GATE MN 2023)

a) Cruel
b) Variety
c) Type
d) Kindred

3) In how many ways can cells in a 3×3 grid be shaded, such that each row and each column have exactly one shaded cell? An example of one valid shading is shown.

(GATE MN 2023)

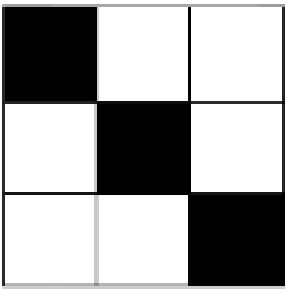


Fig. 3

a) 2
b) 9
c) 3
d) 6

4) There are 4 red, 5 green, and 6 blue balls inside a box. If N number of balls are picked simultaneously, what is the smallest value of N that guarantees there will be at least two balls of the same colour?

One cannot see the colour of the balls until they are picked.

(GATE MN 2023)

a) 4 b) 15 c) 5 d) 2

5) Consider a circle with its centre at the origin O(0,0), as shown. Two operations are allowed on the circle:
Operation 1: Rotation in anti-clockwise direction by any angle. Operation 2: Reflection with respect to any line through the origin.
Which one of the following shapes can be achieved through a combination of these two operations on the circle?

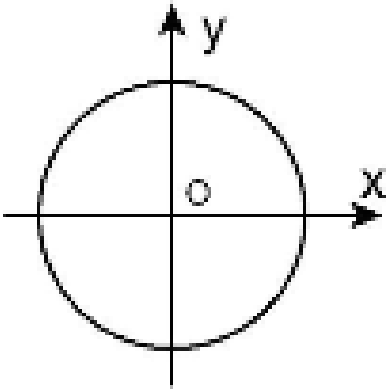
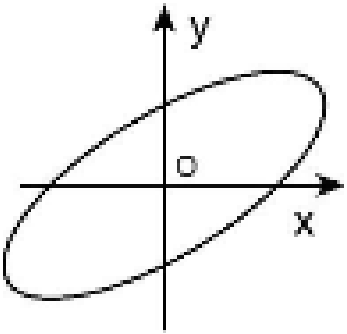
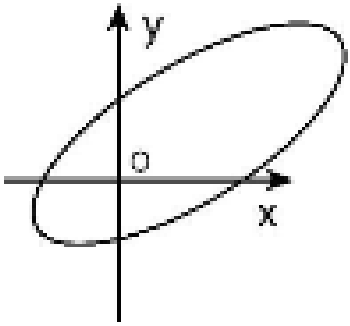


Fig. 5

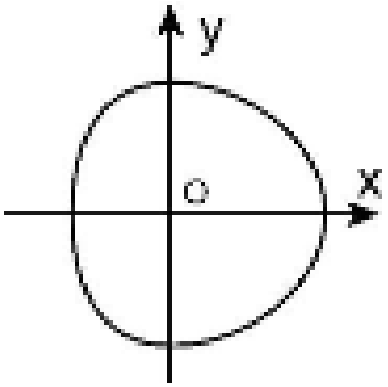
(GATE MN 2023)



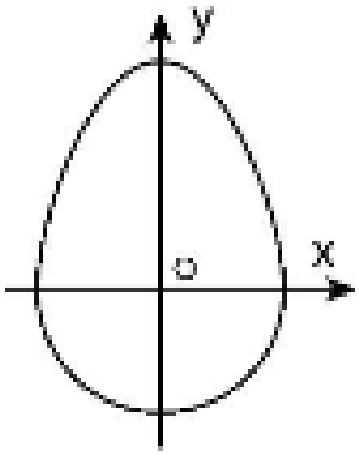
(a)



(b)



(c)



(d)

6) Democracy is a system that provides equality and freedom. Two opinions about democracy are given below:
(I) In democracy, one always respects one's free choice to live, dress or eat in one's own way. (II) In democracy, all citizens are free in matters of their dress, food and faith. (III) In democracy, sometimes one can suppress another person's freedom of expression. (IV) In democracy, sometimes one expresses one's free will by grilling a weaker person.
Which of the above statements are consistent with the principles of democracy?
(GATE MN 2023)

a) (I) only
b) (II), (III) and (IV)
c) (I) and (II) only
d) (III) and (IV) only

7) Three hundred identical cubes are to be arranged in a straight line so that an identical number of cubes are placed on top of each cube (except the two at the ends). How many different arrangements are possible such that only 300 cubes are used?
(GATE MN 2023)

a) 16
b) 48
c) 120
d) 720

8) Based only on the following passage, which one of the options can be inferred most accurately?
When the emergency set up earlier, Appu's mind lost its fresh joy, for he was no longer a carefree child. He was restless, agitated and had lost interest in his studies. Unable to resist the urge, Appu now stole a rupee from his mother's box. For several days, Appu's mind was in turmoil. He avoided his mother, for he was afraid that she

might ask him for the missing rupee. When she didn't, he felt relieved. Appu knew that his mother had discovered the theft, but she had chosen to remain silent. Appu's sense of guilt increased day by day. Finally, unable to bear it any longer, he fell at his mother's feet and cried. His mother lifted him gently, and wiping his tears, said: "Do not do it again, my son. Hereafter, you must become thoughtful."

(GATE MN 2023)

a) The mother was embarrassed about her daughter's singing in a bus.
b) The mother's feelings about her daughter's singing in a bus was only of appreciation.
c) Therefore it was up to Appu to understand value of dignity from his father.
d) When Appu learned at home, his mother wanted him to become thoughtful.

9) If x satisfies the equation $4^{x^2} = 256$, then x is equal to _____.

(GATE MN 2023)

a) 1 b) $\frac{1}{2}$ c) $\log_4 8$ d) $\log_4 3$

10) Consider a spheroidal globe rotating about an axis passing through its poles. There are three points A, B, C situated respectively on the equator, the north pole and midway between the equator and the north pole on the meridian. Let v_A, v_B, v_C and r_A, r_B, r_C denote the tangential velocities and radial distances from the axis, respectively. Which one of the following options is CORRECT?

(GATE MN 2023)

a) $v_A < v_C < v_B$
b) $v_B < v_C < v_A$
c) $v_C < v_B < v_A$
d) $v_A < v_B < v_C$

11) The fault pattern shown in the figure is a case of _____.

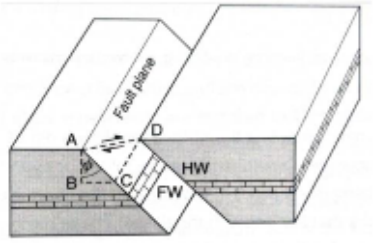


Fig. 11

(GATE MN 2023)

a) Normal fault
b) Reverse fault
c) Strike slip fault
d) Oblique slip fault

12) The joint pattern of a coal face shown in the figure represents _____.

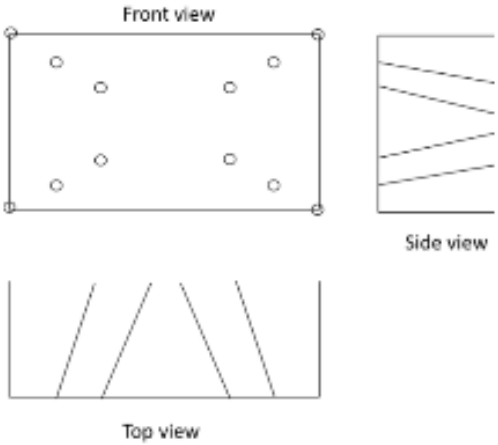


Fig. 12

(GATE MN 2023)

a) Burn cut
b) Pyramid cut
c) Wedge cut
d) Drag cut

13) A shear stress τ acts tangentially to the upper surface of a block and causes a small deformation as shown. The shear strain is calculated by

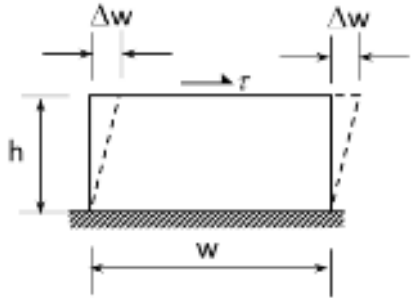


Fig. 13

(GATE MN 2023)

a) $\frac{\Delta x}{h}$ b) $\frac{\Delta x}{l}$ c) $\frac{2\Delta x}{h}$ d) $\frac{2\Delta x}{l}$

14) Given two vectors $A = 3\hat{i} + 2\hat{j}$ and $B = \hat{i} + \hat{j}$, the magnitude of projection of A along B is

(GATE MN 2023)

a) $\frac{5}{\sqrt{2}}$ b) $\frac{5}{\sqrt{3}}$ c) $\frac{3}{\sqrt{2}}$ d) $\frac{2}{\sqrt{3}}$

15) Axial stress versus axial strain curves for two test results of a porous rock from triaxial compression tests are shown in the figure. The pore water pressure for the curve B can be best explained by

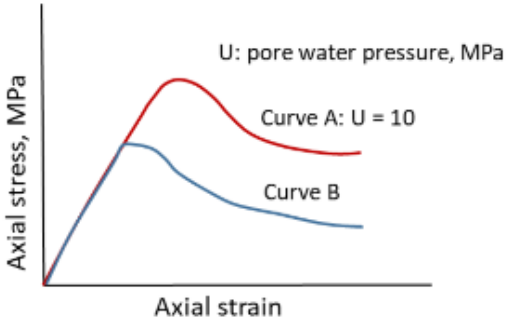


Fig. 15

(GATE MN 2023)

a) $U < 0$
b) $U = 0$
c) $U > 10$
d) $0 < U < 10$

16) Given two random variables X and Y, the expected value $E(XY - 5Y)$ is

(GATE MN 2023)

a) $E(XY) - 5E(Y)$ b) $E(XY) - 5$ c) $5E(XY) - 5E(Y)$ d) $E(XY) - E(X)$

17) The reaction products of calcium hydroxide with acidic ferruginous mine water are

(GATE MN 2023)

a) FeO, Ca^{2+} and H_2
b) Fe_2O_3, CaO and H_2O
c) $Fe(OH)_3$, Ca^{2+} and OH^-
d) $Fe_2(SO_4)_3$, Ca^{2+} and H_2O

18) An underground coal mine experienced 5 serious injuries, 15 reportable injuries, and 25 minor injuries during 2000. If the average employment in the mine is 1200, the total injury rate per 1000 persons is approximately

(GATE MN 2023)

a) 51.0 b) 62.5 c) 37.5 d) 50.0

19) A linear programming problem is given as:

$$\text{Maximize } Z = 2x_1 + 3x_2$$

Subject to

$$2x_1 - x_2 \leq 20$$

$$x_1 - 2x_2 \leq 20$$

$$x_1, x_2 \geq 0$$

The problem has,

(GATE MN 2023)

a) Unbounded solution
b) Infeasible solution
c) Multiple optimal solutions
d) Unique optimal solution

20) A mother section (L = 50m) makes two 2-m slice cuts for secondary blasting completely. What could be the immediate underground level rock cut and loading are mechanized? The suitable mining method is

(GATE MN 2023)

a) Cut and fill stoping
b) Sub-level stoping
c) Unchecked open stoping
d) Breast stoping

21) x and y are functions of independent variables r and θ given below:

$$x = r\cos\theta, \quad y = r\sin\theta$$

The Jacobian of x, y is

(GATE MN 2023)

a) $\tan\theta$
b) $r\sin\theta\cos\theta$
c) r^2
d) r

22) In project scheduling techniques, the CORRECT statement is

(GATE MN 2023)

a) Both CPM and PERT are deterministic
b) Both CPM and PERT are probabilistic
c) CPM is deterministic and PERT is probabilistic
d) CPM is probabilistic and PERT is deterministic

23) As per DGMS guidelines, the risk score in Safety Management Plan for a hazard is computed as

(GATE MN 2023)

a) Consequence × Exposure
b) Consequence × Exposure × Probability
c) Exposure × Probability
d) Consequence × Probability

24) Match the following items with their respective counters

List-I	List-II
P. Isopleths	(1) Slope
Q. Isohyets	(2) Rainfall
R. Isotachs	(3) Wind velocity
S. Isochores	(4) Temperature

TABLE 24

(GATE MN 2023)

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

25) In an astronomical survey at a given station, the pole star is located at an angle of 27° from the horizon. The latitude of the survey station in degrees is

(GATE MN 2023)

(A) $27°N$ (B) $63°N$ (C) $27°S$ (D) $63°S$

26) The position tracking of a point by GPS is based on the technique of

(GATE MN 2023)

a) Graphical resection
b) Analytical resection
c) Triangulation
d) Trilateration

27) Matrix A is negative definite. Which one of the following is NOT the correct statement about the matrix?

(GATE MN 2023)

a) It is symmetric
b) Determinant of A is always less than zero
c) All the eigenvalues are less than zero
d) Trace of A is always less than zero

28) The average ore grade of a copper deposit is 0.9%. The recovery of the metal after processing, smelting and refining is 85%. If the selling price of refined copper is Rs. 400/kg, the break-even cutoff grade (in % Cu) is _____.. *[rounded off to 1 decimal place]*

(GATE MN 2023)

29) A slope stability radar shows that the position of a point P in a mine dump shifts from (200.6, 700.1, 60.0) to (200.5, 700.1, 60.75) over a time of 2 h. The net displacement of the point P (in m) is _____.. *[rounded off to 2 decimal places]*

(GATE MN 2023)

30) A Mohr-Coulomb failure envelope of a sandstone rock is given as

$$\sigma_1 = 30 + 3.5\sigma_3$$

where σ_1 and σ_3, measured in MPa, are the major and minor principal stresses respectively. The angle of the failure plane with the σ_3 axis in degree is _____. *[rounded off to 1 decimal place]*

(GATE MN 2023)

31) A punch hole of diameter 10 mm is to be made in a 5 mm thick rock plate as shown. If the yield strength of rock plate is 25 MPa, the punch force P required in kN is _____.

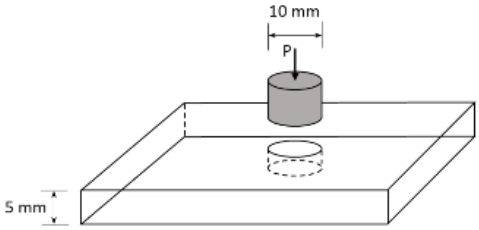


Fig. 31

[rounded off to 1 decimal place]

(GATE MN 2023)

32) "Critical subsidence" has occurred on the surface due to mining of a flat longwall panel at a depth of 200 m. The width of the panel is 150 m. The maximum width of the panel in m that can be mined at a depth of 300 m to reach critical subsidence is _____.. *[rounded off to 1 decimal place]*

(GATE MN 2023)

33) To increase the resistance of a mine roadway by 1.5 Ns^2m^{-8}, the size (in m^2) of the regulator to be installed is _____.. *[rounded off to 2 decimal places]*

(GATE MN 2023)

34) A coal seam of 3.0 m height is mined with a double-ended ranging drum shearer (DERDS) for a web depth of 0.5 m. The coal density is 1.4 tonne/m^3. If the panel width is 150 m the production per cycle in tonne is _____.. *[rounded off to 2 decimal places]*

(GATE MN 2023)

35) In a panel with 50 workers, a miner typically consumes 2.5×10^{-3} m^3/min of oxygen. The percentage of oxygen in the intake air is 20.9%. To ensure minimum permissible oxygen requirement as per CMR 2017 the quantity of ventilating airflow (in m^3/min) to be supplied to the panel is _____.. *[rounded off to 2 decimal places]*

(GATE MN 2023)

36) In a quality control process of coal supplied to a thermal plant, the 3-sigma control limits for fixed carbon (FC) are defined by 40% ± 15%. The process is termed "out of control" if:

Rule 1: 4 out of 5 successive values of FC are situated at the same side of the mean and at a distance more than 1 standard deviation.

Rule 2: Any one value crosses any of the 3-sigma control limits.

For the following continuous data of FC (%): 49, 51, 56, 20, 46, 48, 47, 49, 45, 41, 42, 40, the process is

(GATE MN 2023)

a) out of control because of both rules 1 & 2.
b) out of control because of rule 1 only.
c) out of control because of rule 2 only.
d) not out of control.

37) A tunnel of diameter 8 m is to be driven in a rock mass having quality index, Q of 1.0. Assume the excavation support ratio (ESR) of the tunnel is 1.0. The support requirement of the tunnel wall using fibre reinforced shotcrete (based on the chart prepared by Grimstad and Barton, 1993) is

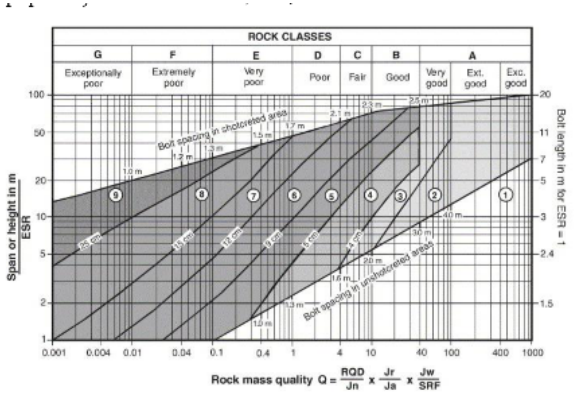


Fig. 37

(GATE MN 2023)

a) Shotcrete of thickness 9–12 cm, bolt length of 2.7–2.8 m
b) Shotcrete of thickness 9–12 cm, bolt length of 3.0–3.2 m
c) Shotcrete of thickness 5–9 cm, bolt length of 2.7–2.8 m
d) Shotcrete of thickness 5–9 cm, bolt length of 2.5–2.6 m

38) Match the following devices with their intended applications.

H

Equation no.	Slope	Intercept
1	2.0	3.0
2	4.0	5.0
3	6.0	2.0

TABLE 41

Device		Application	
(P)	Ground Penetrating Radar	(1)	Spatial positioning of a point
(Q)	Tactile Sensor	(2)	Measurement of a borehole dev
(R)	Global Navigation Satellite System	(3)	Robotic Arm
(S)	Digital Inclinometer	(4)	Locating subsurface features

TABLE 38

(GATE MN 2023)

(A) P=1 ; Q=2 ; R=3 ; S=4
(B) P=4 ; Q=3 ; R=1 ; S=2
(C) P=3 ; Q=4 ; R=2 ; S=1
(D) P=4 ; Q=3 ; R=2 ; S=1

39) The evaluation of the integral

$$I = \int e^{x^e + x^e}\, dx$$

yields

(GATE MN 2023)

(A) $\ln(e^x + x^e)$
(B) $\frac{1}{e}\ln(e^x - x^e)$
(C) $\frac{1}{e}\ln(e^x + x^e)$
(D) $\ln(e^x - x^e)$

40) Given the function

$$f(x) = |x| + |x - 1|$$

For all the real values of x, which one of the following statements is CORRECT?
(GATE MN 2023)

(A) The function is continuous and not differentiable at one point.
(B) The function is continuous but not differentiable at two points.
(C) The function is discontinuous.
(D) The function is continuous and differentiable.

41) The slope and intercept values of three linear equations are
The above system of equations has

(GATE MN 2023)

a) Trivial solution
b) A single solution
c) Multiple solutions
d) No Solution

42) A regression line is constructed between shovel production rate and shovel swing angle for 50 observations as shown below.

	Estimated parameter	Standard error
Intercept	29.6	13.45
Slope	2.5	1.32

TABLE 42

t-values corresponding to level of significance (P) and degree of freedom (DF)

	P						
one-tail	0.1	0.05	0.025	0.01	0.005	0.001	0.0005
DF	t-values						
30	1.31	1.697	2.042	2.457	2.75	3.385	3.646
60	1.296	1.671	2	2.39	2.66	3.232	3.46

If residuals are normally distributed and significance tests of the parameters are conducted at 0.05 significance level, the true statement is _____...

(GATE MN 2023)

a) Both intercept and slope are significant.
b) Intercept is significant but slope is not significant.
c) Intercept is not significant but slope is significant.
d) Both intercept and slope are not significant.

43) A duct of diameter 0.60 m with an exhausting fan has –97.5 mm wg static pressure behind the fan when the air flow rate is 4.0 m^3/s. If an evasee with inlet to outlet area ratio of 1:4 and efficiency 60% is attached to the outlet of the fan, the static pressure of the fan in mm of wg becomes _____...

(GATE MN 2023)

a) -104.26 b) -99.13 c) -90.73 d) -80.6

44) Coordinate of two points A and B are (E 0 m, N 200 m) and (E 300 m, N 200 m), respectively. The bearing of two lines AQ and BO are 67° and 53°, respectively. The easting of point O, in m, is _____...
[rounded off to 2 decimal places]

(GATE MN 2023)

45) Data related to a surface miner operation are given below:

Drum width (m)	: 3.0
Average cutting depth (cm)	: 20
Average cutting speed (m/min)	: 25
Length of pit (m)	: 500
Turning time (min)	: 2
Truck exchange time (s)	: 30
Truck capacity (m^3)	: 15

Considering *in situ* volume, the production rate of the surface miner in m^3/hr is _____...
[rounded off to 1 decimal place]

(GATE MN 2023)

46) A continuous miner served by two shuttle cars produces 240 tonne/hr. The capacity of each shuttle car is 10 tonne. When a single shuttle car operates, the cycle time becomes 4 min. In case one of the shuttle cars is under break-down, the reduction in hourly production from that of two cars in percent is _____...

(GATE MN 2023)

a) 25 b) 33.33 c) 40 d) 50

47) A circular tunnel is developed in a biaxial *in situ* stress field as shown in the figure. If the ratio between tangential stress at the boundary point A and that at the boundary point B is 2.0, the value of k is _____.
[rounded off to 2 decimal places]

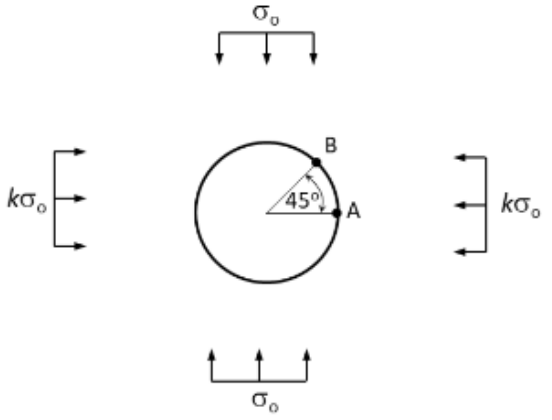


Fig. 47

(GATE MN 2023)

48) Strength of a rectangular coal pillar in MPa is given by

$$S_p = S_1\left(6.64 + 0.54\frac{w}{h} - 0.18\frac{w^2}{h}\right)$$

where $w\,(\geq w)$ and h are width, length and height of the pillar, respectively. The parameter S_1 is constant.

A 30 m square pillar is split into two halves as shown in the figure. The height of the pillar is 3 m. The ratio of safety factors between one half-pillar and the original square pillar is _____.

[rounded off to 2 decimal places]

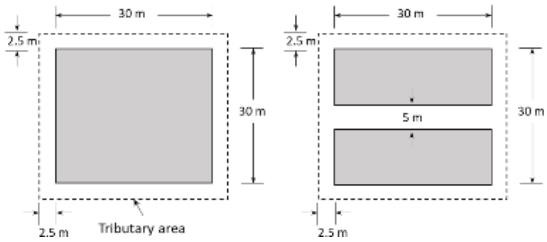


Fig. 48

(GATE MN 2023)

49) A dozer pushes up a 100 kg spool of cable along a 20° incline road at a constant velocity as shown in the figure. The coefficient of static friction between the dozer bucket and the spool (Point B) is 0.45, and coefficient of kinetic friction between road and the spool (Point A) is 0.15.

Consider the spool only slides up the incline. The maximum normal force in N acting at Point B, is _____.

[rounded off to 1 decimal place]

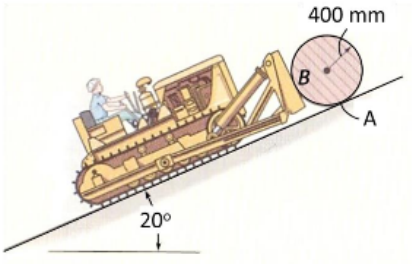


Fig. 49

(GATE MN 2023)

50) Stress waves are sent from the transmitter A to the receiver B through an isotropic and elastic cylindrical rock specimen as shown in the figure.

The length of the specimen is 100 mm. The travel time of longitudinal and shear waves are 0.025 ms and 0.04 ms, respectively. The Poisson's ratio of the rock specimen is _____.

[rounded off to 2 decimal places]

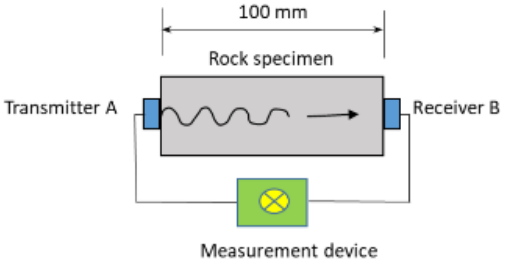


Fig. 50

(GATE MN 2023)

51) A jointed rock sample is subjected to 20 MPa vertical stress as shown in the figure. The modulus of elasticity of the rock is 10 GPa and the normal stiffness of the joint surface is 5 GPa/m. Assuming one-dimensional elastic behaviour of rock and joint, the displacement in mm of the loading surface AB is _____.
[rounded off to 1 decimal place]

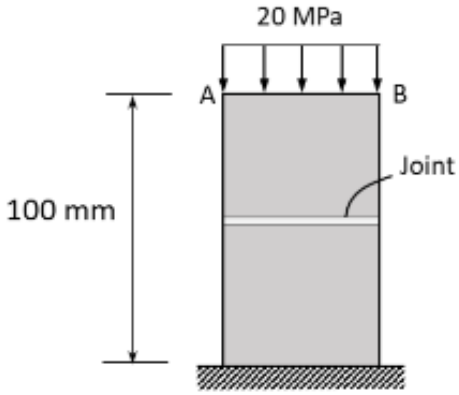


Fig. 51

(GATE MN 2023)

52) An unmanned aerial vehicle (UAV) with payload of 2 kg reaches vertically 100 m in 10 s at uniform velocity. The self-weight of the UAV is 1.2 kg. The power required in lifting in kW is _____.
[rounded off to 2 decimal places]

(GATE MN 2023)

53) An irregular shaped rock sample of mass 60 g displaces 27 g of brine when submerged in a filled jar. The specific gravity of brine is 1.05. The unit weight of the rock sample in kN/m^3 is _____.

[rounded off to 2 decimal places]

(GATE MN 2023)

54) The reliability function of a pump is given as

$$R(t) = \exp\left[-\left(\frac{t}{1000}\right)^{0.5}\right]$$

where t stands for time in years. If the pump comes with a six-month warranty, the number of years for the pump to attain a reliability of 0.9 is _____.
[rounded off to 2 decimal places]

(GATE MN 2023)

55) In a sample of groundwater, the concentration of Ca^{2+} is 200 mg/l. The corresponding calcium carbonate hardness in mg/l is _____.
[rounded off to 1 decimal place]

(GATE MN 2023)

56) A thermal power station receives coal of calorific value 4000 kcal/kg and uses 7000 tonnes of coal every day. Assuming 860 kcal is the heat equivalent of 1.0 kWh, for a thermal efficiency of 40% and electrical efficiency of 85% the power generation per day in MWh is _____.
[rounded off to 1 decimal place]

(GATE MN 2023)

57) A coal company has three mines which transport coal to four washeries. The daily production from each mine, the demand at each washery and unit transportation cost from each mine to each washery are given in table.

Mine	W1	W2	W3	W4	Supply (tonnes/day)
M1	40	50	90	100	900
M2	90	70	80	120	1800
M3	80	40	70	100	2000
Demand (tonnes/day)	400	1200	1500	1600	

TABLE 57

The cost of initial basic feasible solution using Vogel's approximation method is _____.
[rounded off to 1 decimal place]

(GATE MN 2023)

58) A workshop has four tasks and equal number of machines to perform the tasks. Each of the machines can perform only one of the four tasks. The estimated cost at each of the machines to complete each task is given in table:

MACHINE	TASK			
	T1	T2	T3	T4
M1	10	40	60	30
M2	90	70	100	90
M3	40	50	110	70
M4	80	70	80	50

TABLE 58

The total cost of optimal assignment is _____.
[rounded off to 1 decimal place]

(GATE MN 2023)

59) The time between consecutive accidents in days in an underground coal mine in a year are as follows:
10, 15, 6, 18, 12, 14, 16, 9, 21, 15, 26, 18, 22, 25, 13
Assuming exponential distribution, the probability that there will be no accident over a 10-day period is _____.
[rounded off to 2 decimal places]

(GATE MN 2023)

60) A surface mine blast pattern has spacing 4 m and burden 3 m. The diameter of the drill hole is 110 mm. The drilling length is 8.8 m including subgrade of 10%. The bulk explosive density is 900 kg/m^3.
If the powder factor is 2.5 m^3/kg, the charge length in m is _____.
[rounded off to 2 decimal places]

(GATE MN 2023)

61) A mining company makes an initial investment of Rs 200 crore on a project.

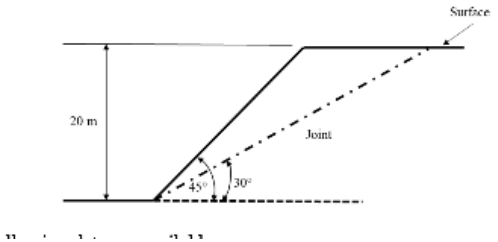


Fig. 61

The following data are available:

a) Production life : 3 years
b) Year wise production after gestation period (Mtonne) : 1.0, 2.0, and 1.0
c) Stripping ratio : 1.5 m^3/tonne
d) Selling price of ore : Rs. 2000 per tonne
e) Ore mining cost : Rs. 500 per tonne
f) Waste mining cost : Rs. 500 per m^3
g) Discount rate : 10%

By ignoring any other cash-flows, if the NPV of the project becomes Rs. 5.367 crore, the gestation period of the project, in years, is _____.
[rounded off to the nearest integer]

(GATE MN 2023)

62) A rock slope is intercepted by a joint plane at an angle 30° as shown in figure. The following data are available:
   a) Unit weight of the rock : 20 kN/m^3
   b) Cohesion of joint : 30 kPa
   c) Friction angle of joint : 22°

   The factor of safety of the rock slope to slide along the joint plane is _____.
   [rounded off to 2 decimal places]

(GATE MN 2023)

63) A mine void of width 20 m, length 50 m and height 30 m is to be filled with mill tailings based cemented paste backfill (CPB).
   The CPB contains tailings:cement:water as 1.0:0.1:0.2 by weight. The specific gravity of tailings and cement are 2.8 and 2.4 respectively. Assuming 20% of the original volume of water is retained in the final backfill, the amount of cement in tonne required so as to fill the void completely is _____.
   [rounded off to nearest integer]

(GATE MN 2023)

64) A fan installed in a mine ventilation system circulates 30 m^3/s of air to two districts A and B as shown in figure below.
   It is desired to increase the quantity of air by 20% in the district B using a booster fan in it. Assuming that the main fan pressure is unchanged, the pressure of the booster fan, in Pa, is _____.

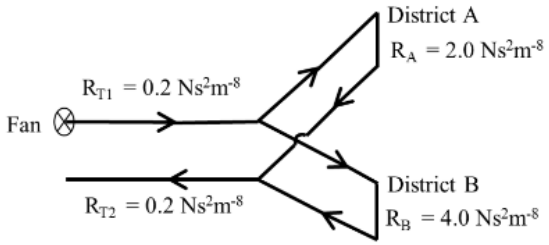


Fig. 64

[rounded off to 2 decimal places]

(GATE MN 2023)

65) Data related to a water turbine pump with backward bladed impellers are given below:
   a) Impeller diameter : 35 cm
   b) RPM : 1200
   c) Angle of curvature of blade : 30°

d) Radial velocity of discharge : 2 m/s
e) Manometric efficiency : 0.8

The number of impellers required in the pump to lift water by a height 300 m is _____.
[rounded off to higher integer]

(GATE MN 2023)

END OF QUESTION PAPER