

The Graduate Aptitude Test in Engineering

GATE 2023 Question Paper

GATE is an entrance examination conducted in India that primarily tests the comprehensive understanding of undergraduate subjects in engineering and sciences for admission into technical postgraduate programs.

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General Aptitude (GA)

Q.1 – Q.5 Carry ONE mark Each

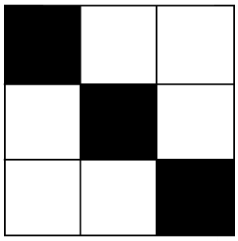
Q.1	The line ran _____ the page, right through the centre, and divided the page into two.
(A)	across
(B)	of
(C)	between
(D)	about

Q.2	Kind : _____ : : Often : Seldom (By word meaning)
(A)	Cruel
(B)	Variety
(C)	Type
(D)	Kindred

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Q.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.
	
(A)	2
(B)	9
(C)	3
(D)	6

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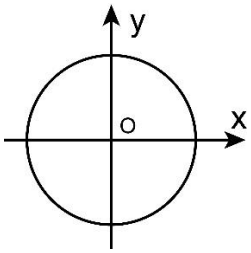
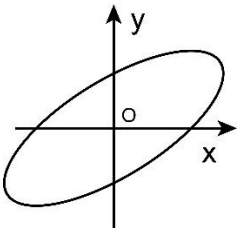
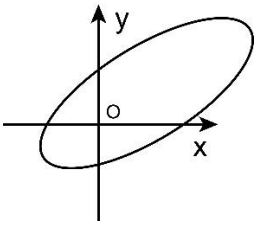
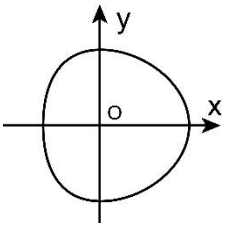
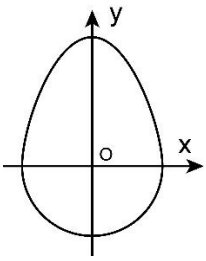
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Q.4	There are 4 red, 5 green, and 6 blue balls inside a box. If N number of balls are picked simultaneously, what is the smallest value of N that guarantees there will be at least two balls of the same colour? One cannot see the colour of the balls until they are picked.
(A)	4
(B)	15
(C)	5
(D)	2

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Q.5	Consider a circle with its centre at the origin (O), as shown. Two operations are allowed on the circle. *Operation 1*: Scale independently along the x and y axes. *Operation 2*: Rotation in any direction about the origin. Which figure among the options can be achieved through a combination of these two operations on the given circle?
	
(A)	
(B)	
(C)	
(D)	

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Q.6 – Q.10 Carry TWO marks Each

Q.6	Elvesland is a country that has peculiar beliefs and practices. They express almost all their emotions by gifting flowers. For instance, if anyone gifts a white flower to someone, then it is always taken to be a declaration of one's love for that person. In a similar manner, the gifting of a yellow flower to someone often means that one is angry with that person. Based only on the information provided above, which one of the following sets of statement(s) can be logically inferred with *certainty*? (i) In Elvesland, one always declares one's love by gifting a white flower. (ii) In Elvesland, all emotions are declared by gifting flowers. (iii) In Elvesland, sometimes one expresses one's anger by gifting a flower that is not yellow. (iv) In Elvesland, sometimes one expresses one's love by gifting a white flower.
(A)	only (ii)
(B)	(i), (ii) and (iii)
(C)	(i), (iii) and (iv)
(D)	only (iv)

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Q.7	Three husband-wife pairs are to be seated at a circular table that has six identical chairs. Seating arrangements are defined only by the relative position of the people. How many seating arrangements are possible such that every husband sits next to his wife?
(A)	16
(B)	4
(C)	120
(D)	720

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Q.8	Based only on the following passage, which one of the options can be inferred with *certainty*? When the congregation sang together, Apenyo would also join, though her little screams were not quite audible because of the group singing. But whenever there was a special number, trouble would begin; Apenyo would try singing along, much to the embarrassment of her mother. After two or three such mortifying Sunday evenings, the mother stopped going to church altogether until Apenyo became older and learnt to behave. At home too, Apenyo never kept quiet; she hummed or made up silly songs to sing by herself, which annoyed her mother at times but most often made her become pensive. She was by now convinced that her daughter had inherited her love of singing from her father who had died unexpectedly away from home. [Excerpt from *These Hills Called Home* by Temsula Ao]
(A)	The mother was embarrassed about her daughter's singing at home.
(B)	The mother's feelings about her daughter's singing at home were only of annoyance.
(C)	The mother was not sure if Apenyo had inherited her love of singing from her father.
(D)	When Apenyo hummed at home, her mother tended to become thoughtful.

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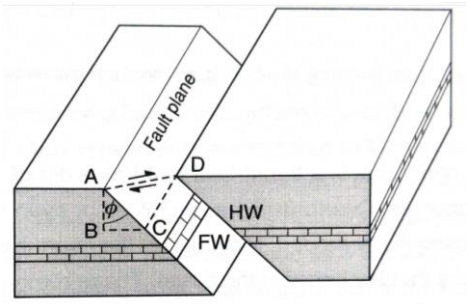
Q.9	If x satisfies the equation $4^{8^x} = 256$, then x is equal to _____.
(A)	$\frac{1}{2}$
(B)	$\log_{16} 8$
(C)	$\frac{2}{3}$
(D)	$\log_4 8$

Q.10	Consider a spherical globe rotating about an axis passing through its poles. There are three points P, Q, and R situated respectively on the equator, the north pole, and midway between the equator and the north pole in the northern hemisphere. Let P, Q, and R move with speeds v_P, v_Q, and v_R, respectively. Which one of the following options is CORRECT?
(A)	$v_P < v_R < v_Q$
(B)	$v_P < v_Q < v_R$
(C)	$v_P > v_R > v_Q$
(D)	$v_P = v_R \neq v_Q$

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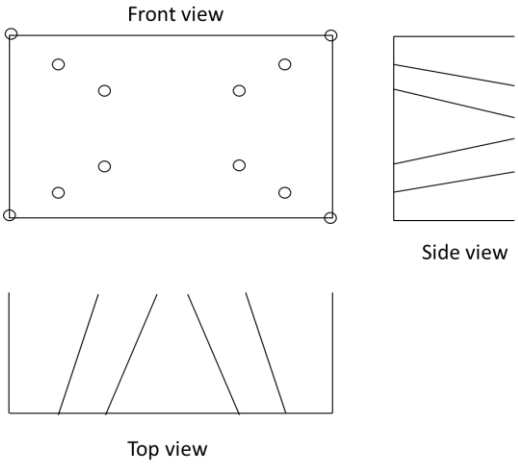
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Q.11 – Q.35 Carry ONE mark Each

Q.11	The fault pattern shown in the figure is a case of _____
	
(A)	Normal fault.
(B)	Reverse fault.
(C)	Strike slip fault.
(D)	Oblique slip fault.

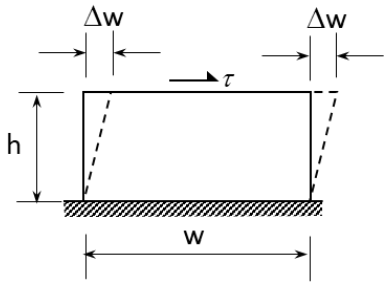
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Q.12	The blast pattern of a coal face shown in the figure represents____
	
(A)	burn cut.
(B)	pyramid cut.
(C)	wedge cut.
(D)	drag cut.

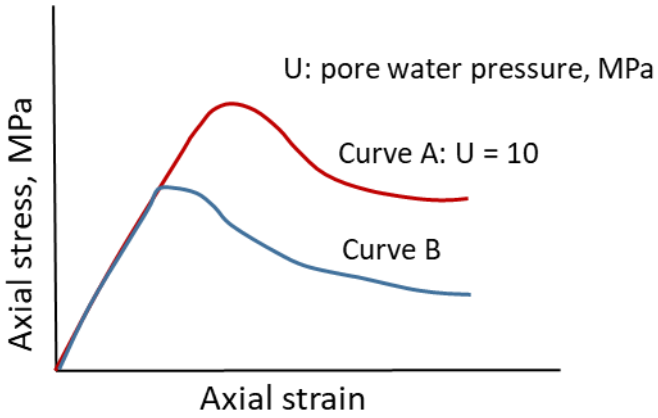
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Q.13	A shear stress τ acts tangentially to the upper surface of a block and causes a small deformation Δw as shown. The shear strain is calculated by
	
(A)	$\frac{\Delta w}{w}$
(B)	$\frac{\Delta w}{h}$
(C)	$\frac{2\Delta w}{w}$
(D)	$\frac{2\Delta w}{h}$
Q.14	Given two vectors $\vec{A} = 3\hat{\imath} + 2\hat{\jmath}$ and $\vec{B} = \hat{\imath} + \hat{\jmath}$, the magnitude of projection of $\vec{A}$ along $\vec{B}$ is
(A)	$\frac{5}{\sqrt{2}}$
(B)	$\frac{5}{\sqrt{13}}$
(C)	$\frac{5}{\sqrt{26}}$
(D)	5

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Q.15	Axial stress versus axial strain curves for two test results of a porous rock from triaxial undrained compression tests are shown in the figure. The pore water pressure for the curve B can be the best explained by
	
(A)	$U < 0$
(B)	$U = 0$
(C)	$U > 10$
(D)	$0 < U < 10$
Q.16	Given two random variables X and Y, the expected value E(3X−5Y) is
(A)	3E(X) −5E(Y)
(B)	3E(X)+5E(Y)
(C)	3E(X) −5E(Y) −15E(XY)
(D)	E(X) −E(Y) −E(XY)

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Q.17	The reaction products of calcium hydroxide with acidic ferruginous mine water are
(A)	FeO, Ca^{+} and H^{+}
(B)	FeO, CaO and H_2O
(C)	FeH_3, Ca^{3+} and OH^{-}
(D)	$Fe(OH)_3$, Ca^{2+} and H_2O
Q.18	An underground coal mine experienced 5 serious injuries, 15 reportable injuries, and 25 minor injuries during 2020. If the average employment in the mine is 1200, then the total injury rate per 1000 persons employed is
(A)	54.0
(B)	20.83
(C)	37.5
(D)	60.0

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Q.19	A linear programming problem is given as: Maximize $Z = 4x_1 + 2x_2$ Subject to: $2x_1 - 2x_2 \leq 20$ $4x_1 \leq 80$ $x_1 \geq 0, x_2 \geq 0$ The problem has
(A)	Unbounded solution.
(B)	Infeasible solution.
(C)	Multiple optimal solutions.
(D)	Unique optimal solution.
Q.20	A tabular, near-flat (dip < 30^o), and less than 2 m thick copper orebody having erratically located grade is to be mined underground. Wall rock and orebody are competent. The most suitable mining method is
(A)	Cut and fill stoping.
(B)	Sub-level stoping.
(C)	Underhand open stoping.
(D)	Breast stoping.

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Q.21	x and y are functions of independent variables r and θ as given below $$x = r\cos\theta, y = r\sin\theta$$ The Jacobian of x, y is
(A)	$\tan\theta$
(B)	$r^2\sin\theta\cos\theta$
(C)	r^2
(D)	r
Q.22	In project scheduling techniques, the CORRECT statement is
(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.
Q.23	As per DGMS guidelines, the risk score in Safety Management Plan for a hazard is computed as
(A)	Consequence × Exposure
(B)	Consequence × Exposure × Probability
(C)	Exposure × Probability
(D)	Consequence × Probability

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Q.24	Match the following items with their respective contours Item: (P) Isopachs; (Q) Isotherms; (R) Isocline Contour: (1) slope; (2) thickness; (3) temperature
(A)	P→1, Q→3, R→2
(B)	P→3, Q→1, R→2
(C)	P→2, Q→3, R→1
(D)	P→2; Q→1; R→3
Q.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
(A)	27° N
(B)	63° N
(C)	27° S
(D)	63° S

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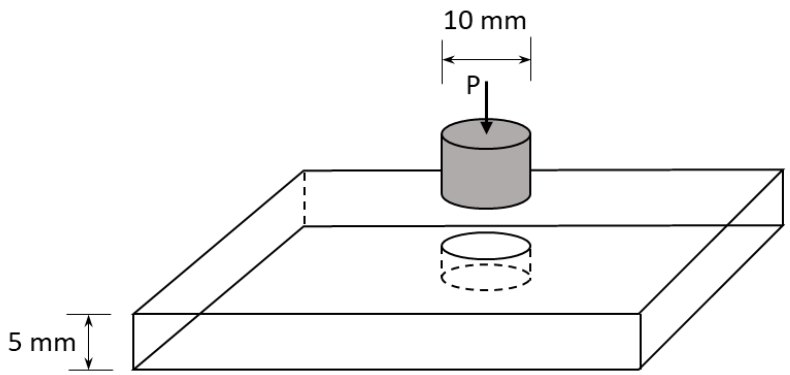
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Q.26	The position tracking of a point by GPS is based on the technique of
(A)	Graphical resection.
(B)	Analytical resection.
(C)	Triangulation.
(D)	Trilateration.
Q.27	Matrix A is negative definite. Which one of the following is NOT the correct statement about the matrix?
(A)	It is symmetric.
(B)	Determinant of A is always less than zero.
(C)	All the eigen values are less than zero.
(D)	Trace of A is always less than zero.
Q.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 640/kg, the sale value in Rs. from mining one tonne of ore is_____. [*rounded off to 1 decimal place*]
Q.29	A slope stability radar shows that the position of a point P in a mine dump shifts from (200, 700, −60) m to (200.05, 700.1, −60.75) m over a time Δt. The net displacement in cm of the point P is_____. [*rounded off to 2 decimal places*]

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Q.30	A Mohr-Coulomb failure envelop 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*]
Q.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 _____. [*rounded off to 1 decimal place*]
	
Q.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*]
Q.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*]

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Q.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 1 decimal place*]
Q.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 20.95%. To ensure minimum permissible oxygen in the return air as per CMR 2017 the quantity of ventilating air in m^3/min to be supplied to the panel is_____. [*rounded off to 2 decimal places*]

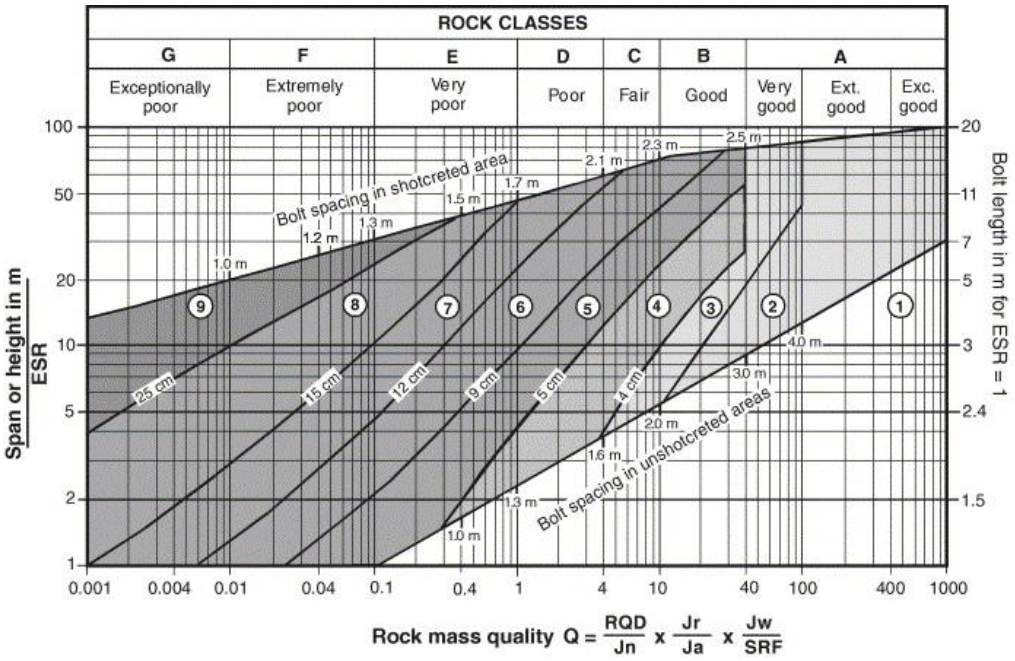
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Q.36 – Q.65 Carry TWO marks Each

Q.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 $40\% \pm 15\%$. 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
(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.

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Q.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 
(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

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Q.38 Match the following devices with their intended applications.

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

(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

Q.39 The evaluation of the integral

$I = \int \frac{e^{x-1}+x^{e-1}}{e^{x}+x^{e}} dx$ yields

(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) $\ln(e^x - x^e)$

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Q.40	Given the function $$f(x) = \lvert x \rvert + \lvert x - 1 \rvert,$$ For all the real values of x, which one of the following statements is CORRECT ?
(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.
Q.41	The slope and intercept values of three linear equations are
	<table><tr><th>Equation no.</th><th>Slope</th><th>Intercept</th></tr><tr><td>1</td><td>2.0</td><td>3.0</td></tr><tr><td>2</td><td>4.0</td><td>5.0</td></tr><tr><td>3</td><td>6.0</td><td>2.0</td></tr></table> The above system of equations has
(A)	Trivial solution.
(B)	A single solution.
(C)	Multiple solutions.
(D)	No Solution.

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Q.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

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 ____

(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.

Q.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

(A) −104.26

(B) − 99.13

(C) −90.73

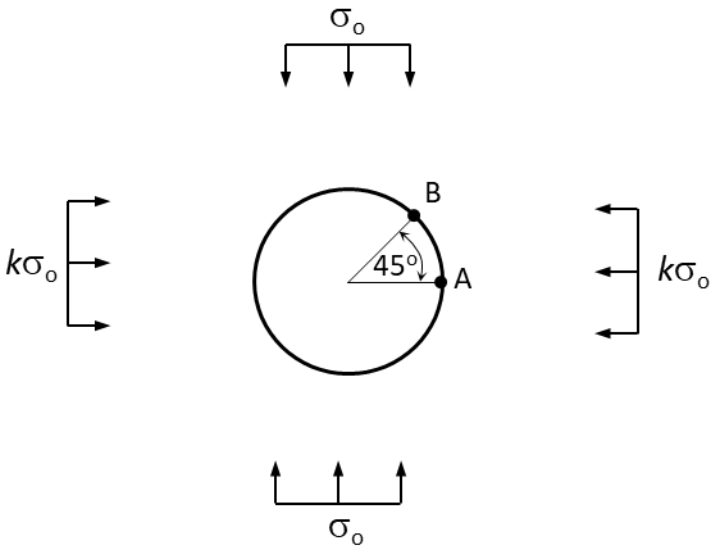
(D) −80.6

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Q.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 AO and BO are 67° and 35°, respectively. The easting of point O, in m, is _____. [*rounded off to 2 decimal places*]
Q.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*]
Q.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 _____. [*rounded off to 1 decimal place*]

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Q.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*] 

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Q.48

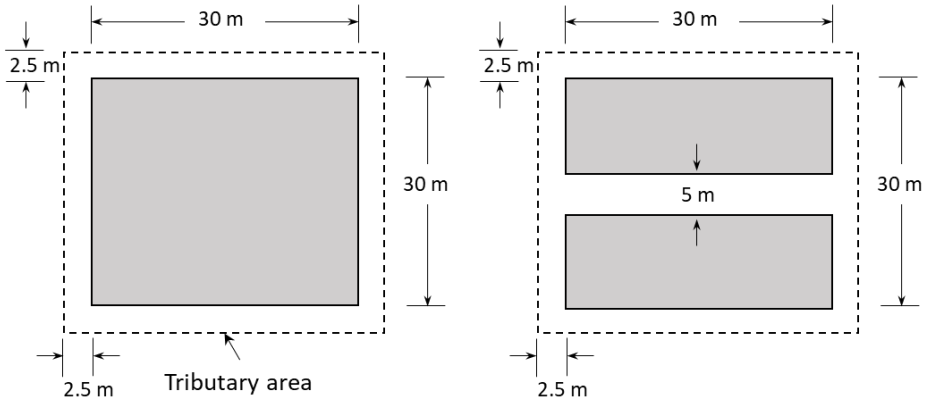
Strength of a rectangular coal pillar in MPa is given by

$$S_p = S_1\left(0.64 + 0.54\frac{w}{h} - 0.18\frac{w^2}{lh}\right)$$

where $w, l(\geq w)$ 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*]

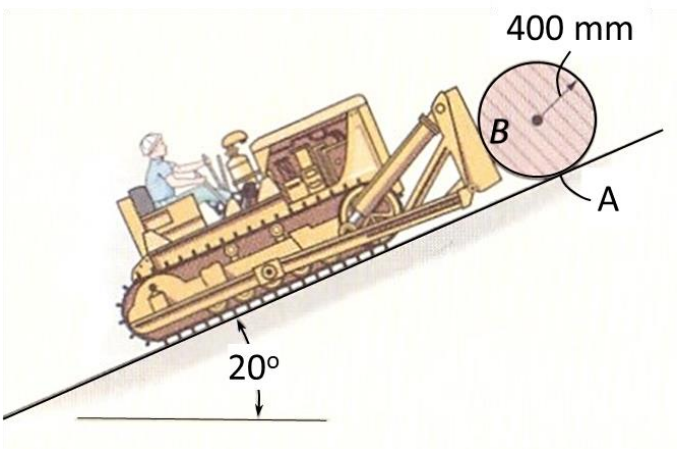


Q.49

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 _____.

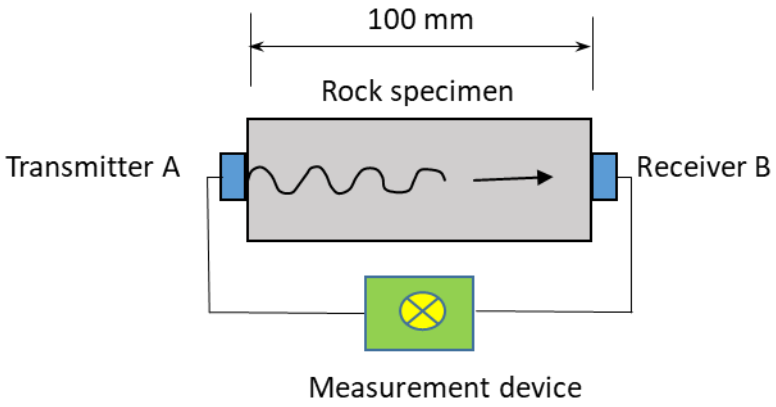
[*rounded off to 1 decimal place*]



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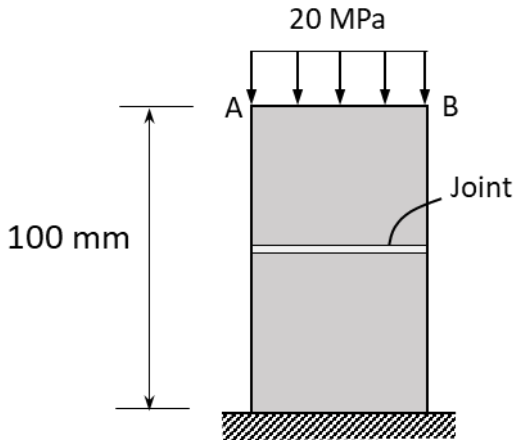
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Q.50	Stress waves are sent from the transmitter A to the receiver B through an isotropic and elastic cylindrical rock specimen as shown in the figure. The length of the specimen is 100 mm. The travel time of longitudinal and shear waves are 0.025 ms and 0.04 ms, respectively. The Poisson's ratio of the rock specimen is_____. [*rounded off to 2 decimal places*] 

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Q.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*] 
Q.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*]
Q.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*]
Q.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*]

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Q.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*]

Q.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*]

Q.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

	Washery				
Mine	W1	W2	W3	W4	Supply (tonnes/day)
M1	19	30	50	10	700
M2	70	30	40	60	900
M3	40	8	70	20	1800
Demand (tonnes/day)	500	800	700	1400	

The cost of initial basic feasible solution using Vogel's approximation method is _____.

[*rounded off to 1 decimal place*]

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Q.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

The total cost of optimal assignment is_____.

[*rounded off to 1 decimal place*]

Q.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*]

Q.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.

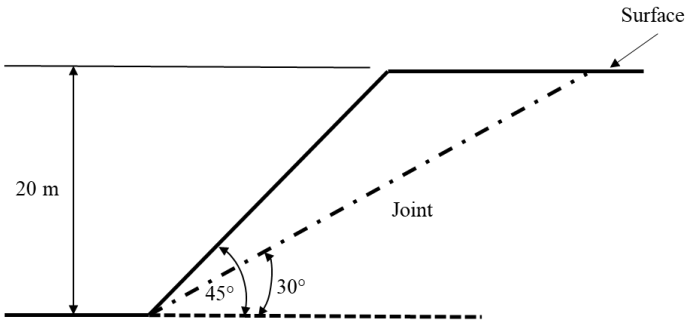
If the powder factor is 2.5 m^3/kg, the charge length in m is _____.

[*rounded off to 2 decimal places*]

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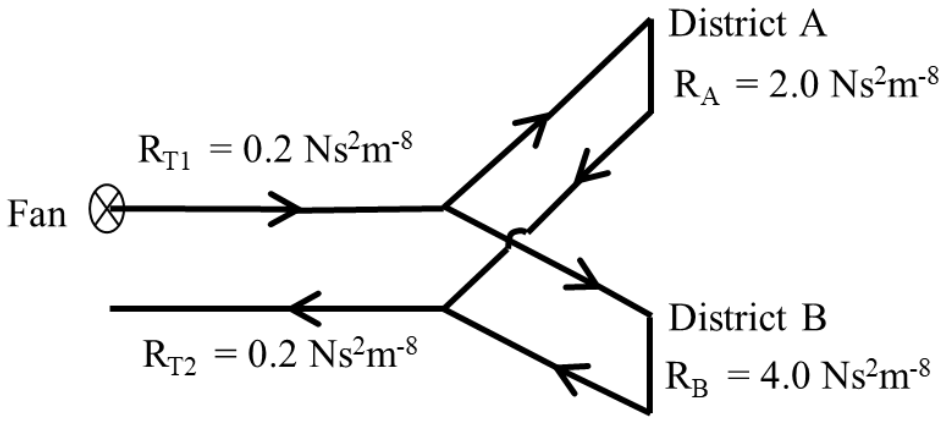
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Q.61	A mining company makes an initial investment of Rs 200 crore on a project. The following data are available: Production life : 3 years Year wise production after gestation period (Mtonne) : 1.0, 2.0, and 1.0 Stripping ratio : 1.5 m^3/tonne Selling price of ore : Rs. 2000 per tonne Ore mining cost : Rs. 500 per tonne Waste mining cost : Rs. 500 per m^3 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*]
Q.62	A rock slope is intercepted by a joint plane at an angle 30° as shown in figure.  The following data are available Unit weight of the rock : 20 kN/m^3 Cohesion of joint : 30 kPa 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*]

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Q.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*]
Q.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_____. [*rounded off to 2 decimal places*] 

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Q.65	Data related to a water turbine pump with backward bladed impellers are given below: Impeller diameter : 35 cm RPM : 1200 Angle of curvature of blade : 30° Radial velocity of discharge : 2 m/s 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*]

END OF QUESTION PAPER

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