Mining Methods

① ~~coal~~ powder factor

$$= \frac{\text{coal produced in tonnes}}{\text{Explosive used in Kg}}$$

② OMS

$$= \frac{\text{output per shift}}{\text{manpower per shift}}$$

Specific gravity

$$= \frac{\text{Density of material}}{\text{Density of water}}$$

③ percentage of Extraction

$$R = \left[1 - \frac{a^2}{(a+b)^2}\right] \times 100$$

Ratio

$$= \left[1 - \frac{a^2}{(a+b)^2}\right]$$

④ width of pillar

a = centre to centre distance − width of gallery (b)

caving height

$$H = \frac{T}{B-1}$$

⑤ No. of faces

F = 3H − 2 → max

F = 2H − 1 → min

Energy spent to fire

$$E = I^2RT$$

⑥ Stress acting in pillar

$$P = \rho \times g \times d \times \frac{(a+b)^2}{a^2} \text{ (or) } \rho \times g \times d \times \frac{1}{1-R}$$

⑦ Tributary area

$$= (a+b)^2 - a^2$$

Vol. of Square

$$= \frac{1}{3} \times \text{Surface area} \times \text{Height}$$

⑧ peak particle velocity

$$V = K\left(D/\sqrt{Q}\right)^{-\beta}$$

V – mm/s, D – m, Q – kg

Detonating pressure

$$P_d = 0.25 \times (VOD)^2 \times \rho$$

ρ – density of explosive

⑨ production in depillaring

$$= \frac{\text{coal produced during depillar in Tonne}}{\text{working day in incubation period}}$$

⑩ Relative ~~bulk~~ Strength (RBS)

$$= \frac{\text{Absolute bulk strength}_?}{\text{Absolute bulk strength}_?} \times 100$$

ABS = AWS × density of explosive

⑪ Average grade of ore block

$$= \frac{\sum L_i \times W_i \times g_i}{L \times W}$$

L – Total length

W – avg. width of block.

⑫ cutting velocity of drill

$$V = \pi D N$$

D – Dia of bit, N – RPM

Length to dia Ratio

$$\frac{L}{D} < 6$$

⑬ Injury rate of x person

$$= \frac{\text{Total injury}}{\text{Total person}} \times x$$

Density

$$= \frac{\text{Mass}}{\text{Volume}}$$

⑭ Break even Stripping Ratio (BESR)

$$= \frac{(\text{Selling price per tonne}) - (\text{production cost tonne})}{\text{Stripping cost per } m^3 \text{ of OB}} \quad (m^3/t)$$

⑮ Overall Slope angle

$$= \tan^{-1}\left[\frac{n \times H}{(n-1)B + n \times H/\tan\theta}\right]$$

⑯ electric circuit

Voltage (V) = current (I) × Resistance (R)

parallel $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots \frac{1}{R_n}$

Series $R_p = R_1 + R_2 + R_3 \cdots + R_n$

⑰ FOS of pillar

$$= \frac{\text{Strength of pillar}}{\text{Stress acting on pillar}}$$

Specific weight

$$= \frac{\text{Weight}}{\text{Volume}}$$

⑱ FOS of circular failure

$$= \frac{\text{Resistive force}}{\text{Driving force}} \Rightarrow \begin{array}{l} RF = C \times L \times r \\ DF = W \times D \end{array}$$

C – cohension, L – arc length $\Rightarrow \frac{\theta}{360^\circ} \times 2\pi r$

w – weight of sliding block

$$FOS = \frac{C \times L \times r}{w \times D} \rightarrow \text{no crack no pressure}$$

$$FOS = \frac{C \times L \times r}{W + P} \rightarrow \text{crack with water pressure}$$

P – water pressure

(19) Diluted grade of ore

$$= \frac{\text{Tonnage of ore} \times \text{Average grade}}{\text{Total tonnage}} \times 100\%$$

(20) Tonnage of ore

= Vol. of ore × Specific gravity × ore grade

(21) Grade of Resultant ore

$$= \frac{V_i \times g_i + V_w \times g_w}{V_i + V_w}$$

percent of dilution

$$= \frac{V_w}{V_i} \times 100\%$$

(22) Mill head grade

$$= \frac{W_i \times g_i + W_w \times g_w}{W_i + W_w}$$

porosity

$$= \frac{\text{Void volume}}{\text{Total vol.}}$$

(23) Match factor

$$= \frac{\text{No. of truck} \times \text{Shovel loading time}}{\text{No. of Shovels} \times \text{Truck cycle time}}$$

(24) OB handled by dragline

$$= \frac{\text{Bucket capacity} \times \text{Fill factor} \times \text{efficiency}}{\text{cycle time}}$$

(25) Hourly output of shovel

$$= \frac{\text{Bucket cap.} \times \text{fill factor} \times \text{Time factor} \times 3600}{\text{cycle time} \times \text{Looseness factor}}$$

(26) Annual production

= production per shift × No. of shift × working days per year

(27) output of Shovel

$$= \frac{\text{B.C.} \times \text{Fill.F} \times \text{Time..} \times \text{Swing factor} \times 3600}{\text{cycle time}}$$

(28) Horizontal force

$$= \frac{1}{2} \times \rho \times g \times d^2$$

Transport rate of conveyor

$$T = a\,b\,V$$

(29) production of Surface miner

$$= \frac{\text{Drum width} \times \text{face length} \times \text{cutting depth} \times \text{Density}}{\text{cycle time}}$$

(30) Minimum bucket capacity of dragline

$$= \frac{\text{Bucket capacity} \times \text{fill factor} \times 3600}{\text{cycle time} \times \text{Swell factor}}$$

(31) strength of pillar

$$= K \frac{a^{\alpha}}{H^{\beta}}$$

$K = 7.2$ Mpa $\quad \frac{7.2 \times 10^6}{9.81} \Rightarrow 733944.9$ Kg/m²

H - height gallery

a - width of pillar

$\alpha - 0.46$, $\beta = 0.66$

(32) Explosive used

$$= \frac{\pi d^2}{4} \times L \times \text{density of exp.}$$

∴ L - charge length

weight

weight = mass × gravity

(33) Factor of safety (FOS) of Slope

$$= \frac{C.A + W.\cos\beta.\tan\phi}{W.\sin\beta}$$

∴ Area(A) = $\frac{H}{\sin\beta}$

∴ W = unit weight × Area of sliding block

$$= \frac{C.A + (W.\cos\beta - V)\tan\phi}{W\sin\beta + U}$$

∴ $U = P \times \cos\beta$

∴ $V = P \times \sin\beta$

(34) Overall stripping ratio

V_o - vol. of ore

V_w - vol. of waste

$$= \frac{\left(\frac{1}{3}\pi r^2 h_c - \frac{2}{3}\pi r^2 \Delta h\right) \times \rho_w}{\frac{1}{3}\pi r^2 \Delta h \times \rho_o}$$

∴ ρ_o - density ore

∴ ρ_w - density waste

And

$$= \frac{V_w \times \rho_w}{V_o \times \rho_o} \Rightarrow \frac{A_1 + 2A_2 + 2A_3 + 2A_5}{A_4 + A_6}$$

Rock Mechanics

① **Length of roof bolt**

$$L = \frac{B}{2}\left(\frac{100 - RMR}{100}\right) \text{ (or) } \frac{B}{3} \text{ (or) } B^{2/3}$$

② **Void ratio & porosity**

$$= \frac{\text{Vol. of void}}{\text{Vol. of solid}} \qquad = \frac{\text{void ratio}}{1 + \text{void ratio}}$$

③ **Angle b/w major (σ_1) & vertical stress (σ_y)**

$$\theta_z = \frac{1}{2}\cos^{-1}\left(\frac{2\sigma_y - \sigma_1 - \sigma_3}{\sigma_1 - \sigma_3}\right)$$

④ **void ratio when porosity given**

$$\text{Void ratio} = \frac{\text{porosity}}{1 - \text{porosity}}$$

⑤ **Saturated density**

$$= \frac{\text{Sp. gr. of sample} + \text{void ratio}}{1 + \text{void ratio}} \times \text{Density of water}$$

⑥ **Dry density**

$$= \frac{\text{unit weight of solids} \times \text{vol. of solids}}{\text{Total volume}}$$

⑦ **RQD%**

$$= \frac{\text{Sum of length of core greater than or equal 10cm}}{\text{Total length of core}} \times 100$$

(or)

$$= 110.4 - 3.68\lambda \text{ (or) } 115 - 3.3\,Jv$$

λ - avg fracture/m Jv - Joints per unit length

⑧ **unit weight**

$$= \frac{\text{weight (W)}}{\text{Volume (V)}}$$

unit weight of water

$$= \frac{\text{weight of water } (W_w)}{\text{Volume of water } (V_w)}$$

⑨ **porosity**

$$= \frac{\text{void volume}}{\text{Total volume}} \quad \& \quad = 1 - \frac{\text{Density of core}}{\text{Density of material}}$$

when density of core & material given

⑩ **Sp. gr. of Soil**

$$= \frac{W_s}{V_s \gamma_w}$$

γ_w - unit weight of water

Sp. gr. of Soil Sample

$$= \frac{W_1}{W_1 - W_2}$$

W_1 - dry, W_2 - wet weight

⑪ **Darcy law**

$$Q = KIA$$

Q - m^3/s, I - gradient, A - Area in m^2

K - Hydraulic conductivity (m/s)

Factor of Safety

$$= \frac{\text{Strength}}{\text{load}}$$

⑫ **Degree of Saturation**

$$S = \frac{V_w}{V_v}$$

V_w - vol. of water, V_v - vol. of void

Stress

$$\sigma = \frac{F}{A}$$

Strain

$$\epsilon = \frac{\Delta l}{l}$$

⑬ **FOS of Roof bolt**

$$= \frac{\text{Strength of roof bolt}}{\text{Load acting on bolt by strata}}$$

Moisture Content

$$= \frac{\text{Mass of water}}{\text{Mass of solid}}$$

⑭ **point load Strength**

$$= P/D^2$$

D - dia of core

P - load at failure

UCS

$$= 24 \times \frac{P}{D^2}$$

⑮ **Brazillian (or) Indirect tensile Strength**

$$= \frac{2P}{\pi D L}$$

L - Height of core

D - Dia of core

⑯ **Shear Strength by punch Shear test**

$$= \frac{P}{\pi D L}$$

L - Thickness of core

⑰ **possion ratio**

$$\nu = \frac{\text{lateral strain}}{\text{longitudinal strain}}$$

(or)

$$\frac{\text{Radial}}{\text{Axial}}$$

Stored Strain energy

$$U = \frac{\sigma^2}{2E}$$

U - Total energy stored in bar

E - young's modulus

(or)

$$U = \frac{P^2 L}{2AE}$$

A - cross sec. Area

(18) Young's modulus

$(E) = \frac{\text{Stress}}{\text{Strain}}$

Stress = P/A

Axial Strain = $\Delta L/L$

Shear modulus

$G = \frac{E}{2(1+\nu)}$

E - young's

ν - poisson's

(19) Bulk modulus

$K = \frac{E}{3(1-2\nu)}$

Volumetric Strain

$\frac{\Delta V}{V} = \epsilon(1-2\nu)$

ΔV - change in vol.

ϵ - Axial strain

(20) Vertical stress

σ_v = unit weight x depth

Ratio b/w Horizontal & vertical stress

$K = \frac{\sigma_H}{\sigma_v}$

To find K $\therefore K = \frac{\nu}{1-\nu}$

(21) Major & Minor principle stress

$$\sigma_1 = \left(\frac{\sigma_x+\sigma_y}{2}\right) + \sqrt{\left(\frac{\sigma_x-\sigma_y}{2}\right)^2 + (\tau_{xy})^2}$$

$$\sigma_3 = \left(\frac{\sigma_x+\sigma_y}{2}\right) - \sqrt{\left(\frac{\sigma_x-\sigma_y}{2}\right)^2 + (\tau_{xy})^2}$$

(22) Mohr - coulomb law

Tensile strength $(\sigma_t) = \frac{2c\cos\phi}{1+\sin\phi}$

compressive " $(\sigma_c) = \frac{2c\cos\phi}{1-\sin\phi}$

ϕ - angle of Internal friction

(23) Ratio b/w σ_c & σ_t

$\frac{\sigma_c}{\sigma_t} = \frac{1+\sin\phi}{1-\sin\phi}$

caving height

$H = \frac{T}{B-1}$

B - bulking factor

(24) Shear strength b/w rock bolt & grout (or) Adherence

$= \frac{\text{Strength} \times \text{Area}}{\pi D L}$

(25) Axial load

Stress = $\frac{\text{load}}{\text{Area}}$

Slenderness ratio

$= \frac{\text{length}}{\text{Diameter}}$

(26) Thickness of roof layer

unit weight of roof layer $= \frac{\text{weight of roof layer}}{\text{Vol. of roof layer}}$

Vol = $l \times b \times h$

Thickness

$\therefore$ weight in N

(27) Q - System (or) Rock mass quality Index

$$Q = \frac{RQD}{J_n} \times \frac{J_r}{J_a} \times \frac{J_w}{SRF}$$

(28) Mohr - coulomb failure (or) direct shear

$\sigma_1 = C_0 + \sigma_3 \tan\phi$

$\therefore C_0 = \frac{2C\cos\phi}{1-\sin\phi}$

$\therefore \tan\phi = \frac{1+\sin\phi}{1-\sin\phi}$

$\sigma_1 = c + \sigma\tan\phi$

(29) S - wave velocity

$V_s = \sqrt{\frac{G}{\rho}}$

P - wave velocity

$V_p = \sqrt{3} \times V_s$ (or) $\sqrt{\frac{\frac{4}{3}G+K}{\rho}}$

(30) Ratio b/w P & S wave

$\frac{V_p^2}{V_s^2} = \frac{2(1-\nu)}{1-2\nu}$

longitudinal waves

$= \sqrt{\frac{E}{\rho}}$

(31) Mean pillar stress

$P = \rho \times g \times D \times \frac{(a+b)^2}{a^2}$ (or) $\rho \times g \times D \times \frac{1}{1-R}$ (or) $\gamma \times D \times \frac{1}{1-R}$

(32) Hock - brown failure criteria

$$\sigma_1 = \sigma_3 + \sigma_{ci}\left(m_b\frac{\sigma_3}{\sigma_{ci}} + s\right)^a$$

uniaxial $\sigma_3 = 0$

$\sigma_c = \sigma_{ci} \times s^a$

Tensile $\sigma_1 = \sigma_3 = \sigma_t$

$\sigma_t = \frac{s \times \sigma_{ci}}{m_b}$

(33) Normal stress & Shear stress

$= \frac{\sigma_1+\sigma_3}{2} + \frac{\sigma_1-\sigma_3}{2}\cos 2\theta$

$= \frac{\sigma_1-\sigma_3}{2}\sin 2\theta$

(34) Normal & shear in Mohr's circle

$= r\cos\theta$

$= r\sin\theta$

(34) global Rock mass

$$\sigma_{cm} = \frac{\sigma_{ci} \times [m_b + 4s - a(m_b - 8s)]\left(\frac{m_b}{4}+s\right)^{a-1}}{2(1+a)(2+a)}$$

(35) Tangential stress at tunnel

$\sigma_{\theta\theta} = P_0[(1+K) + (1-K)\,2\cos 2\theta$

Mine Ventilation

Atkinson's equ

$$P = \frac{KSQ^2}{A^3} \quad (\text{or}) \quad P = \frac{KSV^2}{A} \qquad R = \frac{KS}{A^3}$$

Reynolds no.

$$Re = \frac{VD\rho}{\mu} \quad (\text{or}) \quad \frac{VD}{\mu_k} \qquad D = \frac{4A}{P}$$

For rectangle

for circle

$$d = \frac{4lb}{2(l+b)}$$

$$\frac{4\pi r^2}{2\pi r} = 2r$$

Laminar flow

$$V_{max} = 2V_{avg}$$

Turbulant flow

$$V_{max} = V_{avg}(1.43\sqrt{f} + 1)$$

$$V_{avg} = Q/A$$

pressure change.

$$\Delta P = P_A - P_B \qquad P_{loss} = RQ^2$$

shock pressure loss.

$$P_{shock} = x \times \frac{1}{2}\rho v^2$$

$x \rightarrow$ shock loss factor

Shock loss factor

$$x = \frac{0.25}{r^2\sqrt{a}}\left(\frac{i}{90}\right)^2 \qquad x = \frac{0.6}{r\sqrt{a}}\left(\frac{i}{90}\right)^2$$

normal bend   square bend.

Drag loss of obstruction

$$\rho_D = C_d \frac{1}{2}\rho v^2$$

Drag Force

$$F_D = C_d \cdot \rho v \cdot A_p$$

A_p – Area of obstruction

Drag loss of buntons

$$R_D = \cancel{C_d\,\rho s} / \frac{Fa}{As} \quad P_D = C_D \cdot \frac{a}{A} \cdot \frac{\rho v^2}{2} \cdot F$$

$$F = 0.0035\frac{S}{W} + 0.44$$

S – spacing b/w bunton
W – width of ,,

$$P_d = n \times C_d\,\rho v \times \frac{Fa}{As}$$

For multiple bunton

Equivalent orifice (or) Area of regulator

$$= \frac{1.19}{\sqrt{R_R}} \rightarrow Pa \quad (\text{or}) \quad \frac{0.38}{\sqrt{R_R}} \rightarrow \text{mmw.g}$$

R_R – resistance of regulator

Find density mixing of 2 gases

$$\rho_L = \frac{(Q_1 \cdot \rho_1) + (Q_2 \cdot \rho_2)}{(Q_1 + Q_2)}$$

R. series

$$R = R_1 + R_2 + R_3 \cdots R_n$$

R. parallel

$$\frac{1}{\sqrt{R_p}} = \frac{1}{\sqrt{R_1}} + \frac{1}{\sqrt{R_2}} \cdots$$

leakage of air

$$Q = \sqrt{Q_i \cdot Q_f}$$

Radial velocity

$$u = \frac{Q}{\pi D W}$$

Tangential velocity

$$V = \frac{\pi D N}{60}$$

centrifugal force

$$\frac{mv^2}{R}$$

Head by CF

$$H = \frac{V^2}{g} - \frac{Vu\cot\theta}{g} \qquad H = \frac{V^2}{g} \qquad H = \frac{V^2}{g} + \frac{Vu\cot\theta}{g}$$

Backward   radial   Forward

Electrical power

$$1\phi \Rightarrow EP = VI \quad , 3\phi \Rightarrow EP = \sqrt{3}\,VI\cos\phi$$

mechanical

$$MP = \frac{2\pi N \cdot \tau}{60} \Rightarrow \omega \times \tau$$

Air power

$$AP = PQ$$

Efficieny

$$\eta = \frac{\text{output}}{\text{Input}} \quad , \quad \frac{AP}{EP}$$

Heat produced

= Input power of fan – output power of fan

Total pressure

TP = velocity pressure + static pr...

$$mgh \qquad \frac{1}{2}\rho v^2 \qquad P = RQ^2$$

Total pressure loss of CF

$$P = P_I + P_S + P_F + P_E$$

Inlet   shock   friction   energy conversion

Hydraulic efficieny $= \dfrac{P\,\text{actual}}{P\,\text{actual} + P\,\text{losses}}$

manometric eff = ,,

volumetric eff = ,,

$$P\,\text{actual} + P\,\text{losses} = P\,\text{theoritical}$$

Fan law $Q \propto N$, $P \propto N^2$, $P_{power} \propto N^3$

$P \propto D^2$, $Q \propto D^3$, Power $\propto D^5$

N - Speed, D - Dia

Specific Speed

$$N_s = \frac{N Q^{1/2}}{60 \cdot P^{3/4}}$$

Black damp

= Excess N_2% + Excess CO_2%

Evasee

height = $8\sqrt{A_1}$

area = $\frac{A_2}{A_1} = \frac{4}{1}$ $A_2 > A_1$, $V_2 > V_1$

pressure recovery of evasee

$$= \frac{1}{2} \times \rho \times (V_1^2 - V_2^2) \times \eta$$

$\eta = \frac{P_s \text{ gained}}{\text{change in } P_v}$

Dilute of firedamp

$$L = 22 \times \frac{r}{\sqrt{f}}$$

L - distance from gas
r - radius of duct
f - resistance coeff.

Density of dry air

$$\rho = \frac{B}{287.1T}$$ (T → Kelvin)

wet air

$$\rho = \frac{B - 0.378e}{287.1T}$$

motive column

$$D\left[\frac{T_u - T_D}{T_u}\right] \text{ (or) } D\left[\frac{\rho_d - \rho_u}{\rho_d}\right]$$

ρ - air density
T - Temp

NVP $NVP = P_1 - P_2 \Rightarrow \rho_D g h - \rho_u g h$

$$NVP = \rho g h = \left[\frac{B}{287.1T}\right] g \left[D\left(\frac{T_u - T_d}{T_u}\right)\right]$$

Total pressure of CF

$$= \left[\frac{1}{2}\rho(u_2^2 - u_1^2)\right] + \left[\frac{1}{2}\rho(V_2^2 - V_1^2)\right] + \left[\frac{1}{2}\rho V_{net_2}^2 - V_{net_1}^2\right]$$

Respiratory Quotient

$$\frac{CO_2 \text{ produced}}{O_2 \text{ consumed}}$$

graham's ratio

$$\frac{CO_2 \text{ produced}}{O_2 \text{ consumed}} \times 100$$

Lower flammability

$$\frac{V_1 + V_2 + V_3}{\frac{V_1}{x_1} + \frac{V_2}{x_2} + \frac{V_3}{x_3}}$$

diff. in Temp

$$\Delta T = \frac{D \times g}{\text{Specific heat}}$$

$\Delta T = T_f - T_i$

Quantity of fresh air

$$= \frac{100q}{(C_p - C_a)} - q$$

Layering index

$$L = \left(\frac{24V^2}{c\sqrt{f}}\right)^{1/3}$$

Heat generated

calorific value of carbon × carbon consumed

Equivalent resistance roadway

R/n^2 → parallel, $n \times R$ → Series

n - no. of roadway

critical pressure of booster :-

$$P_c = \frac{P \times \text{resistance of split of booster fan}}{\text{combined resistance of trunk and shaft}}$$

Shock pressure loss

Total inlet pressure − outlet

b+c gas equ

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

units 1 N = 1 pascal, 1 mm Hg = 133.33 pa

1 mm wg = 9.8 pa, 1 pa = 0.1020 mm wg

Economic dia of shaft

$$D = 2.1\left(\frac{KNQ^3}{YZE}\right)^{1/7}$$

width & Height

$$h = 1.9\left(\frac{KNQ^3}{YZE}\right)^{1/7}$$

pressure of incline tube manometer

$P = L \sin\theta \cdot \rho \cdot x$ L - reading scale in mm

ρ - sp. gravity of liquid

Relative humidity

$RH = 100 - 7(T_D - T_W)$, $T_D > 25°c$

$RH = 100 - 8(T_D - T_W)$, T_D - 20 to 25°c

$RH = 100 - 9(T_D - T_W)$, $T_D < 20°c$

Thermal diffusivity

$\alpha = K/\rho c$

Kata cooling power

$$= \frac{\text{Kata factor}}{\text{Time req. for temp to reduce from 38°c to 35°c}}$$

units $P = F/A$, cube a^3, cuboid lbh, Sphere $4/3\pi r^3$

cone $\frac{1}{3}\pi r^2 h$, cylinder $\pi r^2 h$

simpson $\frac{1}{3}$rd rule

$$A = \frac{d}{3}\{(1^{st} + last) + 4(even) + 2(odd)\}$$

Method factor

~~Vavg~~ Vavg velocity = MF × velocity at centre

graham's ratio

$$\frac{CO_{final} - CO_i}{0.265 N_{2f} - O_{2f}} \times 100$$

Mine - Enviroment

Acoustic (or)

① Sound pressure level (L_p)

$$L_p = 20 \log (P/P_0), dB$$

P - pressure in pa, P_0 - constant (2×10^{-5}).pa

② Sound power level (L_W)

$$L_W = 10 \log (W/W_0), dB$$

W - power in W, $W_0 = 10^{-12}$, W

③ Sound intensity level (L_i)

$$L_i = 10 \log (I/I_0), dB$$

I - Intensity, $I_0 = 10^{-12}$, W/m^2

④ Equivalent noise level

$$L_{eq} = 10 \log \left[(t_1 \times 10^{Lp1/10}) + (t_2 \times 10^{Lp2/10}) + \dots + (t_n \times 10^{Lpn/10}) \right], dBA$$

t - Fraction of Time

⑤ Day-night equivalent noise

$$L_{dn} = 10 \log \left[\left(\left(\frac{15}{24}\right)\left(\frac{1}{n_d}\right)\left(10^{Ld/10}\right) \right) + \left(\left(\frac{9}{24}\right)\left(\frac{1}{n_n}\right)\left(10^{Ln+10/10}\right) \right) \right]$$

Ld - Avg. Noise level day, Ln - Avg noise level night

⑥ Speed of wave (or) Sound

$$V = f \times \lambda$$

V - speed of sound m/s

f - frequency, Hz

λ - wavelength, m

⑦ Bandwidth

$$\text{Bandwidth} = f_u - f_L$$

central frequency

$$= \sqrt{f_L \times f_u}$$

⑧ Frequency spectrum Recursive relation

$$\frac{f_u}{f_L} = 2^K$$

$\frac{1}{1}$ octave band K = 1

$\frac{1}{3}$ octave band K = $\frac{1}{3}$

∴ f_u - freq. upper

∴ f_L - freq. Lower

⑦ Relation b/w Sound pressure & power level (S.P. source)

$$L_p = L_w - 20 \log(r) - 11, dB$$

r - radial distance, from source, m

⑧ Relation b/w Sound power & sound Intensity (single point source)

$$L_w = L_i + 20 \log (r) + 11, dB$$

⑨ Sound pressure at different point (S.P. source, eg. Jackhammer)

$$L_{p1} - L_{p2} = 20 \left[\log(r_2) - \log(r_1) \right], dB$$

r_1, r_2 - radial distance, Lp - sound pressure from r_1, r_2

⑩ Sound pressure at diff. points (Line source, eg. conveyor)

$$L_{p1} - L_{p2} = 10 \left[\log(r_2) - \log(r_1) \right], dB$$

⑪ Biological oxygen demand at any time

$$BOD_t = BOD_L \times (1 - e^{-Kt}), (mg/L)$$

BOD_L - ultimate BOD (mg/L), t - time in days

K - constant

⑫ Total Suspended Solids

$$TSS = (A - B)/C, (\mu g/m^3)$$

A - weight of filter with solid

B - weight of filter, C - vol. of sample filtered (m^3)

⑬ BOD at any time

$$BOD_t = [\text{Initial DO} - \text{final DO}] \times [\text{Diluted vol}/\text{sample vol}], (mg/L)$$

DO - Dissolved oxygen

⑭ Stokes settling velocity

$$U = g d^2 \frac{[(\text{density of water} - \text{Density of air})}{(18 \times \text{viscosity})}, m/s$$

d - dia of particle (m), g - acceleration

(15) Illumination of Surface

= candela of source × $(\cos\theta / d^2)$

, lux

θ - angle b/w surface + direction of light rays

d - distance from source, m

(16) BOD of mixture

$$BOD_m = \left[(C_1V_1) + (C_2V_2) / (V_1 + V_2)\right] \text{ (mg/L)}$$

C_1, C_2 - BOD of sol.

V_1, V_2 - vol. of sol.

(17) Surface area covered by beam

$$S = 2\pi(1 - \cos\theta)R^2$$

θ - Beam angle , R - distance

(18) Initial oxygen deficit of mixture

= Saturated value of oxygen in mixture − BOD of mixture

(19) TWA and Dose %

$$TWA = 16.61 \times \log\left(\frac{D}{100}\right) + 90$$

$$\text{Dose (D)} = \left[\frac{C_1}{T_1} + \frac{C_2}{T_2}\right] \times 100\ \%$$

$$T = \frac{8}{2^{\left(\frac{L-90}{5}\right)}}$$

C - time

L - sound, dB

Mine Surveying

① correction factor of incorrect chain

$$CF = \frac{L \pm L'}{L}$$

L - True length
L' - Incorrect "

② correction of absolute length

$$Ca = \frac{l \times c}{L}$$

Actual length $= L \pm Ca$

③ correction for Temp.

$$C_t = \alpha (T_m - T_0) L$$

Actual length $= L \pm C_t$

④ correction of sag

$$C_s = \frac{L(M \times g)^2}{24 \times P^2}$$

Actual length $= L - C_s$

⑤ correction of pull

$$Cp = \frac{(P - P_0) L}{AE}$$

Actual length $= L + Cp$

⑥ representative factor (or) scale

$$RF = \frac{\text{Map distance}}{\text{ground distance}}$$

⑦ To find True lengths

$$L \times l = L' \times l'$$

⑧ Error in measured length

$$= \text{Error in length of tape} \times \sqrt{\frac{l'}{L}}$$

⑨ True length

$$A = \left(\frac{L'}{L}\right)^2 \times A'$$

True volume

$$V = \left(\frac{L_1}{L}\right)^3 \times V'$$

⑩ Slope correction factor

$$= \frac{h^2}{2L}$$

Horizontal distance $= L - SCF$

⑪ SCF when angle given

$$SCF = L(1 - \cos\theta)$$

Horizontal distance $= L \times \cos\theta$

⑫ RF when area given

$$= \frac{\sqrt{\text{plotted area}}}{\sqrt{\text{Actual area}}}$$

Length of arc / curve

$$= r \times \theta$$

θ - in radian
r - radius

⑬ Fore bearing & back bearing

$F \cdot B > 180°$

$F \cdot B = B \cdot B + 180°$

$F \cdot B < 180°$

$F \cdot B = B \cdot B - 180°$

⑭ WCB to QB

$0° - 90° \Rightarrow WCB = QB$

$90° - 180° \Rightarrow 180 - QB$

$180° - 270° \Rightarrow 180 + QB$

$270° - 360° \Rightarrow 360 - QB$

QB to WCB

$QB = WCB$

$180° - WCB$

$WCB - 180°$

$360° - WCB$

⑮ Magnifying power (P)

$$= \frac{\text{size of object}}{\text{size of image}} = \frac{CD}{C_1 D_1} = \frac{f_1}{f_2}$$

f_1 = distance b/w lens & object (CD)
f_2 = " " lens & image ($C_1 D_1$)
f - focal length

Relation among $f_1, f_2, f \Rightarrow \frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$

⑰ Errors in theodolite

linear error

$$= \frac{P}{1000} \times \sqrt{1 + \frac{e^2 N}{12}}$$

P - perimeter, N - No. of side
e = 1

Angular error

$$= L \times \sqrt{n}$$

L - least count
(20 - 1)

⑱ True bearing

$$= \text{magnetic bearing} \pm \text{declination}$$

W - Sub
E - Add

⑲ Latitude & departure

latitude $= \Sigma L \cos\theta$, departure $= \Sigma L \sin\theta$

$$\text{closing error (or) Length} = \sqrt{(\Sigma L \cos\theta)^2 + (\Sigma L \sin\theta)^2}$$

$$\text{Reduced bearing} = \tan^{-1}\left(\frac{\text{Departure}}{\text{Latitude}}\right)$$

(20) Angle b/w two line

= larger angle _ Smaller angle

Relation b/w angles & linear measurement

$\Delta L = L \times \tan \Delta \theta$

(21) Reciprocal levelling

points

$$d = \frac{(b_1 - a_1) + (b_2 - a_2)}{2}$$

error

$$e = \frac{(b_1 - a_1) - (b_2 - a_2)}{2}$$

(22) correction of curvature And refraction

$$C_c = \frac{D^2}{2R} \qquad C_R = \frac{D^2}{14R}$$

R - Radius of earth

D - Distance in km

C_c - also in km

(23) combined curvature

$$C_{CR} = \frac{6D^2}{14R}$$

degree to hours

$1^\circ = \frac{1}{15}$ min/hr/sec

(24) gradient of line

$$\theta = \tan^{-1}\left(\frac{\text{vertical distance}}{\text{Horizontal "}}\right)$$

Height diff. b/w two points

$= S_2 - S_1$

upper Intercept - Lower

(25) Horizontal & vertical dist. of Tacheometric Survey

Case 1

Line of sight horizontal & staff vertical

Horizontal dist. = $KS + C$ $\qquad \therefore S = S_2 - S_1$

Reduced level = $H - S_3$ $\qquad$ H - Height of Instrument

case 2

Line of sight inclined to horizontal & Staff vertical

$H.D = KS(\cos\theta)^2 + C\cos\theta$

$V.D = KS\cos\theta\sin\theta + C\sin\theta$

Reduced. Level = $H + V - S_3$ → middle Intercept

H - Height of Instrument. V - Vertical D

case 3

" " " " staff normal to line of sight

$H.D = KS\cos\theta + C\cos\theta + S_3\sin\theta$

$V.D = KS\cos\theta\sin\theta + C\sin\theta$

Reduced level = $H + V - S_3\sin\theta$

(26) Aerial photography

Scale

$$\text{Scale (s)} = \frac{f}{H-h}$$

f - focal length, m

H - Height of flying, m

h - average elevation, m

Relief displacement

$$R = \frac{rh}{H}$$

r - distance of principle point

(27) Simple curve

Tangent length

$= R\tan\frac{\theta}{2}$

R - radius, θ - Angle

chord length

$= 2R\sin\frac{\theta}{2}$

(28) Reduced length of Staff Station

= RL of Bench Mark + B.S + F.S.

(29) No. of photographs required

$$= \frac{A_g}{A_P} \qquad A_P = L_g \times W_g$$

$$L_g = \frac{L_P(1 - O_L)}{S}, \quad W_g = \frac{W_P(1 - O_S)}{S}$$

A_P - area of photograph

A_g - area we need to photographed

L_g - length of ground distance, W_g - width

L_P - length of photograph, W_P - width

O_L - longitudinal overlap, O_s - side overlap

S - scale of photograph

(30) Area of irregular plot in traverse Survey

Area = $\frac{1}{2}\sum(a+b)(R)$

(31) Interval b/w exposure

Time interval = $\frac{L_g \times 3600}{V}$

V - speed of plane km/hr

L_g - distance

(32) Distortion due to height (or) relief

$$= \frac{h}{H-h} \times P_c = \frac{h}{H} \times P_b$$

(33) conditions of levelling

$\Sigma BS - \Sigma FS = \Sigma \text{Rise} - \Sigma \text{fall} = \Sigma RL$ of last point $- \Sigma RL$ of first point

Mine Machinery

① gear ratio

$$= \frac{\text{Number of teeth on driven gear}}{\text{No. of teeth on drive gear}}$$

② velocity

= pitch circle circumference x RPM

③ Mass of Rope

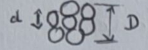
$K \times d^2$

d - in cms

strength of rope

$S \times d^2$

④ Space factor



$$SF = \frac{7 \times d^2}{D^2} \Rightarrow \frac{7 \times \pi \times \left(\frac{d}{2}\right)^2}{\pi \times \left(\frac{D}{2}\right)^2}$$

⑤ pressure to head conversion

$$\text{Head} = \frac{\text{pressure (psi)} \times 231}{\text{specific gravity}}$$

⑥ Head to pressure

$$\text{pressure} = \underset{\text{density of water}}{\rho}\, g\, \underset{\text{head in meter}}{h}$$

Quantity

$$\underset{m^3/s}{Q} = \underset{m^2}{A} \times \underset{m/s}{V}$$

⑦ Speed or velocity

$$= \frac{\pi D N}{60}$$

D - dia N - speed

angular velocity

$$= \frac{2\pi N}{60}$$

⑧ Module of gear system

$$\text{Module} = \frac{\text{Diameter (d)}}{\text{No. of teeth (t)}}$$

⑨ Speed of vechicle

D - dia of wheel
N - RPM

$$\text{speed} = \frac{\pi D N}{\text{gear ratio}}$$

⑩ Torque

τ = Force x radius

power

P = Force x Speed (or) Velocity

⑪ Kinetic energy

$$= \frac{1}{2} m v^2$$

m - mass
v - speed, velocity

potential energy

$$= mgh$$

h - height

⑫ FOS of rope breakage

$$FOS = \frac{\text{breaking force}}{\text{Resistive force}}$$

⑬ FOS of cage

$$FOS = \frac{\text{strength}}{\text{Load}}$$

FOS of rope

$$FOS = \frac{T.\text{ strength} \times \text{Area} \times \text{Space factor}}{\text{Load}}$$

⑭ Drage force

$$= C_d \times A \times \frac{1}{2} \rho v^2$$

Cd - coeff., A - area, v - velocity of air, ρ - air

⑮ wrap factor

$$= e^{\mu\theta}$$

θ - radian

Ratio of weight & Tension

$$\frac{W_1}{W_2} = e^{\mu\theta} \qquad \frac{T_1}{T_2} = e^{\mu\theta}$$

⑯ Energy consumed winder

$$= \frac{mgh}{\eta}$$

$$\eta = \frac{\overset{mgh}{\text{output}}}{\text{Input}}$$

⑰ Tractive effort (or) Force

$= \mu \times W$
$= \mu \times mg$

μ - coeff., W - weight of loco

⑱ Draw bar pull

= Tractive force - Rolling resistance

power = Force x Speed

power = Drawbar pull x Speed

power = (μmg - rolling resistance) x speed

⑲ Drawbar pull ⇒ Force

Force = Mass x Accerlation

power = Force x Speed

⑳ power

$$\text{power} = \tau \times \omega \qquad \therefore \omega = \frac{2\pi N}{60}$$

㉑ Transpartation of belt conveyor

$$T = \underset{\text{area}}{a}\,\underset{\text{bulk density}}{b}\,\underset{\text{velocity (or) speed}}{v}$$

(22) pump input (or) Brake horsepower

$$BHP = \frac{Q \times H_T \times sp.g}{3960 \times efficiency}$$

Q - capacity in gallons/min
H_T = total differential head, ft
η - pump eff. in %

(23) pump output (or) water horsepower

$$WHP = \frac{Q \times H_T \times sp.g}{3960}$$

sp.g - sp. gravity of liq.

(24) Total differential head

$H_T = H_d + H_s$ (with suction lift)

$H_T = H_d - H_s$ (with suction head)

(25) Total suction head (H_s)

$$H_s = h_p + h_s + h_v - h_f$$

hp - pressure head, hs - static, hv - velocity, hf - friction

(26) Total discharge head (H_d)

$$H_d = h_p + \underset{\text{suction}}{h_s} + \underset{\text{velocity}}{h_v} + \underset{\text{friction}}{h_f}$$

hp - discharge pressure head

(27) capacity, Q

$$\frac{Q_1}{Q_2} = \frac{D_1}{D_2}$$

$$\frac{Q_1}{Q_2} = \frac{N_1}{N_2}$$

Head, H

$$\frac{H_1}{H_2} = \frac{D^2}{D^2}$$

$$\frac{H_1}{H_2} = \frac{N^2}{N^2}$$

Affinity Law

BHP

$$\frac{BHP_1}{BHP_2} = \frac{D^3}{D^3} \qquad \frac{BHP}{BHP} = \frac{N^3}{N^3}$$

(28) super elevation

$$= \frac{W v^2}{g R}$$

[on railways]

W - Track width/guage
v - velocity / Turning speed
R - Turning radius

(29) centrifugal ratio

$$= \frac{v^2}{gR} \quad \text{[on road]}$$

centrifugal ratio = centrifugal force/weight of vechicle

(30) Angle of smaller & larger pulley

$$\theta = \tan^{-1}\left(\frac{r_1 - r_2}{D}\right)$$

Smaller pulley $= 180 - 2\theta$

larger pulley $= 180 + 2\theta$

(31) RMS torque

$$\tau = \sqrt{\frac{\Sigma \tau^2 \times t}{\Sigma t}}$$

τ - Torque
t - time

(32) power to move material up

power required (or) work done $= mgh$

m - mass, h - height

(33) centre to centre distance

$$\frac{dia_1 + dia_2}{2} \quad \text{(or)} \quad \frac{(N_1 + N_2) m}{2}$$

N - teeth, m - module

(34) Force Required

F = friction x weigh

$\therefore F = \mu \times R$

(35) Quantity

$Q = V \times A$

$$V = \frac{Q}{A}$$

$$V = \frac{Q}{\frac{\pi D^2}{4}}$$

Theoretical head

$$\frac{v^2}{g} \times \eta$$

$$\therefore v = \frac{\pi D N}{60}$$

Input power

$$IP = \frac{P \times Q}{\eta}$$

(37) weight

$W = m \times g$

Rolling Resistance on upward gradient

Draw bar pull on level ground $- mg \sin\theta$

Mine System Engineering

① Expected duration

$$t_e = \frac{t_o + 4t_m + t_p}{6} \qquad \text{std. dev. } \cancel{\sigma = \frac{t_p - t_o}{2}}$$

② variance

$$\sigma^2 = \left(\frac{t_p - t_o}{6}\right)^2$$

std. deviation

$$SD\ (\sigma) = \sqrt{(\Sigma \sigma^2)}$$

③ probability of project completing

$$D = \frac{T_s - T_c}{\sigma}$$

T_s - scheduled time
T_c - critical path time
σ - std. dev in critical path
D - std. normal variable

④ utilization factor (or) busy (or) traffic Intensity

$$\rho = \frac{\lambda}{\mu}$$

Idle time

$$= 1 - \frac{\lambda}{\mu} \text{ (or) } 1 - \rho$$

λ - arrival rate, μ - service rate, ρ - server in busy

⑤ waiting time system and queue

$$= \frac{1}{\mu - \lambda} \qquad = \frac{\lambda}{\mu(\mu - \lambda)} \text{ (or) } \frac{\rho}{\mu - \lambda}$$

⑥ Length of system and queue

$$= \frac{\lambda}{\mu - \lambda} \text{ (or) } \frac{\rho}{1 - \rho} \qquad = \frac{\lambda^2}{\mu(\mu - \lambda)} \text{ (or) } \frac{\rho^2}{(1 - \rho)}$$

⑦ probability in expo. distribution

$$(P) = e^{-t/m} \text{ (or) } P = e^{-\lambda t}$$

⑧ Reliability of system in series

$$R_s = e^{-(\lambda_1 + \lambda_2 + \cdots \lambda_n)t}$$

λ - failure rate

⑨ Availability

$$= \frac{MTTF}{MTTF + MTTR} \times 100\%$$

(or)

$$= \frac{\text{Repair rate } (\mu)}{\text{Repair rate } (\mu) + \text{Failure rate } (\lambda)} \times 100\%$$

⑩ probability of more than K

$$\rho_K = \left(\frac{\lambda}{\mu}\right)^{K+1}$$

⑪ utilization of equipment

$$\eta = \frac{t_a}{t_w - t_m} \times 100\%$$

⑫ propability in series & parallel

$$= R_1 \times R_2 \times R_3$$

$$= 1 - [(1 - R_1) \times (1 - R_2) \times \cdots \times (1 - R_n)]$$

⑬ variance of failure time

$$= \frac{1}{\lambda^2} \qquad \text{mean time} = \frac{1}{\lambda}$$

⑭ Modified distribution Method (MODI)

$$C_{ij} = u_i + v_j, \quad \Delta_{ij} = C_{ij} - u_i - v_j$$

⑰ Float / slack of a activity

Float = LFT − EFT (or) LST − EST

⑱ Mean time b/w failure (MTBF)

$$MTBF = \frac{\Sigma \text{ operating time}}{\Sigma \text{ No. of failure}}$$

$$MTTR = \frac{\Sigma \text{ Maintanre Times}}{\Sigma \text{ No. of repairs}}$$

$$MTTF = MTBF - MTTR$$

⑲ Actual working hours

= Available hr. − Idle time

⑳ cost slope

$$\text{cost slope} = \frac{C_c - N_c}{N_T - C_T}$$

C_c - crash cost
N_c - Normal cost
N_T - Normal Time
C_T - crash Time

Mine Economics

① Future value of single payement

$$FV = PV(1+i)^n$$

② Effective rate of Return

Annual — half — quarterly

$$= \left[(1+i)^n - 1\right]\times 100 \quad = \left[\left(1+\frac{i}{2}\right)^{2n} - 1\right]\times 100 \quad = \left[\left(1+\frac{i}{4}\right)^{4n} - 1\right]\times 100$$

③ Future value Annuity given

$$FV = A\left[\frac{(1+i)^n - 1}{i}\right]$$

i - Rate of interest

A - Annuity / Annual payement

④ present value Annuity given

$$PV = A\left[\frac{(1+i)^n - 1}{i(1+i)^n}\right]$$

⑤ Net present value (NPV)

$$= \left[\frac{CF_1}{(1+i)} + \frac{CF_2}{(1+i)^2} + \dots \frac{CF_n}{(1+i)^n}\right] - CF_0$$

+ve value we use, -ve value we dont

⑥ Internal rate of return

i_1 - discount rate

i - rate of return

$$NPV = 0$$

If ~~IRR~~ $i_1 > i$ → we dont use

If ~~IRR~~ $i_1 < i$ → we use

⑦ Benefit cost ratio (or) profitability Index

$$PI = \frac{\frac{CF_1}{(1+i)} + \frac{CF_2}{(1+i)^2} + \frac{CF_3}{(1+i)^3} \dots \frac{CF_n}{(1+i)^n}}{CF_0}$$

$$= \frac{\text{Sum of cash inflow}}{\text{Sum of cash outflow}}$$

∴ $PI > 1$ → ✓

∴ $PI < 1$ → ✗

⑧ payback period

$$= \frac{Ci}{\text{Net cash flow per year}}$$

Ci - Invested amount

Net cash flow per year = (Revenue - expenditure on same year)

⑨ Accounting rate of return (or) Average

$$= \frac{\text{Average cas flow per year}}{Ci} \times 100$$

⑩ Hoskold's method — Morkell's method

$$PV = \left[\frac{A}{\frac{r}{(1+r)^n - 1} + r'}\right] \quad = \left[\frac{A}{\frac{r}{(1+r)^n - 1} + r}\right]$$

A - annual return, r' - risk rate, r - safe rate

⑪ Annual capital cast recovery

$$= \frac{(Ci - C_s)\, i \times (1+i)^n}{(1+i)^n - 1}$$

C_s - salvage value

$(1+i)^n$ - no. of years

Ci - Initial Invest

⑫ Depriciation calculation

1, Straight line method

$$D = \frac{Ci - C_s}{n}, \quad BV = Ci - m\left(\frac{Ci - C_s}{n}\right)$$

(m - certain years)

2, Declining balance (or) written down method

$$D_m = a(1-a)^{m-1} \times P, \quad BV_m = (1-a)^m \times P$$

3, Sum of year digit method

$$D_m = (Ci - C_s)\left[\frac{n-m+1}{\left(\frac{n(n+1)}{2}\right)}\right]$$

P - Initial cost

m - m^{th} year

a - depreciation rate

Bv - Book value

⑬ Depletion

~~Depletion of m^{th} year = No. of unit~~

$$\text{Depletion of } m^{th} \text{ year} = \frac{\text{No. of unit sold in } m^{th} \text{ year}}{\text{No. of unit in property at } m^{th} \text{ year}} \times \text{cost of property}$$

⑭ profit

= Selling price - Fixed cost - variable cost

(15) Amortization

$$= \frac{\text{Value of property}}{\text{life of property}}$$

(16) Expected return

$$= \Sigma \text{ outcome} \times \text{probability}$$

(17) NPV = cash inflow - cash outflow

(or)

NVP = Return - Investment

(18) Break even point

$$(x \times SP) = (x \times VC) + FC$$

x - No. of unit , SP - Selling price
VC - variable cost , FC - Fixed cost

(19) profit = Selling price - production cost

Loss = production cost - Selling price

(20) Margin of Safety

= Selling price - Break even price

(21) Depletion Allowance (DA)

1st year

$$DA = \frac{\text{Total investment} \times \text{Sold for First year}}{\text{Total recoverable reserve}}$$

2nd year

$$DA = \frac{\text{Investment of } 2^{nd} \text{ year} \times \text{Sold for } 2^{nd} \text{ year}}{\text{Remaining (or) Revaluated reserves}}$$

geostatistics

① **Mean**

$$\mu = \frac{\Sigma x}{n}$$

std. deviation

$$\sigma = \sqrt{\frac{1}{N}(x-\mu)^2}$$

② **coeff. of variation**

$$= \frac{\text{std. deviation}(\sigma)}{\text{Mean}(\mu)} \times 100\%$$

③ **combined mean & std. dev.**

$$\text{C. Mean} = \mu_1 + \mu_2, \quad \text{C. std.} = \sqrt{\text{Variance } 1 + \text{V.. } 2}$$

④ **Variance**

$$= (\text{std. deviation})^2$$

poisson

$$p(x) = \frac{e^{-\lambda} \cdot \lambda^x}{x!}$$

$$\therefore \lambda = n \times p$$

⑤ **confidence level**

68%	95%	99%
$Q = \mu \pm \frac{\sigma}{\sqrt{n}}$	$= \mu \pm 2\frac{\sigma}{\sqrt{n}}$	$= \mu \pm 3\frac{\sigma}{\sqrt{n}}$

⑥ **relation of mean, mode & median**

$$\text{Mode} = \text{Mean} - 3(\text{Mean} - \text{median})$$

⑦ **cumulative distribution function** (CDF)

$$f(x) = \int_{-\infty}^{x} f(x)\,dx$$

⑧ **Expectation (or) Average (or) Mean**

$$= \int_{-\infty}^{\infty} x \cdot f(x)\,dx$$

⑨ **variance of x**

$$\therefore Ex^2 = \int_{-\infty}^{\infty} x^2 \cdot f(x)\,dx$$

$$= E(x^2) - (Ex)^2$$

⑩ **probability Density function (PDF)**

$$P(x) = \int_{-\infty}^{\infty} f(x)\,dx$$

⑪ **probability of success or failure**

$$p + q = 1$$

p - success
q - failure

⑫ **variance of random variable**

$$Cx = c^2 \operatorname{var}(x)$$

⑬ **Rank of correlation (R)**

$$= 1 - \frac{6\Sigma d^2}{n^3 - n}$$

n - no. of character
d - difference of two Judge

⑭ **coefficient of skewness**

$$= \frac{\text{Mean} - \text{Mode}}{\text{S.D}}$$

Expectation

$$E(x^3) = \left(\frac{x+y}{2}\right)^3$$

⑮ **probability in series & parallel**

series

$$= p(x) + p(y)$$

parallel

$$= 1 - [(1-p(x)) \times (1-p(y))]$$

⑯ **Theory of probability**

(not mutually exclusive)

★ $P(A \cup B) = P(A) + P(B) - P(A \cap B)$

★ $P(A \cup B \cup C) = P(A) + P(B) + P(C) - P(AB) - P(BC) - P(AC) + P(ABC)$

★ $P(A \cup B) = P(A) + P(B)$ (mutually exclusive)

⑰ **Exponential distribution**

$$f(x) = \mu e^{-\mu x}$$

μ - avg. length of Interval

$$f(x) = 1 - e^{-\mu x}$$ → cumulative of expo.

⑱ **Avg. grade by Inverse Distance weighing Method**

$$g = \frac{\Sigma \frac{g}{d^2}}{\Sigma \frac{1}{d^2}} \%$$

g - grade
d - distance

Horizontal

⑲ **constant distance weighing method**

horizontal

$$g = \frac{\Sigma \frac{g}{d}}{\frac{1}{d}} \%$$

g - grade
d - distance

⑳ **Amt. of saleable metal**

$$S = (G \times \eta \times w) - L$$

g - grade
η - recovery
w - weight of ore
L - Losses

㉑ **50^{th} percentile**

$$= \frac{\text{cumulative no.}}{2}$$

㉒ **Expo. distribution**

$$\text{Mean} = \frac{1}{\mu} = \lambda, \quad \text{Variance} = \frac{1}{\mu^2}$$

(22) Avg. grade of vertical section

$$g = \frac{\Sigma L \times G}{\Sigma L}$$ L - length, g - grade

(23) Avg. grade in horizontal section

Triangular method

$$g = \frac{g_1 + g_2 + g_3}{3}$$ → with same thickness

$$g = \frac{g_1 t_1 + g_2 t_2 + g_3 t_3}{t_1 + t_2 + t_3}$$ → with diff thickness

$$t = \frac{t_1 + t_2 + t_3}{3}$$ → Avg. thickness

(24) Semi variogram (or) variance

= sill - covariance

(25) Remaining Reserve in percent

$$= \frac{\text{Total reserve} - \text{Total production}}{\text{Total reserve}} \times 100$$

(26) Effective mean grade (Mg) in %

$$= \frac{\text{weight} \times \text{grade of deposite} - \text{weight} \times \text{grade of rejected ore}}{\text{weight of mined ore}} \%$$

(27) Normal distribution (or) gaussian

$$Z = \frac{x - \mu}{\sigma}$$ x - grade, μ - mean, σ - std. D

(30) covariance and correlogram

covariance = sill - semi variogram

$$\text{correlogram} = \frac{\text{covariance}}{\text{sill}}$$

(31) equ. of straight line

$$y = mx + c$$

Mean Assay value (g/t)

$$= \frac{\Sigma(\text{Distance of influence} \times \text{width} \times \text{Assay})}{\Sigma(\text{distance of influence} \times \text{width})}$$

(32) coeff. of determination

$= r^2$ r - correlation co-eff

(33) covariance b/w two variable

$$= \frac{\Sigma(x - \bar{x})(y - \bar{y})}{N}$$ $\bar{x}, \bar{y}$ - mean

(34) Tonnage factor

$$TF = \frac{\text{volume}}{\text{weight}}$$

Density of material

= sp. gravity × density of water (1000 kg/m³)

(35) Avg. grade ore actually mined

$$= \frac{x_1 g_1 + x_2 g_2 + x_3 g_3}{x_1 + x_2 + x_3}$$

g_1, x_1 = ore in place
g_2, x_2 = diluted ore
g_3, x_3 = ore loss
x - Tonnage, g - grade

(36) grouped data

Median

$$= L + \left[\frac{\frac{N}{2} - cf}{f}\right] \times h$$

Mode

$$= L + \left(\frac{f_1 - f_0}{2f_1 - f_0 - f_2}\right) \times h$$

Mean

$$\bar{x} = \frac{\Sigma f(x)}{\Sigma f}$$

variance

$$= \frac{\Sigma f(x - \bar{x})^2}{(\Sigma f) - 1}$$

std. D

$= \sqrt{\text{variance}}$

f - frequency

(37) Mean deviation

$$= \frac{1}{N} \Sigma f / |x - \bar{x}|$$

(38) Baye's Theorem

$$P(A/B) = \frac{P(B/A)\,P(A)}{P(B)}$$