* NAVAL FORMULAS

* FORMULAS :-

HYDROSTATICS :- $(\overset{04}{\cancel{05}}\,Q)$

$$\Rightarrow W = \rho \times g \times A \times \boxed{H}$$

$H = \frac{h}{2}$ for rectangle

$H = \frac{h}{3}$ for triangle

Density of S.W 1025

Density of F.W 1000 kg/m³

$$\Rightarrow M = \rho \times V$$

$$\Rightarrow W = \rho \times g \times \boxed{A} \times \boxed{H}$$

Area for top (L×b)

Area for short side (b×h)

H at top = 0 if head is not given

If head is given, then $H = \text{Head} + \frac{h}{2}$ for short side

SIMPSON'S :- (03 Q)

$$\Rightarrow \text{Displacement } (\Delta) = \boxed{\frac{h}{3}} \times \boxed{\Sigma V} \times \boxed{\rho}$$

~~in 't'~~ in t/m³

Interval

Addition of all product of volume {From simp table}

$$\Rightarrow \text{Change in mean draught} = \frac{\boxed{M} \times 100}{\boxed{A_W}} \left\{ \frac{\rho_s - \rho_F}{\rho_s \times \boxed{\rho_F}} \right\} \text{ in 'cm'}$$

Displacement (t)

Waterplane area

Density of sea water in t/m³

Density of fresh water in t/m³

$$\Rightarrow \text{Water plane area} = \boxed{\frac{h}{3}} \times \Sigma A \times \boxed{2}$$

If in numerical mention 1/2 co-ordinates

$\frac{\text{Length of ship}}{(\text{no of ord} - 1)}$

{In case of 1/2 coordinates don't consider 1/2 take it full only}

$$\Rightarrow \text{Centroid from midship} = h \times \left\{ \frac{\boxed{\Sigma M_A} + \boxed{\Sigma M_F}}{\Sigma A} \right\}$$

---- If this value (-ve) mean centroid is at forward & if (+ve) mean centroid is at aft.

RUDDER :- (02 Q)

$$\Rightarrow \tan\theta = \frac{V^2 \times G - L}{g \times \rho \times GM}$$

NOTE:- V in knots $\Rightarrow \frac{1852}{3600}$ m/s

Where, V = Ship speed in m/s, L = Centre of buoyancy / Lateral resistance,

G = Centre of gravity, ρ = Radius of vessel turn,

GM = Metacentric height, θ = Angle of heel.

PROPELLER :- (03 Q)

$$\Rightarrow \boxed{P} = \tan(\theta) \times 2\pi \boxed{R}$$

Distance from centre of boss

Pitch of propeller

Pitch angle

$$\Rightarrow \boxed{\text{Speed}} = \frac{\boxed{\text{distance}}}{\boxed{\text{time}}}$$

Knots

N·M

hr

------- {FOR RESISTANCE NUMERICAL}

RESISTANCE :- (03 Q)

$$\Rightarrow \frac{\text{Voyage constant } (C_1)}{\text{Voyage constant } (C_2)} = \left(\frac{\Delta_1}{\Delta_2}\right)^{2/3} \times \left(\frac{V_1}{V_2}\right)^2 \times \left(\frac{d_1}{d_2}\right)$$

Where, $C_1 = C_2 =$ Fuel consumption / day in tonnes,

$\Delta_1 = \Delta_2 =$ Displacement in tonnes.

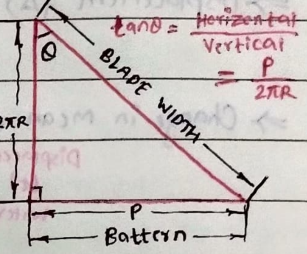
$V_1 = V_2 =$ Speed in knots,

$d_1 = d_2 =$ Distance in N.M.

$$\Rightarrow \frac{C_1}{C_2} = \left(\frac{\Delta_1}{\Delta_2}\right) \times \left(\frac{V_1}{V_2}\right)^{3.8}$$

PROPELLER :-

$$\Rightarrow \text{Blade width} = \frac{\text{Horizontal}}{\sin\theta}$$



$$\tan\theta = \frac{\cancel{\text{Horizontal}}}{\text{Vertical}} = \frac{P}{2\pi R}$$

$$\Rightarrow \text{Block co-efficient} = C_b = \frac{\text{Volume of displacement } (\Delta)}{L \times B \times D \times \rho}$$

Density in 1.025 t/m³

wake fraction

$$\Rightarrow w = 0.5 \times C_b - 0.05$$

Speed of advance in knots

Ship speed in knots

$$\Rightarrow V_a = V(1 - w)$$

Theoretical speed in knots

Real

$$\Rightarrow \text{~~Actual~~ Slip} = \frac{V_T - V_a}{V_T} \times 100.$$

$$\Rightarrow \text{Apparent slip} = \frac{V_T - V}{V_T} \times 100$$

Pitch in M

Propeller revolution in RPM

$$\Rightarrow V_T = \frac{P \times N \times 60}{1852}$$

Pitch ratio

$$\Rightarrow p = \frac{P}{D}$$

Diameter in m.

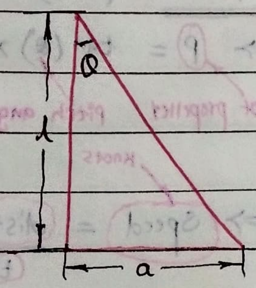
STABILITY :- (02 Q)

Centre of gravity from the Keel

$$\Rightarrow GM = KM - KG$$

Metacentric height

Transverse Metacentre above the Keel



$$\Rightarrow \tan\theta = \frac{a}{\lambda}$$

Deflection of pendulum

Length of pendulum

$$\Rightarrow GM = \frac{m \times d}{\Delta \times \tan\theta}$$

Mass in tonnes

Displacement of ship

Distance of mass transversely moved.

TRIM :- (06 Q)

$$\Rightarrow \text{Increase in draught} = \frac{\mu \times l \times B \times d}{(L - \mu l) \times B}$$

Where, μ = Permeability, l = Length of compartment,
B = Width of Ship/Barge, d = draught of Ship/Barge,
L = Length of Ship/Barge.

$$\Rightarrow \text{Relative density } (R_d) = \frac{\text{Density of oil/substance}}{\text{Density of water}}$$

$$\Rightarrow \text{Change in mean draught} = \frac{\Delta}{A_W} \times 100 \left\{ \frac{\rho_s - \rho_R}{\rho_s \times \rho_R} \right\} \times 1000$$

Density of sea water in t/m

Displacement in (t)

Density of fresh water in t/m³

Waterplane area in m²

$$\Rightarrow \text{Draught } (d) = \frac{M}{\rho \times A}$$

Mass in tonnes.

Area of Barge/Ship.

$$\Rightarrow TPC = \frac{A_W \times \rho}{100}$$

$$\Rightarrow \text{Bodily sinkage} = \frac{M}{TPC} \quad \text{----- in cm.}$$

$$\Rightarrow \text{Load} = W = \rho \times g \times A \times H$$

$H = \frac{H}{2}$ for loads on side & end.

H = H for bottom.

* ELECTRICAL FORMULA'S

* FORMULAS :-

$\Rightarrow \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + R\frac{1}{R_3} + \frac{1}{R_4}$ Resistance in 'Ω'

current

$\Rightarrow I_1 = \frac{V}{R_1}$ in Amps voltage

Reactance in Ω

Impedance

$\Rightarrow X = \sqrt{Z^2 - R^2}$ in ohms. ~~OR~~

Resistance

Inductance in Henries (H)

in Ω

$\Rightarrow L = \frac{X_L}{2\pi f}$ frequency OR $C = \cancel{X_c \times 2\pi f}\ \frac{1}{2\pi f \times X_c}$ in Ω

Capacitance

$\Rightarrow Z = \frac{V}{I}$ in Ω OR $Z = \sqrt{R^2 + (X_L - X_c)^2}$

Capacitive reactance

Inductive reactance

shunt resistor

$\Rightarrow R_{sh} = \frac{V}{I_{sh}\{I - I_m\}}$ coil current

shunt current

Power factor

$\Rightarrow \cos\phi = \frac{R}{Z}$ Impedance

$\Rightarrow P = V \times I \times \cos\phi$

Power dissipation in 'W'
{Also known as Active power}

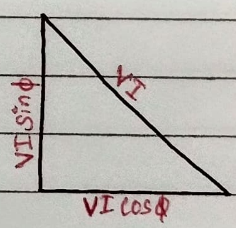
$\Rightarrow P = V \times I \times \sin\phi$

Reactive power in 'W'

$\Rightarrow P = V \times I$ Apparent power in 'W'

NOTE :- S.I unit
Capacitor :- 'F'
Inductor :- 'H'
Impedance :- Ω
Resistor :- Ω
Reactance :- Ω

NOTE :-
$\cos\phi$:- Power factor
ϕ :- Phase angle



⇒ FOR SHUNT MOTOR :-

Flux

Armature current

$\Rightarrow T \propto \phi I_a \ / \ \phi_1 I_{a_1} = \phi_2 I_{a_2}$

Torque

Emf

$\Rightarrow E \propto \phi N \ / \ \frac{E_{b_1}}{E_{b_2}} = \frac{N_1}{N_2}$ Motor speed ----- $\phi_2 = \phi_1$ if not given in ques.

Back Emf in 'V'

$\Rightarrow E_b = V_L - I_a . R_a$ Armature resistance

Line or Terminal voltage

NOTE :-
{consume}
EMF is induced in motor
{produce}
EMF is generate in Generator

⇒ FOR SHUNT GENERATOR :-

$\Rightarrow V_L = I_{sh} \times R_{sh}$ Shunt resistance

Shunt current

Line current

$\Rightarrow I_a = I_L + I_{sh}$

Generated Emf

$\Rightarrow E_g = V_L + I_a . R_a$

$\Rightarrow P = V_L \times I_L \,/\, E_g \times I_a$ in 'KW'

Q7} FEB-24

$\Rightarrow$ **FOR BATTERY :-**

No of cell

$\Rightarrow R_{int} = \cancel{R_{min}} \times n$

Rint

TOTAL INTERNAL RESISTANCE IN 'Ω'

Internal resistance ~~Minimum Voltage~~ (given in Q)

$\Rightarrow I_{max} = \frac{Capacity}{Rate}$

MAX ALLOWABLE CURRENT IN 'A'

$\Rightarrow Max\ V = V_{max} \times n$ | $\Rightarrow Min\ V = V_{min} \times n$

$\Rightarrow \cancel{V_{max}}\ V_{charging} = V_{max} + I_{max} \times \boxed{R_{max} = R_{int}}$

Voltage across battery

Given in question

$\Rightarrow V_{resistance} = V_{sup} - V_{charging}$

VOLTAGE DROP

in Ω

$\therefore R = \frac{V_{resistance}}{I_{max}}$

$\Rightarrow$ Q8} b] MAR-24 :-

$\Rightarrow E = \frac{\phi Z N P}{60}$ in V/ conductor.

$\times 10^{-3}$

$\Rightarrow$ Q8} b] May 2-24 :-

Given in Q

$\Rightarrow R_{hot} = \frac{V}{I}$

Resistance

Temperature coefficient

$\Rightarrow R_{hot} = R_0 (1 + \alpha \times T)$

2000°c

20°c

$\Rightarrow R_{20} = R_0 (1 + \alpha \times T)$

$\Rightarrow I = \frac{V}{R_{20}}$

~~MAY-24~~ MAY2-24

Q9}

$\Rightarrow E_b = V_{avg} \times n$

no of cell

$\Rightarrow R_{int} = R_{int} \times n$

$\Rightarrow R =$ total resistance + R_{int}

TOTAL RESISTANCE

Find current.

$\Rightarrow E_b = V - I R$

$\Rightarrow$ Q5} b] Jan-24 :-

$\Rightarrow F = N \times I$ in A-turns

Magnetomotive force

$\Rightarrow H = \frac{F}{l}$ in A-turns/m

Magnetising force

Mean circumference in 'm'.

$4 \times \pi \times 10^{-7}$ {std value}

$\Rightarrow B = \mu_0 \times H$

Flux density in ↑ (tesla)

$\Rightarrow \phi = B \times A$

Area {Given in Q}

Flux in Webers (Wb)

$\Rightarrow$ Q8} APR 2-24 :-

Diameter ~~{given in Q}~~

$\Rightarrow$ Mean circumference $= \pi \times d$

Rest numerical is same as above ↑↑↑