CIVIL

Kinematics

* $v = \frac{dx}{dt}$ $\quad a = \frac{dv}{dt}$ $\quad a_{avg.} = \frac{\Delta v}{\Delta t}$

$v_{Avg.} = \frac{(v_1 + v_2 + v_3 + \cdots + v_n)}{n}$ $\quad v_{ins.} = \frac{\Delta x}{\Delta t}$ $t \to 0$

* $v = u + at$ $\quad v = u + gt$

$v^2 - u^2 = 2as$ $\quad v^2 - u^2 = 2gh$

$s = ut + \frac{1}{2}at^2$ $\quad h = ut + \frac{1}{2}gt^2$ $\quad g = 9.81\ m/s^2$

* $s = vt$

* slope of s-t graph gives velocity
  here, s = displacement

  Area under v-t graph gives distance

* Time of flight $(T) = \frac{2u\sin\theta}{g}$

  Horizontal Range $(R) = \frac{u^2 \sin 2\theta}{g}$

  Vertical height$_{max.}$ $(H_{max.}) = \frac{u^2 \sin^2\theta}{2g}$

* $u_x = u\cos\theta$ $\quad u_y = u\sin\theta$ (projectile)

* R = resultant velocity $= \sqrt{u^2 + v^2}$

$\theta = \tan^{-1}\left(\frac{v}{u}\right)$

Centroid & Moment Of Inertia

* $\bar{x} = \frac{\Sigma ax}{\Sigma a}$ $\quad \bar{y} = \frac{\Sigma ay}{\Sigma a}$

*

Figure	Area	$\bar{x}$	$\bar{y}$	G
Rectangle	b.d (breadth × length)	$d/2$	$b/2$	$(d/2, b/2)$
Rt. Triangle	$bh/2$ (base × ht./2)	$b/3$ (from base)	$h/3$	$(b/3, h/3)$

Semicircle	$\pi r^2/2$	0 (on y-axis)	$4r/3\pi$	$\left(0, \frac{4r}{3\pi}\right)$
Quarter circle	$\frac{\pi r^2}{4}$	$\frac{4r}{3\pi}$	$4r/3\pi$	$\left(\frac{4r}{3\pi}, \frac{4r}{3\pi}\right)$
Sector of a circle	$R^2\alpha$	$\frac{2R}{3\alpha}\sin\alpha$ (on x-axis)	0	$\left(\frac{2R\sin\alpha}{3\alpha}, 0\right)$
Parabola	$4ah/3$	0	$3h/5$	$(0, 3h/5)$
Semiparabola	$2ah/3$	$3a/8$	$3h/5$	$(3a/8, 3h/5)$
Parabolic Spandrel	$ah/3$	$3a/4$	$3h/10$	$(3a/4, 3h/10)$

* Radius of Gyration :- $k_x = \sqrt{\frac{I_x}{A}}$

$$k_y = \sqrt{\frac{I_y}{A}}$$

* Parallel Axis Theorem → $I_0 = \bar{I}_c + Ad^2$

$\bar{I}_c$ → moment of area about Centroidal axis

Ad^2 → Product of area & sq. of dist b/w the 2 axes

Perpendicular Axis Theorem → $I_{zz} = I_{xx} + I_{yy}$

EQUILIBRIUM OF FORCES AND FRICTION

* Lami's Theorem → $\frac{P}{\sin\alpha} = \frac{Q}{\sin\beta} = \frac{R}{\sin\gamma}$ = constant

* $\mu = \frac{f}{N}$ $\mu = \tan\alpha = \tan\phi$

  α = angle of limiting friction
  ϕ = angle of repose

* In all sums find ΣH ΣV, R, θ & ΣM. Also find $\bar{x}$, $\bar{y}$. → $\bar{x} = \frac{\Sigma M_o}{\Sigma F_x}$ $\bar{y} = \frac{\Sigma M_o}{\Sigma F_y}$

  (common for all)

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ANALYSIS OF FORCE SYSTEMS

* $\Sigma F_x = f_{x_1} + f_{x_2} + f_{x_3} \cdots \cdots = \Sigma H$

$\Sigma F_y = f_{y_1} + f_{y_2} + f_{y_3} \cdots \cdots = \Sigma V$

$R = \sqrt{(\Sigma F_x)^2 + (\Sigma F_y)^2} = \sqrt{(\Sigma H)^2 + (\Sigma V)^2}$

* $\alpha = \tan^{-1}\left(\frac{\Sigma V}{\Sigma H}\right)$

* Moment = Force x ⊥r. dist.

$M_0 = (F \times d_1) + (F \times d_2) + \cdots$

* Varignon's principle

* Moment arm = $d = \left|\frac{\Sigma M_0}{R}\right|$

ENGINEERING MECHANICS

* $F = ma$

* parallelogram law $\longrightarrow$ $R = \sqrt{F_1^2 + F_2^2 + 2F_1F_2\cos\theta}$

$$\alpha = \tan^{-1}\left(\frac{F_2 \sin\theta}{F_1 + F_2\cos\theta}\right)$$

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